

Coal Combustion Byproducts

1. The accumulation of boron in *Agropyron elongatum* grown in coal fly ash and sewage sludge mixture.

Wong, J. W. C.; Jiang, R. F.; and Su, D. C.
Water, Air and Soil Pollution 106(1/2): 137-147. (1998)
NAL Call #: TD172 .W36; ISSN: 0049-6979
Descriptors: application rates/ ash/ boron/ capacity/ coal/ effects/ fly ash/ growth/ mixtures/ plant composition/ seasons/ sewage/ sewage sludge/ sludges/ soil/ symptoms/ toxicity/ chemical constituents of plants

Abstract: A greenhouse pot experiment was conducted to investigate the boron (B) release capacity of coal fly ash and sewage sludge mixtures, and the accumulation of B in *Agropyron elongatum* [*Elymus elongatus*] after two consecutive growing seasons. Sludge was amended with fly ash at application rates of 0, 5, 10, 35, and 50% (w/w), and each mixture was then mixed with a loamy soil at either 1:1 or 1:5 (v/v). Both water soluble B (WS-B) and hot water soluble B (HWS-B) increased with increasing fly ash amendment rate. Shoot B concentrations also increased significantly according to the rate of ash amendment. The ash-sludge mixture improved plant growth with the highest total dry weight yield at 10% ash amendment rate. Boron toxicity symptoms in leaf tips were observed at 35% and 50% ash amendment rate at both soil mixing ratios. Hot water soluble B and WS-B decreased significantly after consecutive cropping of *Agropyron* especially at a low ratio of mixture with soil i.e. 1:5 (v/v). However, soil available B contents at \geq 35% ash application rate and 1:1 (v/v) soil mixing ratio were still excessive for normal plant growth, suggesting that deleterious effects on plant growth would be experienced in later seasons owing to the high amounts of residual B.

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2. Accumulation of heavy metals in vegetables, pulse and wheat grown in fly ash amended soil.

Barman, S. C.; Kisku, G. C.; and Bhargava, S. K.
Journal of Environmental Biology 20(1): 15-18. (1999)
NAL Call #: QH540.J65 ; ISSN: 0254-8704

Descriptors: aubergines/ cabbages/ cadmium/ carrots/ chemical composition/ chickpeas/ chromium/ copper/ fly ash/ heavy metals/ industrial wastes/ iron/ lead/ lettuces/ nickel/ peas/ radishes/ soil/ soil amendments/ spinach/ tomatoes/ turnips/ uptake/ vegetables/ wheat/ zinc/ Araliales/ brinjal/ Capparales/ eggplants/ pea/ vegetable crops

Abstract: Heavy metals in soil and in 12 plant species (turnips, cabbages, carrots, radishes, spinach, peas, coriander, lettuces, tomatoes, brinjal [aubergine], gram [*Cicer arietinum*] and wheat) were determined in fields receiving fly ash from a thermal power plant. The metal contents (Cd, Cu, Zn, Fe, Ni, Cr and Pb) in the soil samples were higher than in the control soil. In Cd, Zn and Pb the concentration was either below or within the critical concentration. In the edible parts of the plant Cu, Zn and Pb concentration were within the recommended permissible limits, whereas Cd, Cr and Ni concentrations were sometimes higher. Accumulation of metals in plants varied from species to species and also within the different parts of a plant.

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3. Acidic and alkaline bottom ash and composted manure blends as a soil amendment.

Mukhtar, S.; Sadaka, S. S.; Kenimer, A. L.; Rahman, S.; and Mathis, J. G.

Bioresource Technology 99(13): 5891-5900. (2008)
NAL Call #: TD930.A32 ; ISSN: 0960-8524

Descriptors: ash/ cattle manure/ composts/ leachates/ nutrient content/ physicochemical properties/ soil amendments

Abstract: Potential water quality impacts associated with using bottom ash (BA) and composted dairy manure (CM) as a soil amendment were evaluated in this study. Two column studies were conducted to evaluate three blends of acidic BA and CM (BA:CM, v/v) namely, B_{1ac} (95:5), B_{2ac} (90:10), and B_{3ac} (80:20) and three blends of alkaline BA and CM (BA:CM, v/v), namely, B_{1al} (95:5), B_{2al} (90:10), and B_{3al} (80:20) under constant head water table conditions. Samples from standing water (top) and leachate (bottom) were collected at weekly intervals until day 49 to evaluate the effects of different blend ratios and elapsed time on standing water and leachate chemical and physical properties. A higher CM content in both acidic and alkaline blends resulted in higher leachate concentrations for solids and nutrients tested in this study. Alkaline blends had higher standing water and leachate nutrients concentration compared to acidic blends. After day 28, standing water total dissolved solids (TDS) concentrations for all acidic blends was below the USEPA drinking water standard however, TDS value for alkaline blend was always below the standard. Similar trends were also observed for NO₃-N and phosphorus (P) concentrations for both blends. Based on these findings, it was concluded that acidic and alkaline blends B_{1ac}, B_{1al}, B_{2ac} and B_{2al} may be considered as a soil amendment material.

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4. Adsorption-desorption studies of selected chlorophenols and herbicides and metal release in soil mixtures with fly ash.

Albanis, T. A.; Danis, T. G.; and Kourgia, M. G.
Environmental Technology 19(1): 25-34. (1998)
NAL Call #: TD1.E59; ISSN: 0959-3330

Descriptors: 2,4 dichlorophenol/ adsorption/alachlor/ desorption/ fertilizers/ fly ash/ herbicides/ metolachlor/ phenols/ soil/ weedicides/ weedkillers

Abstract: The influence of fly ash on the adsorption and desorption of four selected chlorophenols and two herbicides was studied in mixtures with a sandy clay loam (SCL) soil. Fly ash and soil mixtures with a range of fly ash content from 0 to 30% were used to study adsorption and desorption of four chlorophenols, 2,4-DCP, 2,4,6-TCP, 2,3,5,6-TCP and PCP as well as two selected herbicides,alachlor and metolachlor, in batch experiments. The linear isotherms indicated a constant partition of chlorophenols and herbicides between the bulk solution and mixtures of fly ash and soil, for a concentration range from 0.025 to 0.2 mg/litresuperscript 3 for chlorophenols and 0.1 to 10 mg/litre for herbicides. Mass balance estimations show that the adsorbed amounts of chlorophenols in mixtures of soil with 30% fly ash content, are up to 36.5% for 2,4-DCP,

55.8% for 2,4,6-TCP, 68.7% for 2,3,5,6-TCP and 84.9% for PCP and the respectively adsorbed amounts of herbicides in mixtures with 20% fly ash are up to 37.5% for alachlor and 43.2% for metolachlor. In contrast, the amounts of desorption decrease as the fly ash content and the number of chlorines in the phenolic ring increase. Results of leaching tests of metals from soil mixtures with fly ash showed that as the fly ash content and pH values increase, the concentration of Mg, Mn and Fe decreases in the aqueous solutions by metal precipitation. The concentrations of Ni, Cu and Zn remain at low levels and the concentration of Cr increase due to the formation of more soluble metal species at high pH values. Reproduced with permission from the CAB Abstracts database.

5. Adsorption-desorption studies of selected herbicides in soil-fly ash mixtures.

Konstantinou, I. K. and Albanis, T. A.

Journal of agricultural and food chemistry 48(10): 4780-4790. (Oct. 2000)

NAL Call #: 381 J8223 ; ISSN: 0021-8561 [JAFCAU]

Descriptors: atrazine / propazine/ prometryn/ propanil/ molinate/ adsorption/ desorption/ clay loam soils/ fly ash/ pollution control/ soil pollution/ application rate/ sandy clay loam soils

Abstract: Fly ash and soil mixtures with a range of fly ash content from 0 to 100% were used to study the adsorption and desorption of herbicides atrazine, propazine, prometryne, propanil, and molinate in batch experiments. The isotherms shapes according to Giles classification (Giles et al., 1960) were S, L, and H as the substrate changed from sandy clay loam (SCL) to fly ash, depending on the percent of fly ash in the mixture. The adsorption isotherms fit the Freundlich equation $x/m = K(f) C^{(1/n)}$. The $K(f)$ values increase with the increase of the fly ash content. The mean percent amounts of herbicides, for a range of concentration 1-20 mg L⁻¹, adsorbed on the soil were 21.9% for atrazine, 50.7% for propazine, 29.04% for prometryne, 43.14% for molinate, 31.35% for propachlor, and 46.34% for propanil. Mass balance estimations show that the adsorbed amounts of the herbicides increase along with the fly ash content in the sorbent mixture and reach the 99% in the "pure" fly ash. In contrast, the amounts desorbed with water decrease as the fly ash content increases. The n values ranged from 0.82 to 3.05 indicating that the carbon content of fly ash plays a significant role during the sorption process and an increase of heterogeneity of solid substrate. The increase of the amounts desorbed with acetone indicates that the sorption of organic compounds onto fly ash is believed to occur principally via the weak induction forces of London or dispersion forces which are characteristic of the physical adsorption process. The results of this research demonstrate that the fly ash shows a significant capacity for adsorption of organic compounds from aqueous solution. This citation is from AGRICOLA.

6. Advances in studies in effects of fine coal ash on agricultural crops.

Wang Zhaofeng and Feng Yongju

Journal of Shandong Agricultural University (Natural Science edition) 34(1): 152-156. (Mar. 2003); ISSN: 1000-2324.

Notes: 4 tables, 43 ref. Summaries (En, Zh). Citation Notes: CN (China).

Descriptors: coal ash/ field crops

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7. Agricultural use of a flue gas desulfurization by-product.

Dick, Warren; Chen, Liming; and Nelson Jr., Sid. In: Proceedings of the 1998 91st Annual Meeting & Exposition of the Air & Waste Management Association. San Diego, CA, USA.: Air & Waste Management Association; 1998.

Notes: Chapter Number: Pittsburgh, PA, United States.

Descriptors: Agriculture/ Byproducts/ Composition/ Desulfurization/ Economics/ Flue gases/ Fly ash/ Trace elements/ Duct injection technology/ Fluesorbent materials/ Turf grass/ Air pollution control

Abstract: Few, if any, economical alternatives exist for operators of small coal-fired boilers that require a flue-gas desulfurization system which does not generate wastes. A new duct-injection technology called 'Fluesorbent' has been developed to help fill this gap. Fluesorbent FGD was intentionally designed so that the saturated SO₂-sorbent materials would be valuable soil amendments for agricultural or turf-grass land. Agricultural and turf grass studies recently commenced using spent Fluesorbent materials from an FGD pilot program at an Ohio power plant. In the first year of testing, alfalfa yields on field plots with the FGD by-products were approximately 250% greater than on plots with no treatment, and about 40% greater than on plots treated with an equivalent amount of agricultural lime. Because the FGD by-products contained trace elements from included fly ash, the chemical composition of the alfalfa was significantly improved. Detailed yield and chemical data are presented.

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8. Agricultural uses for flue gas desulfurization (FGD) gypsum.

United States Environmental Protection Agency [Also available as: EPA530-F-08-009], 2008

<http://www.epa.gov/epawaste/partnerships/c2p2/pubs/fgd-fs.pdf>

Descriptors: gypsum/ agriculture/ flue gas desulfurization/ FGD

9. Alkali soil reclamation with flue gas desulfurization gypsum in China and assessment of metal content in corn grains.

Sakai, Y.; Matsumoto, S.; and Sadakata, M.

Soil and Sediment Contamination 13(1): 65-80. (2004)

NAL Call #: TD878 .J68; ISSN: 1058-8337

Descriptors: agricultural production/ air pollution/ alkaline soils/ arsenic/ bioavailability/ boron/ cadmium/ chromium/ coal/ combustion/ copper/ crop production/ desertification/ desulfurization/ exchangeable sodium/ fly ash/ gypsum/ lead/ maize/ manganese/ nickel/ polluted soils/ reclamation/ risk assessment/ sodium/ soil amendments/ soil chemical properties/ soil ph/ soil pollution/ soil types/ sulfur/ sulfur dioxide/ atmospheric pollution/ chemical properties of soil/ corn/ desulphurization/ elemental sulphur/ Mn/ sulphur/ sulphur dioxide

Abstract: Flue gas desulfurization gypsum (FGDG), the by-product of wet and semi-dry desulfurization processes, has been used as an alkali soil amendment in China. We

evaluated the change in soil properties, agricultural production and the safety of FGDG as a soil amendment. As a result, soil pH and ESP (exchangeable sodium percentage) decreased and corn production increased in FGDG-treated plots. The metal (B, Cr, Mn, Ni, Cu, As, Cd, Pb) contents in soil, FGDG, and corn grains were quantified by ICP-MS. Consequently, the contents of almost all metals in FGDG were lower than in soil. Moreover, the contents of almost all of the metals in the corn grains in the FGDG-treated plots were almost the same or lower than those in the control plot. Statistical analysis indicated that there was no effect of gypsum application on the metal content in the corn grains. Almost all of the metal contents were lower than the standard values set by FAO/WHO for human intake. The results showed that the FGDG from wet and semi-dry FGD processes is suitable as an alkali soil amendment.

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10. Alkaline biosolids and EDTA for phytoremediation of an acidic loamy soil spiked with cadmium.

Wong, J. W.; Wong, W. W.; Wei, Z.; and Jagadeesan, H. *Science of the Total Environment* 324(1-3): 235-46. (May 2004)

NAL Call #: RA565.S365; ISSN: 0048-9697

Descriptors: Biodegradation, Environmental/ Brassica: chemistry: growth & development/ Cadmium: isolation & purification: pharmacokinetics/ Chelating Agents: chemistry/ Edetic Acid: chemistry/ Environmental Pollution: prevention & control/ Hydrogen-Ion Concentration/ Soil/ Soil Pollutants: isolation & purification: pharmacokinetics

Abstract: A greenhouse experiment was conducted to investigate the growth of Brassica juncea and Cd phytoextraction in a mimicked Cd contaminated acidic loamy soil amended with alkaline biosolids, prepared from sewage sludge and coal fly ash, in the presence and absence of EDTA at 2 mmol kg⁻¹. The acidic loamy soil was spiked with 0, 5, 20, 50 and 100 mg Cd kg⁻¹ in the form of CdCO₃ and then amended with 4% alkaline biosolids (w/w). Alkaline biosolids and 0.12% CaCO₃ amendments resulted in a higher biomass than unamended soil spiked with 20 mg kg⁻¹ Cd where plants did not survive and of the two amendments, alkaline biosolids amendment had higher plant dry weight yield and phytoextraction of Cd. Adding 2 mmol kg⁻¹ EDTA to alkaline biosolids amended soil significantly increased the solubility of Cd ions by 9- to 29-fold, but plant Cd accumulation decreased by a factor of 24-48%. The results indicate that alkaline biosolids amendment is an effective approach for assisting growth of B. juncea and phytoextraction of Cd from the contaminated acidic loamy soil, but further application of chelating agents did not enhance the phytoextraction efficiency of Cd. This citation is from PubMed.

11. Alkaline coal fly ash amendments are recommended for improving rice-peanut crops.

Swain, D. K.; Rautaray, S. K.; and Ghosh, B. C.

Acta Agriculturae Scandinavica Section B, Plant Soil Science 57(3): 201-211. (2007)

NAL Call #: 11 Ac82 ; ISSN: 0906-4710

Descriptors: coal/ crop residues/ crop yield/ farmyard manure/ fly ash/ groundnut oil/ groundnuts/ kernels/ lateritic soils/ lime/ nitrogen fertilizers/ NPK fertilizers/ nutrient

availability/ nutrient uptake/ organic amendments/ phosphorus/ phosphorus fertilizers/ plant nutrition/ potassium/ potassium fertilizers/ residual effects/ rice/ sandy loam soils/ sludges/ soil types genetic/ arachis oil/ FYM/ paddy/ peanut oil/ peanuts/ phosphate fertilizers/ potash fertilizers

Abstract: A field experiment investigating amendments of organic material including farmyard manure, paper factory sludge and crop residues combined with fly ash, lime and chemical fertilizer in a rice-peanut cropping system was conducted during 1997-98 and 1998-99 at the Indian Institute of Technology, Kharagpur, India. The soil was an acid lateritic (Halustaf) sandy loam. For rice, an N:P:K level of 90:26.2:33.3 kg ha⁻¹ was supplied through the organic materials and chemical fertilizer to all the treatments except control and fly ash alone. The required quantities of organic materials were added to supply 30 kg N ha⁻¹ and the balance amount of N, P and K was supplied through chemical fertilizer. Amendment materials as per fertilization treatments were incorporated to individual plots 15 days before planting of rice during the rainy season. The residual effects were studied on the following peanut crop with application of N:P:K at 30:26.2:33.3 kg ha⁻¹ through chemical fertilizer alone in all treatments, apart from the control. An application of fly ash at 10 t ha⁻¹ in combination with chemical fertilizer and organic materials increased the grain yield of rice by 11% compared to chemical fertilizer alone. The residual effect of both lime and fly ash applications combined with direct application of chemical fertilizer increased peanut yields by 30% and 24%, respectively, compared to chemical fertilizer alone. Treatments with fly ash or lime increased P and K uptake in both the crops and oil content in peanut kernel compared to those without the amendments. Alkaline coal fly ash proved to be a better amendment than lime for improving productivity of an acid lateritic soil and enriching the soil with P and K.

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12. Alkaline fly ash effects on boron sorption and desorption in soils.

Matsi, T. and Keramidas, V. Z.

Soil Science Society of America Journal 65(4): 1101-1108. (July 2001-Aug. 2001)

NAL Call #: 56.9 So3; ISSN: 0361-5995 [SSSJD4]

Descriptors: boron/ sorption/ desorption/ fly ash/ alkalinity/ acid soils/ calcareous soils/ equations/ application rate/ Greece/ freundlich equation/ langmuir equation/ phenomenological equation

Abstract: Application of alkaline fly ash to soils is expected to result in an increase in B sorption capacity. If fly ash is B-rich, B phytotoxicity might occur depending not only on B loads and magnitude of soil sorption capacity for B, but also on the strength of B retention by sorption surfaces of the fly ash amended soils. This strength determines the ease through which B releases into the soil solution. Aged-alkaline fly ash was applied to one calcareous and two acid soils at rates equal to 0, 5, 20, and 50 g kg⁻¹ of soil, and the impact of fly ash addition on B sorption in these soils was characterized, by means of the parameters (affinity and maximum) obtained through fitting B sorption data to the nonlinear Freundlich, Langmuir isotherms, and the phenomenological equation of Keren et al. Boron was added to the untreated and the fly ash-treated soils, left in

contact for 30 d, and its desorbability was studied. It was observed that although B sorption maximum of soils tended to increase upon fly ash addition, the affinity of B to sorption sites remained practically unaltered in most of the cases. Boron sorption was an exothermic reaction and the greatest part (more than 60%) of sorbed B in the fly ash-treated soils could be easily desorbed within 24 h, reaching 80% for the acid soils and 100% for the calcareous soil after 120 h of desorption time. It was concluded that although there was a tendency of an increase in B sorption capacity in most cases upon fly ash addition, this increase was not generally accompanied by an increase in strength of B retention by soil surfaces. A major part of added B in the fly ash-treated soils remained labile enough to be released in the soil solution in a short time.

This citation is from AGRICOLA.

13. Amelioration of alkali soil using flue gas desulfurization byproducts: Productivity and environmental quality.

Wang, S. J.; Chen, C. H.; Xu, X. C.; and Li, Y. J. *Environmental Pollution* 151(1): 200-4. (Jan. 2008)

NAL Call #: QH545.A1E52; ISSN: 0269-7491

Descriptors: China/ Coal/ Crops, Agricultural: growth & development/ Environmental Monitoring: methods/ Environmental Remediation: methods/ Gases/ Hydrogen-ion Concentration/ Industrial Waste/ Medicago sativa/ Metals, Heavy: analysis/ Power Plants/ Seeds: chemistry/ Soil Pollutants: analysis/ Zea mays

Abstract: In this study, flue gas desulfurization (FGD) byproducts are used to ameliorate alkali soil. The average application rates for soils with low exchangeable sodium percentage (ESP), mid ESP, and high ESP are 20.9, 30.6, and 59.3 Mg ha⁻¹, respectively. The experimental results obtained for 3 consecutive years reveal that the emergence ratios and yields of the crops were 1.1-7.6 times and 1.1-13.9 times those of the untreated control, respectively. The concentrations of Cr, Pb, Cd, As, and Hg in the treated soils are far below the background values stipulated by the Environmental

Quality Standard for Soils (GB15618-1995). Their concentrations in the seeds of corn and alfalfa grown in the treated soils are far below the tolerance limits regulated by National Food Standards of China. The results of this research demonstrate that the amelioration of alkali soils using FGD byproducts is promising.

This citation is from PubMed.

14. Amelioration of coal mine spoils through fly ash application as liming material.

Ajaya Srivastava and Chhonkar, P. K.

Journal of Scientific and Industrial Research 59(4): 309-313. (2000)

NAL Call #: 475 J82; ISSN: 0022-4456

Descriptors: biomass/ bulk density/ coal mine spoil/ density/ dry matter/ exchangeable potassium/ fly ash/ lime/ liming/ liming materials/ oats/ phosphorus/ potassium/ reclamation/ spoil heap soils/ sulfur/ uptake/ colliery spoil/ elemental sulphur/ sulphur

Abstract: The feasibility of fly ash as compared to lime to ameliorate the low pH of acidic coal mine spoils under controlled pot culture conditions are reported using Sudan grass (*Sorghum sudanense*) and oats (*Avena sativa*) as indicator crops. It is observed that at all levels of

applications, fly ash and lime significantly increase the pH of mine spoils, available phosphorus, exchangeable potassium, available sulphur and also uptake of phosphorus, potassium, sulphur and oven-dried biomass of both these test crops. The fly ash significantly decreases the bulk density of coal mine spoils, but, there is no effect on bulk density due to lime application. However, when the spoils are amended with either fly ash or lime, the root growth occurs throughout the material. Fly ash and lime do not cause elemental toxicities to the plants as evidenced from the dry matter production by the test crops. The results indicate that fly ash to be a potential alternative to lime for treating acidic coal mine spoils.

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15. Amelioration of soil acidity with class c fly ash: A field study.

Schlossberg, Maxim J.; Waltz, F. Clint Jr; and Miller, William P.

In: Coal Combustion Byproducts and Environmental Issues. Uppsala, Sweden.)

233 Spring Street, New York, NY 10013: Springer; pp. 190-194; 2006.

Notes: 7th International Conference on Biogeochemistry of Trace Elements.; ISBN: 0387258655

Descriptors: biochemistry and molecular biophysics/ soil science/ agronomy: agriculture/ Gramineae: angiosperms, monocots, plants, spermatophytes, vascular plants/ fly ash/ soil acidity/ coal combustion product

Abstract: Coal combustion products (CCP) include fly ash and bottom ash and are generated nationally at rates of 10(8) Mg per year. Fly ashes (FA) comprise the majority of CCP production, and can possess widely-variable physicochemical properties. Current consumption/utilization of FA in the US does not approach production levels, and results in FA stockpiling. Class-C fly ash is generated from combustion of sub-bituminous and lignite coal products. This class of FA often possesses an alkaline pH, resulting from calcium, magnesium, and potassium oxide inclusions. Some Class-C FA have been reported to contain as much as 60% calcium carbonate equivalency (CCE), prompting investigations of FA as a lime substitute in agricultural/horticultural applications. Furthermore, FA often possesses small concentrations of exchangeable micronutrients. Thus, considering availability of Class-C FA, its potential beneficial use as a liming agent, and the expansive area of low-to-medium maintenance turfgrass systems currently afflicted by suboptimal soil pH levels; our objective was to evaluate the acid-neutralizing efficacy of a Class-C FA when substituted for pulverized limestone (PL) in field application. This study was conducted on a severely-acidic bermudagrass (*Cynodon* spp. L.) rough of a Georgia golf course during 2001 and 2002. Following material characterization, CaCO₃ equivalent was applied at a prescribed rate of 3.8 Mg CaCO₃ ha⁻¹, using either PL or Georgia-produced FA (CCE = 45.5%). Soil samples collected one year following showed FA to have neutralized significantly greater acidity in the upper 8 cm of soil than the PL. Furthermore, exchangeable P, Mg, and Zn levels in the FA-treated 0-8 cm of soil exceeded levels observed in the PL-treated or control plots. Due to the disparity in CCE, requisite FA application greatly exceeded that of PL, reducing economic advantage of FA-substitution. However, in locations where Class-C FA is plentiful, high-grade PL is

costly, and soil pH suboptimal for important crops; results of this study indicate soil liming with Class-C FA to be a beneficial use of this CCP. Comprehensive characterization of CCP and proper application rate (not exceeding agronomic requirements) are essential components of beneficial use.

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16. Amendment of fly ash to container substrates for ornamental plant production.

Chen, Jianjun and Li, Yuncong.

In: Coal Combustion Byproducts and Environmental Issues. June 15 -19, 2003.)

Uppsala, Sweden: Springer, 233 Spring Street, New York, NY 10013, United States; pp. 177-183; 2006.

Notes: 7th International Conference on Biogeochemistry of Trace Elements.; ISBN: 0387258655

Descriptors: biogeography: population studies/ agrichemicals/ nutrition/ horticulture: agriculture/ Acanthaceae: angiosperms, dicots, plants, spermatophytes, vascular plants/ organic matter/ fly ash

Abstract: Ornamental plants are largely produced in containerized soilless substrates that generally consist of sphagnum peat, bark, and other organic matter. Such substrates initially have a low pH (around 4.0) and limited amount of mineral nutrients. In order to raise pH and increase fertility, commercial ground limestone and chemical fertilizers have to be incorporated into the substrates. Fly ash, a coal combustion byproduct possessing alkalinity and containing essential mineral elements in silt-sized particles, could be an alternative to limestone amendments and nutrient sources for container substrates. This study examined chemical properties of four fly ash sampled from power plants in (1) North Carolina, (2) Michigan(a), (3) Florida, and (4) Michigan(b) and incorporated an appropriate amount of each fly ash or a commercial dolomite, respectively, into a soilless basal substrate, resulting in fly ash- or dolomite-amended substrates. After testing chemical properties of the substrates, seedlings of Pink Splash (*Hypoestes phyllostachya* Bak.), a herbaceous ornamental foliage plant, were planted in the basal, fly ash-, and dolomite-amended substrates. Substrate pH and plant heights were monitored during the course of plant growth. All fly ashes were able to raise the pH of the basal substrate from 3.8 to 7.4 except the one collected from Michigan(b) that was unable to change the pH regardless of the amount of fly ash used. Plants grown in the substrates amended with fly ash from North Carolina, Michigan(a), and Florida had comparable heights and similar fresh and dry weights as well as overall quality to those grown in the dolomite-amended substrate. Whereas, plants grown in the basal substrate and the substrate amended with Michigan(b) fly ash were significantly smaller and had less fresh and dry weights than those grown on the rest of substrates, thus, plants were not marketable. These results show that fly ash, after selection based on their chemical properties, can be used as alternative to commercial dolomite in soilless substrates for ornamental plant production. Utilization of fly ash as a container substrate amendment may represent a new market for the beneficial use of coal combustion byproducts.

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17. Analysis of impact of the harmful element contents on soils and crops in the farmland incurred by fly ash.

Xu Hong

Bulletin of the Chinese Society of Mineralogy, Petrology and Geochemistry 18(1): 29-32. (Jan. 1999); ISSN: 1007-2802.

Notes: Original title: Kuangwu Yanshi Diquhuaxue Tongbao. Language: Chinese. References: 6; 5 tables.

Descriptors: analysis / ash/ Asia/ China/ Far East/ heavy metals/ impact statements/ Jiangsu China/ Nanjing China/ pollution/ soils/ yields/ Environmental geology

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18. Applicability of fly-ash, phosphate solubilizing microbes and mycorrhizae for sustainable productivity of banana.

Phirke, N. V.; Chincholkar, S. B.; Yadav, K. R.; and Kothari, R. M.

Biotechnology of Microbes and Sustainable Utilization: 161-165. (2002)

Descriptors: agricultural soils/ arsenic/ bananas/ bioavailability / cadmium/ calcium/ chromium/ crop production/ crop yield/ ectomycorrhizas/ fermentation/ fly ash/ food chains/ lead/ mercury/ mycorrhizal fungi/ mycorrhizas/ NPK fertilizers/ nutrient requirements/ phosphate/ phosphate solubilizing bacteria/ phosphorus fertilizers/ rhizosphere/ roots/ soil amendments/ soil conditioners/ soil types/ sustainability/ trace elements/ dietary standards/ food requirements/ Hyphomycetes/ microelements/ nutritional requirements/ phosphate fertilizers/ *Tricholoma imbricatum*/ *Tricholomataceae*

Abstract: Research in the last two decades indicated a possibility of using fly ash to amend agricultural soil for ramified root system, and also as source of micronutrients as well as some macronutrients such as Ca and phosphate. To take advantage of these inherent attributes of fly ash, it has been utilized for the higher productivity of banana (cv. Shrimanti), at lesser cost to be more remunerative to the farmers. To optimize the use of phosphate from fly ash and reduce dependence on imported phosphatic fertilizers, the use of phosphate solubilizing microbes was developed. Attempts have been made to screen the most efficient phosphate solubilizing microbes (tentatively identified as *Aspergillus* sp.) from the elite banana rhizosphere. Their nutritional requirements are optimized on two litre scale fermentation for farm scale trials. Besides optimizing sustained availability of solubilized phosphate, the application of mycorrhizas (*Tricholoma imbricatum*) has been explored to minimize the chances of entrance of toxic elements from fly ash (Cd, Hg, As, Pb and Cr) in the food chain. Thus, a natural waste has been explored to serve as a resource of nutrients through the catalytic roles of phosphate solubilizers and mycorrhizas in eco-friendly and sustainable manner.

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19. Application of coal ash to environmental improvement: Transformation into zeolite, potassium fertilizer, and fgd absorbent.

Kikuchi, Ryunosuke

Resources, Conservation and Recycling 27(4): 333-346. (1999)

NAL Call #: TP156.R38R47; ISSN: 0921-3449

Descriptors: Waste Management: Sanitation/ flue gas desulfurization: FGD, waste processing method/ Construction Industry/ Civil Construction Materials/ Coal: Energy Source/ Coal Reserves/ Economic Growth/ Population Growth/ Power Plants/ Recycling/ Soil Improvement/ Soil Retention/ Sustainable Development/ Wastewater Treatment

Abstract: The rapid increase in population and economic growth have led to an increase in energy demand. Coal reserves are distributed worldwide, and coal is now known to be the most stable and available energy source. However, utilization of coal as an energy source involves the generation of a great amount of coal ash, and the recycling rate of the ash is rather low. Coal ash is mainly used in civil construction materials, and there is a limit to the demand for coal ash by construction industries: therefore, the increasing amount of coal ash will be a serious problem in the near future. Different applications should be considered. In this paper, three environmentally-friendly methods for coal ash recycling are described. Firstly, alkali treatment can transform coal ash to zeolite, which is used in deodorant and for wastewater treatment and soil improvement. Secondly, potassium silicate fertilizer is produced from coal ash and has a higher retentivity in the soil than that of conventional fertilizers. Thirdly, emission of sulfur dioxide is controlled by flue gas desulfurization using coal ash. It is considered that environmentally-friendly use of coal ash is important from the viewpoints of energy, economy, and environmental strategy in order to realize the concept of sustainable development.

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20. Application of emerging tools and techniques for measuring carbon and microbial communities in reclaimed mine soils.

Palumbo, A. V.; Fisher, L. S.; Martin, M. Z.; Yang, Z. K.; Tarver, J. R.; Wullschlegel, S. D.; and Daniels, W. L. *Environmental Management* 33(Supplement 1): S518-S527. (2004); ISSN: 0364-152X

Descriptors: analytical methods/ carbon sequestration/ chemical composition/ degraded land/ DNA sequencing/ fly ash/ microbial flora/ mined land/ mineral content/ polymerase chain reaction/ reclaimed soils/ sewage sludge/ soil amendments/ soil composition/ soil fungi/ soil types/ species diversity/ spectroscopy/ analytical techniques/ microbial communities/ microflora/ mined sites/ nucleotide sequence analysis/ nucleotide sequencing/ PCR

Abstract: As part of a study of the potential for carbon sequestration in degraded mine lands, we examined the carbon content of reclaimed mine soils treated with soil amendments (e.g., fly ash and biosolids) using two emerging techniques; terminal restriction fragment-length polymorphism (TRFLP) and laser-induced breakdown spectroscopy (LIBS). Both of these techniques have potential use for measuring aspects of carbon content and its role in the soil ecosystem. To better understand the relationship between the microbial community and the amount of carbon within mine soils, we examined the diversity among fungal communities in soils with different carbon content using TRFLP. TRFLP was run on 18S rDNA from polymerase chain reaction (PCR) amplification using primers specific for fungi. Results from the TRFLP were compared to sequencing of 18S clones. The diversity based on sequence analysis was much higher than that indicated by the TRFLP-based analysis. Rarefaction

analysis of the data indicated that the total diversity was even higher than we were able to measure with both levels of effort; however, it was clear that we effectively sampled the dominant populations. The LIBS technique displayed a strong linear relationship when compared to conventional techniques (LECO and Walkley-Black) of measuring carbon in soils. In addition, discrepancies were noted between the two conventional techniques for soils with high carbon content.

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21. Application of fly ash in reclamation of wastelands through plantations and floriculture.

Alka Thapliyal and Anushree Malik

Floriculture, Ornamental and Plant Biotechnology: 288-297. (2006)

Descriptors: acid soils/ alkaline soils/ floriculture/ fly ash/ microbial flora/ organic amendments/ plantations/ reclamation/ sodic soils/ soil fertility/ soil types/ waste land/ waste management/ waste utilization/ microbial biomass/ microflora/ waste ground

Abstract: This article links two terms wastelands and fly ash, which sound distinct but have several common implications. In their present forms both are waste and a rather problematic one that could spread further if poorly managed. Their management itself is difficult and economically unfavorable. At the same time both could have great potential if utilized prudently. The present article emanates from the need to realize the veiled potential and to find out how fly ash and wasteland can complement each other for the benefit of Humanity and our environment. Consequently this article introduces and deals individually with wastelands and fly ash in the first two sections followed by a synergy (concept of joint or symbiotic management of wastelands and fly ash) in the subsequent section. Lab/field scale applications of fly ash in wasteland reclamation are summarized with special emphasis on the benefits of organic/microbial culture-amended fly ash. Prospects of floriculture on abandoned fly ash dumps are also discussed.

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22. Application of phosphorus sorbing materials to streamside cattle loafing areas.

Penn, C. J. and Bryant, R. B.

Journal of Soil and Water Conservation Ankeny 61(5): 303-310. (2006); ISSN: 0022-4561

Descriptors: aluminium sulfate/ dairy farms/ fly ash/ gypsum/ losses from soil/ phosphorus/ rain/ residues/ runoff/ silt loam soils/ simulation/ soil amendments/ sorption/ water quality/ water treatment/ aluminium sulphate/ aluminum sulfate/ losses from soil systems/ rainfall/ United States of America/ water composition and quality

Abstract: Excessive soil phosphorus (P) concentrations among cattle loafing areas located in close proximity to surface waters represent great potential for P transport. This study assessed the ability of several P sorbing materials in reducing P losses from streamside cattle loafing areas. Simulated rainfall was applied at seven (time 1) and 28 (time 2) days after P sorbing material applications to runoff plots on cattle loafing areas located at Amish farms. Treatments consisted of alum, water treatment

residuals, fly-ash, gypsum, and no amendment (control). Alum addition reduced time 1 runoff P concentrations the most followed by water treatment residuals - gypsum, then fly-ash. However, runoff P losses from P sorbing materials were not significantly different from the control at time 2. These results suggest that P sorbing materials alone provide only a temporary solution to P losses from cattle loafing areas and should be used with other best management practices.
Reproduced with permission from the CAB Abstracts database.

23. Arsenate displacement from fly ash in amended soils.

Qafoku, N. P.; Kukier, U.; Sumner, M. E.; Miller, W. P.; and Radcliffe, D. E.

Water, Air and Soil Pollution 114(1/2): 185-198. (1999)

NAL Call #: TD172 .W36; ISSN: 0049-6979

Descriptors: adsorption/ anions/ arsenic/ columns/ displacement/ environmental protection/ fly ash/ groundwater/ gypsum/ interactions/ leachates/ leaching/ particles/ phosphate/ phosphorus/ pollution/ soil/ sulfate/ treatment/ arsenate/ environmental pollution

Abstract: A study in repacked columns was conducted to determine whether or not As becomes mobile when $\text{Ca}(\text{H}_2\text{PO}_4)_2$ and CaSO_4 are used as leaching solutions, and to compare the competitive interactions between PO_4^- - AsO_4 and SO_4^- - AsO_4 . Arsenic concentration in leachate was approx. ten times greater when $\text{Ca}(\text{H}_2\text{PO}_4)_2$ was used to leach the columns as compared to CaSO_4 . A maximum concentration of 800 micro g As litre-1 was found in the leachate in this case, which is much higher than the groundwater limit of 50 micro g litre-1 for drinking water. In fly ash, the portion of arsenate non-specifically adsorbed is believed to be much lower than that of specifically adsorbed. Sulfate anions were able to displace only non-specifically adsorbed arsenate. In this case the concentration of As in leachate was within acceptable limits. On the other hand, phosphate can compete with arsenate for all available adsorption sites, non-specific and specific. Phosphate displacement of both forms of arsenates increases As mobility in both control and fly ash treatments.

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24. Arsenic accumulation by Chinese brake fern in amended coal fly ash.

Szuri, Sheena Powell; Guanira, Katia; Ma, Lena Q ; Allen, Marshall; Moos, Lawrence; and Cai, Yong.

In: 229th National Meeting of the American Chemical Society. Abstracts of Papers American Chemical Society, San Diego, CA.; Vol. 229 (Part 1).; pp. U841-U842; 2005. ISBN: 0065-7727

Descriptors: Toxicology/ Environmental Sciences/ Forestry/ Filices: Plants, Pteridophytes, Vascular Plants/ bioremediation: applied and field techniques/ phytoextraction: laboratory techniques/ Organic Matter/ Biomass/ Environment

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25. Arsenic and lead release from fly ash stabilized/solidified soils under modified semi-dynamic leaching conditions.

Moon, D. H. and Dermatas, D.

Journal of Hazardous Materials 141(2): 388-394. (2007)

NAL Call #: T55.3.H3J6; ISSN: 0304-3894

Descriptors: arsenic/ diffusion/ diffusivity/ fly ash/ leaching/ lead/ polluted soils/ soil pollution/ soil stabilization/ soil testing/ soil types/ solidification/ remediation

Abstract: A fly ash-based stabilization/solidification (S/S) technique was investigated using field soil samples contaminated with arsenic (As) and lead (Pb). A semi-dynamic leaching test was used to evaluate the effectiveness of the S/S treatment. By assessing the cumulative fractions of leached As and Pb, the effective diffusion coefficient (D_e) and a leachability index (LX) were measured and used for evaluating the effectiveness of the S/S treatment. Overall, As release was reduced by 98.3% and Pb release was reduced by 98.5% upon addition of 25% Class C fly ash. The mean D_e decreased significantly and the mean LX was always above 9 for all treated samples, indicating that the treated soils were acceptable for "controlled utilization". The mechanism controlling As leaching from all treated samples appeared to be a mixture of wash-off and diffusion. Diffusive As release was proportional to fly ash content. The mechanism controlling Pb leaching when samples were treated with 25% fly ash appeared to be wash-off.

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26. Arsenic and nickel enrichment coefficients for crops growing on coal ash .

Zgorelec, Zeljka; Basic, Ferdo; Kistic, Ivica; Wenzel, Walter W; and Custovic, Hamid

Cereal Research Communications 36(Suppl. S, Part 2): 1219-1222. (2008); ISSN: 0133-3720

Descriptors: field crops/ coal ash/ transport/ accumulation/ arsenic/ nickel

Abstract: Around the city of Tuzla, BiH soil covered coal ash disposal sites have been used for food and fodder production since 1992. To our knowledge this is the first report on the cultivation of coal ash disposal sites for agriculture purposes. We observed high concentrations of As and Ni in alkaline coal ash. In this paper, we investigated arsenic and nickel transport and accumulation in barley and soybean grown on substrates made up of different soil and ash ratios. After three growth cycles in the greenhouse we observed significant differences ($p < 0.05$) between the Ni enrichment coefficients of Dora cultivar of soybean and Rex cultivar of barley, but no significant difference between the As enrichment coefficients of soybean and barley. Dora cultivar of soybean and Rex cultivar of barley showed very low uptake of arsenic, the enrichment coefficient varied between 0.05% and 0.51% depending on the crop and the treatment. The nickel enrichment coefficient of Rex cultivar of barley varied between 0.01% and 0.94%. The enrichment coefficient for Ni in Dora cultivar of soybean indicated higher uptake and varied between 5.64%, and 34.79%.

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27. Arsenic and selenium speciation in aged flue gas desulfurization amended soil.

Punshon, Tracy; Jackson, Brian P.; Seaman, John C.; Adriano, Domy C.; and Burger, Joanna.
 In: Seventh International Conference on the Biogeochemistry of Trace Elements. Uppsala, Sweden.) Sajwan, Kenneth S.; Twardowska, Irena; Punshon, Tracy; and Alva, Ashok K. (eds.)
 New York, NY, United States : Springer Science+ Business Media, Inc.; 2006.
Notes: References: 30; illus. incl. 2 tables.
Descriptors: arsenic/ bioavailability/ coal/ combustion/ concentration/ desulfurization/ gases/ ICP mass spectra/ mass spectra/ metals/ nutrients/ pesticides/ Plantae/ pollutants/ pollution/ sedimentary rocks/ selenium/ soils/ solid waste/ speciation/ spectral/ vegetation/ waste disposal/ environmental geology
 © American Geological Institute

28. Arsenic, boron, selenium, and molybdenum displacement and transport in a fly ash amended soil leached with calcium phosphate solution.

Qafoku, N. P.; Dudka, S.; Sumner, M. E.; and Miller, W. P.
Communications in Soil Science and Plant Analysis 32(9-10): 1499-1512. (2001)
NAL Call #: S590.C63; ISSN: 0010-3624 [CSOSA2]
Descriptors: arsenic/ boron/ selenium/ molybdenum/ leaching/ solutions/ monocalcium phosphate/ fly ash/ topsoil/ Ultisols/ phosphorus/ application rate/ displacement
Abstract: Substantial amounts of arsenic (As), selenium (Se), molybdenum (Mo), and boron (B) can be added with fly ash (FA) in FA amended soils. Leaching of these potential contaminants and the effect of soil solution anion composition on their retention and displacement is not well documented in the literature. The objective was to compare the interactions between phosphorus (P) in the leaching solution and As, B, Se, and Mo on FA surfaces and to estimate the mobility of As, B, Se, and Mo in a FA amended Cecil topsoil (Ultisol). Two FAs, A (216 mg As kg⁻¹) and B (51 mg As kg⁻¹), were used. Each ash was mixed with soil at the equivalent rates of 2 and 41 kg As ha⁻¹. These mixtures were used to pack the columns, which were leached with 1,66 mmol(c) calcium phosphate [Ca(H₂PO₄)₂] L⁻¹ solution. The results show that the concentrations of As, B, Mo, and Se in the leachate and their total amounts removed from the surface horizon (0-20 cm) of a FA amended soil depend on the initial contents of these elements in FA and the rate of FA application. As appears much faster and in higher concentrations in the leachate of treatments that received the highest As rate. The maximum As concentration and the total As amount released in the leachate, were much higher in the low As FA (B) than in the high As FA (A). The low As ash, therefore, seems to be more hazardous than the high As ash when both applied in rates to yield 41 kg As ha⁻¹. The differences observed between treatments in As, B, Mo, and Se mobility are also due to the ratio soil/FA in different treatments. Because under acid conditions some variable charge minerals in the soil and FAs develop positive charge and anion exchange capacity, larger amounts of As, B, Mo, and Se may be retained and their movement through the soil column may be retarded. This could be another reason why lower amount of As, B, Mo, and Se were released in the A (acid FA) than the B treatments (alkaline FA). This citation is from AGRICOLA.

29. Assessing organic amendments used by sugarcane growers for improving soil chemical and biological properties.

Antwerpen, R. van; Haynes, R. J.; Meyer, J. H.; and Hlanze, D.
Proceedings of the Annual Congress South African Sugar Technologists' Association 77(293-304)(2003); ISSN: 1028-3781
Descriptors: cattle manure/ filter cake/ fly ash/ green manures/ organic amendments/ pine bark/ poultry manure/ soil amendments/ soil biology/ soil chemical properties/ sugarcane/ sugarcane trash/ chemical properties of soil/ clarification mud/ microbial biomass/ poultry litter
Abstract: Sugarcane has been produced as a sole crop for at least 30 years in the Midlands area of KwaZulu-Natal and for more than 75 years on the coast. On poor soils, a yield decline or plateau has been observed, despite the release of new sugarcane varieties with increased yield potential. Soil surveys conducted in the sugar industry have shown a steady deterioration of soil chemical, physical and biological properties as the period under sugarcane cultivation has increased. Proactive growers have used a range of organic amendments to improve and sustain soil quality, including filtercake, fly ash, pine bark, cane trash, poultry and cattle manures, and the incorporation of a fallow crop (green manuring). A survey conducted in 2001 to determine the efficacy of these amendments, in particular on the biological properties of soils, found that filtercake and green manuring had the greatest effect on improved soil biological properties, as indicated by microbial biomass carbon and metabolic quotient. Reproduced with permission from the CAB Abstracts database.

30. Assessing the feasibility of land application of fly ash, sewage sludge and their mixtures.

Sajwan, K. S.; Paramasivam, S.; Alva, A. K.; Adriano, D. C.; and Hooda, P. S.
Advances in Environmental Research 8(1): 77-91. (2003); ISSN: 1093-0191.
Notes: DOI: 10.1016/S1093-0191(02)00137-5.
Descriptors: absorption/ feasibility studies/ fly ash/ fly ash/ land disposal/ land application/ leachates/ leaching/ metals/ migration/ plants/ sewage sludge/ sludge disposal/ soil/ waste disposal/ wastewater disposal
Abstract: Land disposal of fly ash (FA) and sewage sludge (SS) is a major problem due largely to their potentially harmful constituents. Combined use of FA and SS however may help reduce the associated pollution potential. In this paper we summarize the results of several case studies designed to assess the feasibility of land application of FA with and without SS. A wide range of application rates was tested under laboratory, greenhouse and field conditions. The leaching of metals from soil columns amended with moderate rates of FA applications (8-16 Mg ha super⁻¹) generally had no significant impact on the metal content of leachate or their downward migration in the soil. The application of FA or SS at a much high rate (74.1 Mg ha super⁻¹) significantly increased both leaching and downward migration of metals. The use of 1:1 FA+SS mixture at 148.2 Mg ha super⁻¹ reduced metal leaching compared to the combined metal quantities leached when FA or SS applied at 74.1 Mg ha super⁻¹. The results

indicate that combined use of FA and SS at a rational rate of application should not cause any significant effect on drainage water quality. Plant studies conducted using FA and SS mixtures indicated that these materials could be beneficial for biomass production, without contributing significant metal uptake or leaching. The application of FA as high as 560 Mg ha super(-1) in a long-term field trial had no detectable deterioration in soil or groundwater quality and no substantial increases in plant uptake of metals and other trace elements were observed. Low to moderate rates of FA and SS therefore could be successfully used as soil amendments, particularly so when used as a mixture. Abstract reproduced from the Water Resources Abstracts database with permission from ProQuest LLC. © 2007 ProQuest LLC; all rights reserved. Further reproduction is prohibited without permission.

31. Assessing trace element uptake by vegetation on a coal fly ash landfill.

Woodbury, P. B.; Rubin, G.; McCune, D. C.; Weinstein, L. H.; and Neuhauser, E. F.
Water, Air and Soil Pollution 111(1/4): 271-286. (1999)
 NAL Call #: TD172 .W36; ISSN: 0049-6979
 Descriptors: analytical methods/ assessment/ boron/ contamination/ fly ash/ landfills/ molybdenum/ risk assessment/ selenium/ shoots/ soil pollution/ trace elements/ uptake/ vegetation types/ waste disposal/ analytical techniques/ microelements/ Mo/ United States of America
 Abstract: Vegetation was collected from two sites on a soil-capped coal fly ash landfill in New York State, USA, during June of 1991 and June and August of 1992 in order to develop methods and assess the risks posed by the uptake of potentially toxic elements such as Se, B, and Mo by vegetation on contaminated sites. The mean concentrations (micro g/g dry weight) of Se and Mo in the shoots did not exceed, respectively, 0.12 and 18.7 in bird's-foot trefoil (*Lotus corniculatus*), 0.06 and 12.1 in red clover (*Trifolium pratense*), 0.07 and 5.3 in timothy grass (*Phleum pratense*), and 0.09 and 2.2 in a mixture of grasses. These concentrations were greater than those in the same species harvested concurrently from a non-landfill site. The mean concentrations of B at the landfill ranged from 29-53 micro g/g in the legumes and from 2-11 micro g/g in the grasses, less than those at one non-landfill site but greater than those at another. Within the landfill, the concentration of Se in grasses was not correlated with the concentration of Se in soil and fly ash. The concentration of Se in grasses on both landfill sites was double that of grasses on the non-landfill site despite higher mean concentrations of Se in the upper soil (0-15 cm) on the non-landfill site. Grass roots appeared to be accessing Se from the ash by means of mass flow or other mechanisms. It is suggested that contemporaneous transect sampling of at least two species be used to assess the uptake of potentially toxic trace elements on landfills or other sites where contamination may occur.
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32. Assessment of polychlorinated dibenzo-p-dioxins and dibenzofurans contribution from different media to surrounding duck farms.

Lee, W. J.; Shih, S. I.; Li, H. W.; Lin, L. F.; Yu, K. M.; Lu, K.; Wang, L. C.; Chang-Chien, G. P.; Fang, K.; and Lin, M.
Journal of Hazardous Material 163(2-3): 1185-1193. (Apr. 2009)
 NAL Call #: T55.3.H3J6; ISSN: 0304-3894
 Descriptors: ducks/ dibenzofurans/ dioxins/ China
 Abstract: Since the "Toxic Egg Event" broke out in central Taiwan, the possible sources of the high content of polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs) in eggs have been a serious concern. In this study, the PCDD/F contents in different media (feed, soil and ambient air) were measured. Evaluation of the impact from electric arc furnace dust treatment plant (abbreviated as EAFDT plant), which is site-specific to the "Toxic Egg Event", on the duck total-PCDD/F daily intake was conducted by both Industrial Source Complex Short Term model (ISCST) and dry and wet deposition models. After different scenario simulations, the worst case was at farm A and at 200g feed and 5g soil for duck intake, and the highest PCDD/F contributions from the feed, original soil and stack flue gas were 44.92, 47.81, and 6.58%, respectively. Considering different uncertainty factors, such as the flow rate variation of stack flue gas and errors from modelling and measurement, the PCDD/F contribution fraction from the stack flue gas of EAFDT plant may increase up to twice as that for the worst case (6.58%) and become 13.2%, which was still much lower than that from the total contribution fraction (86.8%) of both feed and original soil. Fly ashes contained purposely in duck feed by the farmers was a potential major source for the duck daily intake. While the impact from EAFDT plant has been proven very minor, the PCDD/F content in the feed and soil, which was contaminated by illegal fly ash landfills, requires more attention.
 This citation is from PubMed.

33. Assessment of soil disturbance using magnetic susceptibility and fly ash contents on a Mississippian mound in Illinois.

Olson, K. R.; Jones, R. L.; and Lang, J. M.
Soil Science 169(10): 737-744. (2004)
 NAL Call #: 56.8 So3; ISSN: 0038-075X
 Descriptors: alluvial soils/ archaeological material/ charcoal/ erosion/ fly ash/ horizons/ magnetic properties/ mounds/ organic matter/ palaeoecology/ Palaeosols/ radiocarbon dating/ soil formation / susceptibility/ tillage/ paleoecology/ paleosols/ soil cultivation/ soil genesis/ United States of America
 Abstract: The Twenhafel Mound, a Middle Mississippian burial mound in Jackson County, Illinois, was most likely built between A.D. 500 and A.D. 900. The existence of the mound has been known since the French settled in the nearby town of Cahokia in 1699. Since the time of European settlement, the mound has not been legally protected from treasure hunters. The land was privately purchased and settled in the 1850s. Many similar and

adjacent mounds were excavated in a search for treasure or artifacts, leveled for farming, or hauled away. The primary objectives of this research are to determine the extent and time of mixing by excavation and/or tillage, the source of the mound materials, and the rate of diagnostic soil horizon formation. Fly ash was used as a time indicator. The depth of fly ash in the soil on the summit of the mound is consistent with the soil being tilled and mixed to a 40-cm depth. The sideslope of the mound has a similar significant depth of occurrence but has a higher amount of fly ash in the surface layer, suggesting that some tillage translocation and erosion of the summit soil has resulted in deposition on the sideslope. The soil developed in the alluvial fan adjacent to the mound has a similar texture and supports the theory that the mound was constructed from soil materials obtained from this alluvial fan rather than the theory that earth was carried from the adjacent bluffs formed in loess. Radiocarbon analysis of charcoal and organic matter found in the 80 to 130-cm layer suggests that 99% of the carbon is modern (<100 yrs old), which is consistent with the findings that trace amounts of fly ash in the layer were most likely moved into the layer by late historical human excavations and/or bioturbation. Reproduced with permission from the CAB Abstracts database.

34. Assessment of sugarcane crop applied with advanced engineering techniques using satellite remote sensing data.

Rao, V. V.; Rao, P. V. K.; and Venkataratnam, L. In: Proceedings of the 61st Annual Convention of the Sugar Technologists' Association of India. New Delhi, India.; pp. a56-a64; 1999.

Descriptors: assessment/ composts/ fertilizers/ fly ash/ measurement/ monitoring/ remote sensing/ satellites/ sugarcane/ metrology/ surveillance systems

Abstract: In field studies in 1997-98 in Andhra Pradesh, sugarcane was remote sensed to analyse the effects of earth radiation nullifying diverters, bore well water diverters, oxygen diverters, sonic treatment, fly ash, biofertilisers and compost.

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35. Barley seedling growth in soils amended with fly ash or agricultural lime followed by acidification.

Renken, R. R.; McCallister, D. L.; Tarkalson, D. D.; Hergert, G. W.; and Marx, D. B.

Soil Science 171(5): 414-422. (2006)

NAL Call #: 56.8 So3; ISSN: 0038-075X

Descriptors: acid soils/ acidification/ aluminium/ application rates/ barley/ calcium/ Entisols/ exchangeable aluminium/ fly ash/ growth/ lime/ lime requirement/ liming materials/ Mollisols/ roots/ seedling growth/ seedlings/ shoots/ soil acidity/ soil amendments/ soil ph/ soil types/ aluminum/ exchangeable aluminum/ United States of America

Abstract: Calcium-rich coal combustion fly ash can be used as an amendment to neutralize soil acidity because of its oxides and carbonate content, but its aluminium content could inhibit plant growth if soil pH values fall below optimal agronomic levels. This study measured root and shoot growth of an acid-sensitive barley (*Hordeum vulgare* L. 'Kearney') grown in the greenhouse on three naturally acid soils. The soils were either untreated or amended with

various liming materials (dry fly ash, wet fly ash, and agricultural lime) at application rates of 0.5, 1, and 1.5 times the recommended lime requirement, then treated with dilute acid solutions to simulate management-induced acidification. Plant growth indexes were measured at 30 days after planting. Root mass per plant and root length per plant were greater for the limed treatments than in the acidified check (0.0 x rate). Root growth in the limed treatments did not differ from root growth in the original nonacidified soils. Top mass per plant in all limed soils was either larger than or not different from that in the original nonacidified soils. Based on top mass per plant, no liming material or application rate was clearly superior. Both fly ash and agricultural lime reduced the impact of subsequent acidification on young barley plants. Detrimental effects of aluminium release on plant growth were not observed. Calcium-rich fly ash at agronomic rates is an acceptable acid-neutralizing material with no apparent negative effects. Reproduced with permission from the CAB Abstracts database.

36. Beneficial land application uses of FGD products.

Dick, W. A.; Kost, D. A.; and Chen, L.

In: 23rd Annual International Pittsburgh Coal Conference, PCC - Coal-Energy, Environment and Sustainable Development. Pittsburgh, PA.; 2006. ISBN: 1890977233; 9781890977238

Descriptors: byproducts/ combustion/ concentration (process)/ fossil fuels/ sulfur/ sulfur dioxide/ energy production/ flue gas desulfurization (FGD) technologies/ flue gases

Abstract: Combustion of fossil fuels for energy production releases sulfur dioxide (SO₂) at a rate proportional to the S concentration in the fuel. Industrialized nations have adopted flue gas desulfurization (FGD) technologies to reduce SO₂ emissions. FGD technologies will generate increased amounts of product in the future as more utilities install scrubbers for SO₂ control. These FGD products raise economic and environmental issues for which satisfactory solutions still need to be found. The type of coal and desulfurization process used influences the chemical composition and properties of an FGD product. The properties of the FGD material have a direct impact on potential land application uses. FGD properties most commonly captured for beneficial purposes are (1) ability to neutralize acid, (2) high amounts of soluble calcium and sulfate, (3) source of plant nutrients, and (4) uniform particle size. Land application uses of FGD materials are identified by matching the properties of the FGD material with improvement in some ecosystem function (or functions). For beneficial use, the change in ecosystem function is assumed to be positive. FGD use must be considered in terms of recommended application rates, environmental impact and economic return. Beneficial land application implies the applied FGD material will improve the soil (primarily) and also the total environment. Often, the intended benefit relates to plant growth, but there may be other benefits to soil or water such as reduction of erosion, improved quality of runoff and/or leachate water, or improved internal drainage. The application rate must be sufficient to cause soil improvement, but not so great as to constitute disposal of the FGD material. Although there is recognition of the potential of using FGD materials in agriculture, there is also uncertainty whether this use is sustainable. Currently, there is a general lack of

acceptance in the agricultural community for using FGD materials. This barrier can only be overcome by research and sound knowledge that sometimes already exists in the scientific and technical literature. To promote use of FGD products, especially FGD gypsum, a national network of agricultural demonstration and research sites has been established. Network sites, strategically located in the United States, are available to producers, users and marketers of FGD products to provide places where observations can be made as to the benefits of FGD product use under regional agricultural conditions. In addition, data on crop yields, environmental impacts and economic benefits will aid in the marketing of the FGD products.

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37. Beneficial uses of clean coal combustion by-products; soil amendment and coal refuse treatment examples and case studies.

Dick, Warren A.; Chen, Liming; and Hao, Yueli.

In: Use and disposal of coal combustion by-products at coal mines: A technical interactive forum. Morgantown, WV, United States.) Vories, Kimery C. and Throgmorton, Dianne (eds.); 2000.

Notes: References: 35; illus. incl. 5 tables.

Descriptors: agriculture/ ash/ case studies/ characterization/ coal/ coal combustion byproducts/ coal mines/ combustion/ geochemistry/ land use/ mines/ nutrients/ pH/ sedimentary rocks/ soil treatment/ sulfates/ United States/ utilization/ waste disposal/ waste management/ Environmental geology

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38. Beneficial uses of flue gas desulfurization by-products: Examples and case studies of land application.

Dick, W. A.; Hao YueLi; Stehouwer, R. C.; Bigham, J. M.; Wolfe, W. E.; Adriano, D.; Beeghly, J. H.; and Haefner, R. J.

In: Land Application of Agricultural, Industrial, and Municipal By-Products/ Power, J. F.; Dick, W. A.; Kashmanian, R. M.; Sims, J. T.; Wright, R. J.; Dawson, M. D.; and Bezdicek, D.; Series: Soil Science Society of America 6.

Madison, USA: Soil Science Society of America Inc. 2000; pp. 505-536.

Descriptors: application to land/ fly ash/ industrial wastes/ power stations/ scrubber sludge/ waste gases/ waste management/ waste utilization/ coal ash/ land application

Abstract: The properties of coal combustion wastes and their impacts on land application uses are summarized. Case studies of flue gas desulfurization waste use in agriculture, reclamation of coal-mined land and mining wastes, and as an engineering or construction material are also discussed.

Reproduced with permission from the CAB Abstracts database.

39. Benefits and constraints for use of FGD products on agricultural land.

Clark, R. B.; Ritchey, K. D.; and Baligar, V. C. 80(6): 821-828. (2001); ISSN: 00162361 [FUELA].

Notes: doi: 10.1016/S0016-2361(00)00162-9.

Descriptors: Agglomeration/ Aluminum/ Boron/ Coal combustion/ Compaction/ Desulfurization/ Flue gases/

Phosphorus/ Soil pollution/ Sulfur compounds/ Toxicity/ Trace elements/ Sulfite/ Coal byproducts

Abstract: Considerable amounts of coal combustion products (CCPs) are generated when coal is burned for generation of electricity. To meet Clean Air standards, large amounts of S must not be emitted into the atmosphere, which means considerable amounts of flue gas desulfurization products (FGDs) are and will be produced. Beneficial uses of FGDs are continually being sought to reduce waste, decrease cost of disposal, and provide value-added products. Beneficial agricultural uses of FGDs include application as amendment to acidic soil to mitigate low pH problems (Al and Mn toxicities); provide plant nutrients (i.e. Ca, S, and Mg); improve soil physical properties (e.g. water infiltration and soil aggregation); help alleviate soil compaction and improve aggregate stability of sodic soils; and inactivate P under high P-soil conditions to reduce P runoff. Co-utilization of FGDs with organic materials (manures, composts, biosolids) should also provide many benefits when used on land. Constraints for use of FGDs on agricultural land could be both insufficient or excessive amounts of CaCO₃, CaO, and/or Ca(OH)₂ in raising soil pH insufficiently or too much; excessive Ca to cause imbalanced Mg, P, and K in soils/plants; Ca displacement of Al from soil exchange sites to induce Al toxicity in plants; high B to induce B toxicity in plants; excessive sulfite which is toxic to plants; and excessive amounts of undesirable trace elements (e.g. As, Cd, Cr, Ni, Pb, and Se) which could potentially contaminate water and pose toxicity to plants/animals/microorganisms. Most constraints should not impose problems for FGD use on land.

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40. Bermudagrass sod growth and metal uptake in coal combustion by-product-amended media.

Schlossberg, M. J.; Vanags, C. P.; and Miller, W. P. *Journal of Environmental Quality* 33(2): 740-748. (2004) NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: application to land/ byproducts/ fly ash/ lawns and turf/ soil chemical properties/ soil physical properties/ uptake/ Bermuda grass/ chemical properties of soil/ Cynodon transvaalensis/ land application/ lawns and sports turf/ physical properties of soil/ United States of America

Abstract: Coal combustion by-products (CCB) include fly ash and bottom ash and are generated nationally at rates of 108 Mg yr⁻¹. Land applications of CCB have improved physicochemical properties of soil, yet inherent bulkiness and trace metal content of CCB often limit their use.

Likewise, utilization of biosolids and manure as fertilizer can be problematic due to unfavorable nutrient ratios. A 2-yr field study evaluated environmental and technical parameters associated with CCB-organic waste utilization as growth media in turfgrass sod production. Experimental growth media formulated with CCB and organic waste and a sand-compost control mixture were uniformly spread at rates from 200 to 400 m³ ha⁻¹ and sprigged with hybrid bermudagrass [*Cynodon dactylon* (L.) Pers. x *C. transvaalensis* Burt-Davy]. Leaf clippings were collected and analysed for total elemental content each year. In Year 2, growth media samples were collected during establishment 47 and 84 days after planting (DAP) and viable *Escherichia coli* organisms were quantified. At harvest (99 or 114 DAP), sod biomass and physicochemical properties of the growth media were

measured. During sod propagation, micronutrient and metal content in leaf clippings varied by growth media and time. After 47 d of typical sod field management, viable *E. coli* pathogens were detected in only one biosolids-amended plot. No viable *E. coli* were measured at 84 DAP. In both years, sod biomass was greatest in media containing biosolids and fly ash. Following installation of sod, evaluations did not reveal differences by media type or application volume. Using CCB-organic waste mixes at the rates described herein is a rapid and environmentally safe method of bermudagrass sod production. Reproduced with permission from the CAB Abstracts database.

41. Bio-efficacy of flyash-based herbal pesticides against pests of rice and vegetables.

Sankari, S. A. and Narayanasamy, P. *Current Science* 92(6): 811-816. (2007); ISSN: 0011-3891
Descriptors: aubergines/ botanical insecticides/ fly ash/ insect pests/ neem seed extract/ non wood forest products/ okras/ plant extracts/ plant pests/ rice/ turmeric/ vegetables/ brinjal / eggplants/ minor forest products/ neem/ non timber forest products/ paddy/ vegetable crops
Abstract: The bio-efficacy of fly ash (FA)-based herbal pesticides on certain insect groups is reported. The eight FA-based herbal pesticides showed efficacy in thwarting various groups of pests infesting rice and vegetables, thus indicating them to be potential biopesticides. Among all the treatments, FA+10% turmeric dust and FA+10% neem seed kernel dust showed the highest efficacy against all the test insects, including *Epilachna vigintioctopunctata* on aubergine and *Spodoptera litura* on okra, followed by the FA+10% *Vitex negundo* dust and FA+10% *Eucalyptus globulus* dust and FA+10% *Ocimum sanctum* [*Ocimum tenuiflorum*] dust treatments. Reproduced with permission from the CAB Abstracts database.

42. Biochemical parameters and bacterial species richness in soils contaminated by sludge-borne metals and remediated with inorganic soil amendments.

Mench, M.; Renella, G.; Gelsomino, A.; Landi, L.; and Nannipieri, P. *Environmental Pollution* 144(1): 24-31. (2006)
 NAL Call #: QH545.A1E52; ISSN: 0269-7491
Descriptors: acid phosphatase/ alkaline phosphatase/ arylsulfatase/ beta glucosidase/ biological activity in soil/ cadmium/ enzyme activity/ fly ash / heavy metals/ hydrolases/ iron/ microbial flora/ nickel/ polluted soils/ pollution control/ proteinases/ soil amendments/ soil bacteria/ soil enzymes/ soil flora/ soil pollution/ soil types/ sorption/ species richness/ urease/ acid phosphomonoesterase/ alkaline phosphomonoesterase/ arylsulphatase/ beringite/ microbial biomass/ microbial communities/ microflora/ proteases/ remediation/ soil respiration
Abstract: The effectiveness of two amendments for the in situ remediation of a Cd- and Ni-contaminated soil in the Louis Fargue long-term field experiment was assessed. In April 1995, one replicate plot (S1) was amended with 5% w/w of beringite (B), a coal fly ash (treatment S1+B), and a second plot with 1% w/w zerovalent-Fe iron grit (SS) (treatment S1+SS), with the aim of increasing metal sorption and attenuating metal impacts. Long-term responses of daily respiration rates, microbial biomass,

bacterial species richness and the activities of key soil enzymes (acid and alkaline phosphatase, arylsulfatase, beta -glucosidase, urease and protease activities) were studied in relation to soil metal extractability. Seven years after initial amendments, the labile fractions of Cd and Ni in both the S1+B and S1+SS soils were reduced to various extents depending on the metal and fractions considered. The soil microbial biomass and respiration rate were not affected by metal contamination and amendments in the S1+B and S1+SS soils, whereas the activity of different soil enzymes was restored. The SS treatment was more effective in reducing labile pools of Cd and Ni and led to a greater recovery of soil enzyme activities than the B treatment. Bacterial species richness in the S1 soil did not alter with either treatment. It was concluded that monitoring of the composition and activity of the soil microbial community is important in evaluating the effectiveness of soil remediation practices. Reproduced with permission from the CAB Abstracts database.

43. Biochemical responses of *Cassia siamea* Lamk grown on coal combustion residue (fly ash).

Kumar, A.; Vajpayee, P.; Ali, M. B.; Tripathi, R. D.; Singh, N.; Rai, U. N.; and Singh, S. N. *Bulletin of Environmental Contamination and Toxicology* 68(5): 675-683. (2002)
 NAL Call #: RA1270.P35A1; ISSN: 0007-4861
Descriptors: animal manures/ cattle dung/ cattle manure/ cysteine/ enzyme activity/ enzymes/ fly ash/ heavy metals/ lipid peroxidation/ nitrate reductase/ phytotoxicity/ reclamation/ soil amendments/ superoxide dismutase/ thiols/ *Cassia siamea*/ mercaptans
Abstract: Experiments were conducted using *Cassia siamea* plants grown on fly ash (FA), FA+garden soil (GS), FA+cow dung manure (CM), and FA+press mud (PM) in 1:1 ratio to determine the effect of heavy metal accumulation on cysteine, non-protein thiol contents, lipid peroxidation (measured in terms of malondialdehyde (MDA) content), superoxide dismutase (SOD) (antioxidant enzyme) and nitrate reductase activities. Heavy metal uptake by *C. siamea* plants induced lipid peroxidation in leaves after 20 days exposure to raw FA and FA-amended by soil, CM and PM in 1:1 ratio. Maximum MDA content as observed in plants grown in FA. Stimulation of SOD activity was observed in plants grown in raw FA and all the 3 types of amendments. However, this antioxidant enzyme was most active in plants grown in FA+PM amendment. An increase in cysteine content of plants grown in raw FA, FA+GS, FA+CM and FA+PM was observed. However, it was maximum in leaves of plants grown on FA+PM for 20 days while its minimum concentration was recorded when plants were grown in GS for the same duration. Maximum increase in non-protein thiol content was recorded when plants were grown in FA-amended by PM for 20 days while minimum non-protein thiol content was observed when plants were grown in raw FA for 60 days. Nitrate reductase activity (NRA) was also found affected by toxicity of FA. Maximum inhibition in NRA was recorded in plants grown for 60 days in raw FA. However, it was minimum when plants were growing in FA-amended GS in 1:1 ratio. The highest concentration of each heavy metal (Cu, Zn, Fe and Ni) was recorded in plants grown in FA-amended with PM. It is concluded that *C. siamea* is a highly suitable species for plantation on FA landfills as it thrives well and has metal

detoxification potential. Among the different FA amendments, PM was found to be the most suitable amendment for amelioration of FA.
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44. Biomass yield and phosphorus availability to wheat grown on high phosphorus soils amended with phosphate inactivating residues. III. Fluidized bed coal combustion ash.

Codling, E. E.; Mulchi, C. L.; and Chaney, R. L.
Communications in Soil Science and Plant Analysis 33(7-8): 1085-1103. (2002)
NAL Call #: S590.C63; ISSN: 0010-3624 [CSOSA2]
Descriptors: coal/ soil amendments/ Triticum aestivum/ dry matter accumulation/ crop yield/ phosphorus/ nutrient availability/ soil fertility/ nutrient content/ manganese/ poultry manure/ fluidized bed wastes
Abstract: The high phosphorus (P) soils in the poultry producing areas of Maryland's Eastern Shore pose an environmental risk to surface and ground water. Amendments with calcium (Ca) salts and calcium-rich byproducts have been considered in management practices for reducing P solubility in soil solution. A growth chamber experiment was conducted using fluidized bed coal ash (BA) at increasing rates on Matapeake, Evesboro, and Woodstown soils that had received poultry litter for over 30 years which increased Mehlich 3-phosphorus (M3-P) to levels above 800 mg kg⁻¹. The objectives of the study were to 1) determine the effects of BA on plant dry biomass yield (BM), wheat tissue P and Mn levels, and 2) examine pH, extractable P and Mn concentrations in the BA treated soils following three cropping cycles. BA was incorporated into each soil at rates of 0, 10, 25, and 50 g kg⁻¹ soil followed by incubation for seven weeks. Three crops of "Grandin" wheat (*Triticum aestivum* L.) were grown in succession. Biomass yield (BM) was significantly reduced with BA additions for the three soils. Plant P concentrations were progressively lowered with increased rates of BA for all BA additions for all three soils. Plant Mn levels were substantially reduced with additions of BA in response to the large increase in pH for all soils. Soil pH values increased from 5.0 +/- 0.2 in the control soils to >10.2 at the 50 g kg⁻¹ rate, and decreased during cropping cycles. Both water soluble P (WSP) and M3-P concentrations were significantly decreased upon addition of BA in all soils. Although WSP concentrations showed higher correlations with plant P concentration than M3-P levels, in terms of P sequestration in soils, WSP amounts were reduced by an average of 27 mg kg⁻¹ and 33 mg kg⁻¹ at addition of 10 g kg⁻¹ and 50 g kg⁻¹ while M3-P quantities were reduced by approximately 130 mg kg⁻¹ and 500 mg kg⁻¹, respectively, when averaged over soil and cycles. The large increase in soil pH, which reduced P in wheat at the 10 g kg⁻¹ BA, would suggest that this material may not be suitable for field application to sequester P in high P soils. This citation is from AGRICOLA.

45. Boron accumulation by maize grown in acidic soil amended with coal combustion products.

Clark, R. B.; Zeto, S. K.; Ritchey, K. D.; and Baligar, V. C.
78(2): 179-185. (1999); ISSN: 00162361 [FUELA]
Descriptors: plant dry matter/ shoot boron concentrations/ soil pH and electrical conductivity/ acidity/ boron/ carbonates/ crops/ cultivation/ electric conductivity of solids/

fluidized bed combustion/ fly ash/ lime/ plants (botany)/ soils/ toxicity/ acidic soil/ coal combustion products (CCP)/ plant dry matter / coal combustion

Abstract: Coal combustion products (CCPs) have potential for use as soil amendments on acidic soils. One concern for plants grown on acidic soils amended with CCPs is boron (B) toxicity, since many CCPs contain considerable B. Maize (*Zea mays* L.) was grown (greenhouse) on acidic soil [Umbric Dystrochept, pH 3.9 (1 soil:1 10 mM CaCl₂)] amended with 15 CCPs [two fly ashes (FAs), three fluidized bed combustion products (FBCs), one calcium (Ca) oxide (CaO) material, six high Ca sulfite (CaSO₃) flue gas desulfurization products (FGDs), and three high Ca sulfate (CaSO₄) FGDs] at different levels to determine accumulation of B in shoots. Plants were also grown in soil amended with Ca carbonate (CaCO₃, lime) and chemical grade CaSO₄ and CaSO₃ as controls. Among the CCPs tested, FAs contained the highest B levels. Shoot B concentrations were as high as 500 mg kg⁻¹ without reductions in dry matter (DM) for plants grown on soil amended with one FA. Plants grown with one FBC had sufficient B to suspect potential B toxicity, and plant DM was greatly reduced or died when grown with 0.5% of this material. Relatively high shoot B concentrations were noted in plants grown with the highest levels of high CaSO₃ FGDs. High shoot B concentrations (~300 mg kg⁻¹) were noted for plants grown with 5% levels of one high CaSO₄ FGD, and DM declined after reaching these levels. Plants grown on soil amended with CaO had low shoot B. Some of the CCPs used in this study contained sufficient B to potentially induce B toxicity in plants grown on the acidic soil amended with the various CCPs. Maize growth was generally enhanced when grown on soil amended with the CCPs at appropriate levels. © 1998 Elsevier Science Ltd. © 2009 Elsevier B.V. All rights reserved.

46. Calcium co-amendments modify extractable orthophosphate levels in fresh and composted cattle manure.

Whalen, J. K.
Water, Air and Soil Pollution 141(1-4): 105-124. (Nov. 2002)
NAL Call #: TD172 .W36; ISSN: 0049-6979 [WAPLAC]
Descriptors: cattle manure/ composts/ land application/ soil fertility/ nutrient availability/ phosphorus/ calcium oxide/ calcium hydroxide/ fly ash/ nutrient uptake/ Hordeum vulgare/ barley/ sandy loam soils/ nutrient content/ crop yield/ seeds/ barley straw/ nitrogen/ soil pH/ phosphates/ cement dust/ lime/ Internet resource
This citation is from AGRICOLA.

47. CBR and DCP correlation for Class C fly ash-stabilized soil.

Misra, A.; Upadhyaya, S.; Horn, C.; Kondagari, S.; and Gustin, F.
Geotechnical Testing Journal 29(1): 30-36. (2006); ISSN: 0149-6115
Descriptors: bearing characteristics/ clay soils/ fly ash/ penetrometers/ soil stabilization/ soil types/ bearing capacity
Abstract: The dynamic cone penetrometer (DCP) test is being increasingly used for assessing the California bearing ratio (CBR) values of sub-grade soil in the field. The purpose of this laboratory investigation was to establish a correlation between CBR and DCP for soils stabilized with

Class C fly ash. In this laboratory study, natural soil (Type CL-lean clay) mixed with Class C fly ash was used to establish the correlation at different percentages of Class C fly ash and moisture. It was found that a good correlation exists between CBR and DCP for Class C fly ash-stabilized soils and that the correlations are similar to those developed by other researchers. The correlations developed here may be used for rapid field determination of CBR values of clay soils stabilized with Class C fly ash. Reproduced with permission from the CAB Abstracts database.

48. Changes in amino acid profile and metal content in seeds of *Cicer arietinum* L. (chickpea) grown under various fly-ash amendments .

Gupta, D. K.; Tripathi, R. D.; Rai, U. N.; Dwivedi, S.; Mishra, S.; Srivastava, S.; and Inouhe, M.

Chemosphere 65(6): 939-945. (Nov. 2006)

NAL Call #: TD172 .C54; ISSN: 0045-6535.

Notes: [Erratum: 2007 Jan, v 66, issue 7, p 1382].

Descriptors: *Cicer arietinum*/ chickpeas/ plant proteins/ amino acid composition/ protein content/ chemical concentration/ bioaccumulation/ iron/ copper/ zinc/ cadmium/ chromium/ metals/ fly ash/ sawdust/ soil amendments/ press mud

This citation is from AGRICOLA.

49. Changes in physical and chemical properties of three soil types in India as a result of amendment with fly ash and sewage sludge.

Veeresh, H.; Tripathy, S.; Chaudhuri, D.; Ghosh, B. C.; Hart, B. R.; and Powell, M. A.

Environmental Geology 43(5): 513-520. (Feb. 2003)

NAL Call #: QE1.E5; ISSN: 1073-9106 [ENGOE9]

Descriptors: agricultural soils/ Oxisols/ Alfisols/ Vertisols/ soil amendments/ physicochemical properties/ India

Abstract: The use of coal fly ash and domestic sewage sludge in agriculture is being considered as one of the methods for recycling of these wastes in an environmental beneficial manner. Mixtures with soil were prepared at different proportions of fly ash and sludge, either alone or in combination at a maximum application rate of 52 t ha⁻¹. The changes in the selected properties and heavy metal contents of three soil types in India were studied after incubating the respective mixtures for 90 days at near field capacity moisture level. Sewage sludge, due to its acidic and saline nature, high organic matter and heavy metals content, had more impact on soil properties than the fly ash. Sludge application produced several changes including an increase in available nitrogen, organic carbon, salinity and water-holding capacity of the soils. The concentrations of major cations and heavy metals also increased because of the sludge application and the pH was decreased. However, the levels of individual metal concentrations in all the mixture types were below the allowable limits prescribed by several environmental agencies. Using fly ash either alone or in equal quantity with sewage sludge had little influence on soil properties and heavy metal content. The relative availability (RA) of heavy metals in three soils amended with 52 t ha⁻¹ of sewage sludge was observed to be highest in oxisol, followed by alfisol and vertisol.

This citation is from AGRICOLA.

50. Changes in the properties of sandy soil fertilized with different doses of ashes from "Dolna Odra" power station .

Meller, E.

Folia Universitatis Agriculturae Stetinensis, Agricultura 78: 189-201. (1999).

Notes: Original title: Zmiany we wasciwosciach gleby piaszczystej nawozonej zroznicowanymi dawkami popioow z elektrowni "Dolna Odra".

Descriptors: application rates/ biological activity in soil/ cadmium/ cobalt/ fertilizers/ fly ash/ magnesium/ phosphorus/ physical properties/ power stations/ properties/ sandy soils/ soil/ soil properties/ soil resources/ soil texture/ trace elements/ zinc/ microelements

Abstract: The effect of applications of 15, 30, 60 and 120 t fly ash/ha on physical, chemical and biological soil properties was studied on a sandy soil in a one-factor field experiment in Poland. The results show that the applied amounts of fly ash did not significantly affect the soil texture and other physical properties. There was no positive influence of ashes on biological activity in the arable-humic soil horizon (Ap) either. Ash fertilization contributed to clear but short soil deacidification. The soil resources, mainly of available magnesium and phosphorus, also improved. Although the concentration of some trace elements (Zn, Co, Cd) increased, their content was always lower than the permissible amount for agricultural soils.

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51. Characteristics of ash (coal, wood and rice hull) and its potential use as an additive in poultry manure for protecting the environment.

Nahm, K. H.

Korean Journal of Poultry Science 33(1): 65-80. (2006); ISSN: 1225-6625

Descriptors: acidity/ agricultural soils/ alkalinity/ biomass/ coal/ fly ash/ odour abatement/ organic carbon/ pH/ phosphorus/ poultry manure/ reviews/ rice husks/ silica/ soil amendments/ soil types/ solubility/ wood ash/ hydrogen ion concentration/ odor abatement/ potential of hydrogen/ poultry litter/ rice hulls

Abstract: This review focuses on the literature published about ash characteristics and their environmental uses. There is no uniform physico-chemical definition of the selected ashes (coal fly ash-CFA, wood ash-WA, and rice hull ash-RHA) used in various studies. These ashes vary greatly in their acidity (pH < 6.0) or alkalinity (pH > 12.5) based on the conditions at which they were farmed and the composition of the ash source. CFA amendment to manure reduced manure-P solubility and application of CFA amended manure to agricultural soils is a method to improve water quality WA may prove to be a valuable manure odour control amendment since it contains a high level of carbon. A major biomass source is rice hull (husk) which provides an ash source (RHA). The rice hull and RHA are sources of silica, comprising approximately 20 and 60%, respectively. So far research has been directed at the use of CFA, WA and RHA as soil amendments, but there is potential use of these materials as manure additives to sequester P and reduce odors.

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52. Characteristics of boron accumulation by fly ash application in paddy soil.

Lee SeulBi; Lee YongBok; Lee ChangHoon; Hong ChangOh; Kim PilJoo; and Yu Chan

Bioresource Technology 99(13): 5928-5932. (2008)

NAL Call #: TD930.A32 ; ISSN: 0960-8524

Descriptors: boron/ fly ash/ leaves/ paddy soils/ phytotoxicity/ rice / rice soils/ silicates/ soil amendments/ soil types/ paddy/ South Korea

Abstract: Fly ash has a high content of plant available silicate which is strongly needed for rice cultivation in Korea. One concern for plants grown on soils amended with fly ash is boron (B) toxicity because most of the fresh fly ash contains considerable B. This study was conducted in paddy soil to determine B uptake by rice and characteristics of B accumulation in soil after fly ash application (0, 40, 80, and 120 Mg fly ash ha⁻¹). In all fly ash treatments, B content in rice leaves and available B in soil at all growing stage were higher than those of control, but were not exceeded a toxicity levels. Boron occluded in amorphous Fe and Al oxides comprised ca. 20-39% of total B and was not affected by fly ash application. Most of the B was accumulated by fly ash application as a residual B which is plant-unavailable form, comprised >60% of the total B in soil. Thus, fly ash can be a good soil amendment for rice production without B toxicity.

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53. Characteristics of synthetic soil aggregates produced by mixing acidic "Kunigami Mahji" soil with coal fly ash and their utilization as a medium for crop growth.

Jayasinghe, G. Y.; Tokashiki, Y.; and Kitou, M.

Soil Science and Plant Nutrition 54(2): 264-276. (2008)

NAL Call #: 56.8 SO38 ; ISSN: 0038-0768

Descriptors: acid soils/ aggregates/ bulk density/ cation exchange capacity/ coal/ crop yield/ electrical conductivity/ exchangeable cations/ fly ash/ growing media/ growth/ particle density/ saturated hydraulic conductivity/ soil chemical properties/ soil ph/ soil physical properties/ soil types/ soybeans/ starch/ Ultisols/ waste paper/ waste utilization/ water holding capacity/ Capparales/ chemical properties of soil/ physical properties of soil/ potting composts/ rooting media/ soybeans

Abstract: This study was carried out to examine the characteristics and potential utilization of synthetic soil aggregates (SSA) produced by mixing acidic "Kunigami Mahji" soil in Okinawa, Japan, with waste materials, such as coal fly ash, used paper and starch, as media for crop growth. A series of different SSA were produced by incorporating various percentages (i.e. 0, 20, 40, 60, 80 and 100%) of coal fly ash into the "Kunigami Mahji" soil with used paper and starch. The particle density and bulk density of the original "Kunigami Mahji" soil were 2.67 and 1.23 g cm⁻³, respectively. The increased percentages of added coal fly ash, used paper and starch significantly decreased the particle and bulk densities of SSA compared with the original "Kunigami Mahji" soil because of the low particle and bulk densities of the coal fly ash (2.10 and 0.96 g cm⁻³, respectively). The SSA particle density varied between 2.39 and 2.14 g cm⁻³, and bulk density varied between 0.72 and 0.81 g cm⁻³, depending on the additional percentages of coal ash from

20-100%. Maximum water-holding capacity and saturated hydraulic conductivity were increased with the formation of SSA with coal fly ash, used paper and starch binder compared with the original "Kunigami Mahji" soil. The saturated hydraulic conductivity values of the SSA increased because of their low bulk density compared with the original soil. The addition of coal fly ash, used paper and starch to the acidic (pH=4.62) "Kunigami Mahji" soil to form SSA increased the pH (6.70-9.96), electrical conductivity, exchangeable cation concentration and cation exchange capacity. The addition of coal fly ash up to 60% increased the aggregate strength. The growth and yield of komatsuna and soybean crops with SSA as a crop growth medium was assessed. Both crops showed the highest growth and yield when grown with SSA containing 20% of coal fly ash. Synthetic soil aggregates containing more than 20% of coal fly ash reduced plant growth and yield. Therefore, SSA produced from "Kunigami Mahji" soil with 20% of coal fly ash, used paper and starch can be successfully used as a medium for crop growth. Reproduced with permission from the CAB Abstracts database.

54. Characterization of different coal fly ashes for their application in the synthesis of Zeolite X as cation exchanger for soil remediation.

Terzano, R.; Spagnuolo, M.; Medici, L.; Tateo, F.; and Ruggiero, P.

Fresenius Environmental Bulletin 14(4): 263-267. (2005);

ISSN: 1018-4619

Descriptors: arsenic/ cadmium/ cation exchange/ chemical composition/ chromium/ copper/ fly ash/ heavy metals/ lead/ nonclay minerals/ polluted soils/ soil amendments/ soil pollution/ soil types/ toxic substances/ trace elements/ X ray diffraction/ zeolites/ zinc/ microelements/ poisons/ remediation

Abstract: Four different coal fly ashes have been characterized for their potential application in the synthesis of Zeolite X for its use as cation exchanger for the remediation of heavy metal-polluted soils. Their chemical composition, with particular attention to the concentration of trace elements potentially toxic for the environment, has been determined by total dissolution and ICP-OES analysis. The relative amount of Zeolite X synthesized after 4 days of incubation at 60 degrees C starting from fly ash and the possible synthesis of other minerals has been investigated by means of X-ray diffraction. The fly ashes have been evaluated by their morphology (SEM analysis), granulometry (laser granulometry) and loss on ignition (LOI). Moreover, the fraction of potentially toxic elements, such as As, Cd, Cr, Cu, Pb and Zn, which can be released in solution during the synthetic process, has been quantified. Among the coal fly ash varieties analysed, one resulted to possess suitable properties for the synthesis of environmentally applicable Zeolite X, since it showed higher yield, no byproducts, lower mean particle size (useful for a quicker dissolution of the ash), and very low concentrations of potentially toxic elements. Finally, this coal fly ash has been fully characterized with regards to its chemical composition (major and minor constituents) by total dissolution and ICP-OES analysis, but also X-ray fluorescence of its fused powder.

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55. Characterization of thermal power station fly ash with relevant to plant nutrients availability.

Sanjay Bhojar

Annals of Plant Physiology 16(1): 29-35. (2002); ISSN: 0970-9924

Descriptors: calcium oxide/ cation exchange capacity/ chemical composition/ copper/ electrical conductivity / fly ash/ iron/ magnesium oxide/ manganese/ moisture content/ nitrogen/ nutrient availability/ particle density/ pH/ phosphate/ power stations/ soil amendments/ solubility/ zinc/ hydrogen ion concentration/ Mn/ potential of hydrogen

Abstract: This study was conducted to characterize the composition of fly ash from thermal power station in Korada District, Nagpur, Madhya Pradesh, India, to identify the available nutrients. The results showed that fly ash was near neutral in reaction (pH 7.5), free from soluble salts with EC 0.21 dSm⁻¹, low in organic carbon content (0.32%) and very poor CEC (0.44 cmol (P+)/kg). Air dried fly ash showed insignificant moisture content (0.38%) and negligible water solubility (0.26%). Fly ash was found to have substantially maximum water holding capacity (37.71%) with particle density 1.40 g/cm³. Very low content of total N (0.056%) and P₂O₅ (0.087%) was observed, and the total K₂O (0.172%), CaO (1.6%) and MgO (0.96%) content were significant. Total micronutrient content was substantial and the availability of Fe, Zn, Mn and Cu was 3.81, 1.30, 3.98 and 3.60 ppm, respectively. Based on the characteristics of fly ash, it can be used as soil amendment to increase surface area and porosity of soil, and effectively act as cheap source of plant nutrients especially of micronutrients.

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56. Chemical and physical properties of dry flue gas desulfurization products.

Kost, D.; Bigham, J. M.; Stehouwer, R. C.; Beeghly, J. H.; Fowler, R.; Traina, S. J.; Wolfe, W. E.; and Dick, W. A. *Journal of Environmental Quality* 34(2): 676-686. (Mar. 2005-Apr. 2005)

NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: air pollution/ contaminants/ industrial byproducts/ coal/ fly ash/ chemical residues/ chemical analysis/ physicochemical properties/ dioxins/ sulfur dioxide/ soil amendments/ processing technology/ particle size distribution/ leachates

Abstract: Beneficial and environmentally safe recycling of flue gas desulfurization (FGD) products requires detailed knowledge of their chemical and physical properties. We analyzed 59 dry FGD samples collected from 13 locations representing four major FGD scrubbing technologies. The chemistry of all samples was dominated by Ca, S, Al, Fe, and Si and strong preferential partitioning into the acid insoluble residue (i.e., coal ash residue) was observed for Al, Ba, Be, Cr, Fe, Li, K, Pb, Si, and V. Sulfur, Ca, and Mg occurred primarily in water- or acid-soluble forms associated with the sorbents or scrubber reaction products. Deionized water leachates (American Society for Testing and Materials [ASTM] method) and dilute acetic acid leachates (toxicity characteristic leaching procedure [TCLP] method) had mean pH values of >11.2 and high mean concentrations of S (primarily as SO₄(²⁻)) and Ca.

Concentrations of Ag, As, Ba, Cd, Cr, Hg, Pb, and Se (except for ASTM Se in two samples) were below drinking water standards in both ASTM and TCLP leachates. Total toxicity equivalents (TEQ) of dioxins, for two FGD products used for mine reclamation, were 0.48 and 0.53 ng kg⁻¹. This was similar to the background level of the mine spoil (0.57 ng kg⁻¹). The FGD materials were mostly uniform in particle size. Specific surface area (m² g⁻¹) was related to particle size and varied from 1.3 for bed ash to 9.5 for spray dryer material. Many of the chemical and physical properties of these FGD samples were associated with the quality of the coal rather than the combustion and SO₂ scrubbing processes used.

This citation is from AGRICOLA.

57. Chemical characteristics and heavy metal solubility of fly ash remediation systems under clayey soil conditions.

Sagoe-Crentsil, K. K.

In: Challenges posed by urban and industrial contaminants; Contaminated site remediation conference. Fremantle, West. Aust., Australia.) Johnston, C. D. (eds.) Wembley, West Aust., Australia (AUS): CSIRO Land and Water, Centre for Groundwater Studies; 1999.

Notes: References: 7; illus. incl. 1 table.

Descriptors: ash/ base metals/ cement/ Clay soils/ Eh/ hydrochemistry/ metal ores/ pH/ pollution/ reclamation/ soils/ waste treatment/ Environmental geology
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58. Chemical characteristics of an acid sulphate soil from Kerala amended with lime and flyash.

Ramesh, V. and Chhonkar, P. K.

Journal of the Indian Society of Soil Science 49(4): 719-726. (2001)

NAL Call #: 56.9 IN2; ISSN: 0019-638X

Descriptors: acid sulfate soils/ calcium/ cation exchange capacity/ exchangeable calcium/ fly ash/ iron/ lettuce/ lime/ liming/ nutrient availability/ residual effects/ rice/ soil chemical properties / soil ph/ soil types/ zinc/ acid sulphate soils/ chemical properties of soil/ paddy/ thionic soils

Abstract: Effect of fly ash and lime applications on some chemical characteristics of Sulfaquept (kari) growing rice and its residual effect under lettuce crop was studied. Fly ash did not increase pH, EC and exchangeable calcium content of the soil under both the crops. The effect of liming as well as its interaction with fly ash was significant with respect to these parameters. The available sulfur content of the soil was increased with fly ash but declined with lime application. However, the residual effect of lime alone resulted in increased sulfur content. Fly ash application significantly increased the available iron and zinc content of soil while lime reduced both of them. However, fly ash amended soils under lettuce did not affect available zinc content while liming decreased it. Fly ash application increased the exchangeable aluminium content of the soil under both crops while the effect of lime was not noticeable. The residual fly ash and lime tended to reduce available cadmium.

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59. Chemical characterization of ash from gasification of alfalfa stems: Implications for ash management.

Mozaffari, M.; Rosen, C. J.; Russelle, M. P.; and Nater, E. A.

Journal of Environmental Quality 29(3): 963-972. (2000)
NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: aromatic hydrocarbons/ arsenic/ ash/ cadmium/ calcium/ carbon/ chemical composition/ chlorine/ cobalt/ crop residues/ electric power/ fly ash/ gasification/ lead/ lucerne/ naphthalene/ polycyclic hydrocarbons/ potassium/ selenium/ soil amendments/ waste management/ waste utilization/ alfalfa

Abstract: Electricity generation from biomass is an attractive option from an environmental perspective. Pilot studies have indicated that lucerne (*Medicago sativa*) stems are suitable feedstock for energy generation via gasification. Detailed information on chemical characteristics of the ash generated from gasification of lucerne stem is required to develop environmentally and economically sound ash management strategies. Lucerne fly and bottom ashes were characterized with respect to chemical properties that are important in developing ash management practices with emphasis on beneficial utilization as a soil amendment. Mean concentrations of total C, K, Ca, and Cl were 424, 120, 85, and 26 g kg⁻¹, respectively, in fly ash. In bottom ash, the mean concentrations of C, K, and Ca, were 63, 61, and 193 g kg⁻¹. Concentrations of total Pb, As, Cd, Co, and Se were below detection limits in both ash types. Naphthalene ranged from 6.2 to 74 mg kg⁻¹, but concentrations of many other polycyclic aromatic hydrocarbons were low or below mg kg⁻¹ detection limits. Available K and P in fly ash were 90 to 120 and 8 to 10 g kg⁻¹, respectively. Mean CaCO₃ equivalent value of fly ash was 400 g kg⁻¹, its electrical conductivity (EC) and pH were 127 dS m⁻¹ and 11.5, respectively. These results suggest that when managed properly, gasified lucerne ash could potentially be utilized as a beneficial soil amendment with few potential environmental concerns.

Reproduced with permission from the CAB Abstracts database.

60. Chemical characterization of synthetic soil from composting coal combustion and pharmaceutical by-products.

Guest, C. A.; Johnston, C. T.; King, J. J.; Alleman, J. E.; Tishmack, J. K.; and Norton, L. D.

Journal of Environmental Quality 30(1): 246-253. (2001)
NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: byproducts/ chemical composition/ coal/ composting/ fly ash/ growing media/ organic wastes/ sewage sludge/ potting composts/ rooting media

Abstract: Land application of coal combustion byproducts (CCBs) mixed with solid organic wastes (SOWs), such as municipal sewage sludge, has become increasingly popular as a means of productively using what were once considered waste products. Although bulk chemical and physical properties of several of these CCB-SOW materials have been reported, detailed information about their synthesis and mineralogy of the CCB-SOW materials has not been reported. In this paper, chemical and mineralogical properties of a soil-like material obtained from composting a mixture of CCBs with a pharmaceutical fermentation byproduct (FB) were investigated at the laboratory and field scale. All starting materials and

products were characterized by X-ray diffraction (XRD), fourier transform infrared (FTIR) spectroscopy, and elemental analyses. The results showed that the FB was strongly bound to the CCBs and could not be removed by washing. Within 2 weeks of the start of a composting study, there was a rapid drop in pH from 12 to 8, an increase in temperature to 70 degrees C, and a reduction in the dissolved oxygen content, attributed to the rapid establishment of a highly active microbial population. Composting produced a soil-like material with high levels of plant nutrients, a high nutrient retention capacity, and metal contents similar to median levels of those metals reported for soils. The levels of boron and soluble salts are such that sensitive plants may initially show toxicity symptoms. However, with adequate rainfall, leaching should rapidly remove most of the B and soluble salts. With care, the material produced is safe for use as a synthetic topsoil. Reproduced with permission from the CAB Abstracts database.

61. Chemical composition of leachate of dairy manure mixed with fluidized bed combustion residue.

Elrashidi, M. A.; Baligar, V. C.; Korcak, R. F.; Persaud, N.; and Ritchey, K. D.

Journal of Environmental Quality 28(4): 1243-1251. (Aug. 1999)

NAL Call #: QH540.J6; ISSN: 0047-2425.

Notes: References: 41; illus. incl. 2 tables.

Descriptors: agricultural waste/ aluminum/ animal waste/ boron / cadmium/ chlorine/ chromium/ copper/ fluidized bed combustion residue/ halogens/ heavy metals/ iron/ leachate/ lead/ manganese/ metals/ nickel/ pollutants/ pollution/ soils/ sulfur/ waste disposal/ water quality/ zinc/ environmental geology

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62. Chemical evaluation of nutrient supply from fly ash-biosolids mixtures.

Schumann, A. W. and Sumner, M. E.

Soil Science Society of America Journal 64(1): 419-426. (Jan. 2000-Feb. 2000)

NAL Call #: 56.9 So3; ISSN: 0361-5995 [SSSJD4]

Descriptors: organic fertilizers/ fertilizer analysis/ fly ash/ sewage sludge/ poultry manure/ mixtures/ nutrient availability/ extraction/ dris

Abstract: Prediction of plant nutrient supply from fly ash and biosolids (sewage sludge and poultry manure) may enhance their agricultural use as crop fertilizer. Two mild extraction methods (42-d equilibration with ion-exchange resins, 2-d equilibration with pH 4.8 buffered nutrient solution) and analysis of nutrient data by the Diagnosis and Recommendation Integrated System (DRIS) were tested with 29 fly ash samples, four biosolids samples, and their mixtures. The resin method was useful for major nutrient (N, P, K, Ca, Mg, S) extraction from fly ashes and organic materials, particularly where mineralizable fractions of N and P under aerobic conditions are required. However, resins were inefficient in extracting P from high-Fe sewage sludges because organic waste samples caused premature failure of semipermeable membranes and fouling of resins. Extraction of fly ash with dilute buffered nutrient solution was more successful because micro-nutrient recovery was improved, major nutrients were correlated to the resin method, both addition and removal of nutrients were recorded, DRIS analysis was possible, and equilibration

was rapid (2 d). The overall nutrient supply from these extremely variable fly ashes was: Cu = Fe approximately equal to B approximately equal to Mo > Ca > S > Zn > > Mn > N > Mg > P > K (high micronutrient, low major nutrient supply). For biosolids, the major nutrients ranked: P N approximately equal to Ca > S > Mg > K (sewage sludges), and N > Ca approximately equal to K > P > Mg > S (poultry manures). In mixtures of fly ash with 26% sewage sludge the order was: Ca > S > N > Mg > P > K, while in mixtures of fly ash and 13% poultry manure, the nutrients ranked: Ca > K approximately equal to N approximately equal to S > Mg > P. Optimal plant nutrition (especially N-P-K balancing) should be possible by mixing these three waste materials. This citation is from AGRICOLA.

63. Chemical properties of lateritic soil and yield of rice as influenced by addition of fly ash.

Subramoniam, S. R. and Chandrasekaran, A. *International Rice Research Notes* 30(1): 35-37. (2005)
 NAL Call #: SB191.R5I6; ISSN: 0117-4185
Descriptors: acid soils/ application rates/ calcium/ cation exchange capacity/ coir/ crop yield/ electrical conductivity/ exchangeable calcium/ exchangeable magnesium/ fly ash/ iron/ irrigated conditions/ lateritic soils/ lime/ liming/ magnesium/ nitrogen/ nutrient availability/ nutrient content/ organic carbon/ phosphorus/ potassium/ red soils/ rice/ rice husks/ rice soils/ soil chemical properties/ soil organic matter/ soil ph/ soil types/ waste utilization/ zinc/ chemical properties of soil/ coconut fibre/ Madras/ organic matter in soil/ paddy/ red earths/ rice hulls

Abstract: A field experiment was conducted to assess the use of fly ash, coir pith and rice husk ash in improving the lateritic soils of Kanyakumari District in Tamil Nadu, India under irrigated rice cultivation. Different combinations of fly ash (10 and 15 tonnes/ha) with different doses of lime, rice risk ash (12.5 tonnes/ha), raw coir pith (12.5 tonnes/ha), and coir pith compost (12 tonnes/ha). Grain yield was maximum in the treatment with 15 tonnes fly ash/ha and 12 tonnes lime/ha. Application of fly ash, lime and other industrial wastes had a positive effect on grain and straw yield. The pH, electrical conductivity and cation exchange capacity of the red lateritic acid soil increased with fly ash addition. Organic carbon content increased from 0.22-0.36% due to the organic compounds released from coir pith compost. Available NPK and exchangeable Ca and Mg likewise increased with fly ash application. Exchangeable Ca and Mg content was maximized with the application of fly ash with lime, but available Fe content of the soil decreased. Zn content of the soil was not affected. Fly ash contained a negligible amount of Fe but the lime addition decreased Fe availability in the soil. Reproduced with permission from the CAB Abstracts database.

64. Chemical speciation and phytoavailability of Zn, Cu, Ni and Cd in soil amended with fly ash-stabilized sewage sludge.

Su, D. C. and Wong, J. W. *Environment International* 29(7): 895-900. (Jan. 2004)
 NAL Call #: TD169.E54; ISSN: 0160-4120
Descriptors: Biodegradation, Environmental/ Biological Availability/ Carbon: chemistry/ Coal/ Environmental Monitoring/ Industrial Waste/ Metals, Heavy: chemistry: pharmacokinetics/ Particulate Matter/ Refuse Disposal: methods/ Sewage: chemistry/ Zea mays: chemistry: growth

& development

Abstract: A sequential extraction method was used to determine chemical forms of Cu, Zn, Ni and Cd in fly ash-stabilized sludge. A loamy acid soil amended with fly ash-stabilized sludge was used to grow corn under greenhouse conditions. Sewage sludge amended with coal fly ash can reduce the availability of Cu, Zn, Ni and Cd in the sludge. Increasing fly ash amendment rate significantly reduced DTPA-extractable Cu, Zn, Ni and Cd concentrations. Percentages of Cu, Zn and Ni in residual fraction increased with an increase in fly ash amendment rates. Majority of Cu was associated with organic form, but Zn and Ni were associated with Fe-Mn oxide and residual forms. Addition of ash-amended sludge to soil significantly increased dry mass of corn. With coal fly ash amendment rate increasing, concentrations of Zn and Cu in shoot tissues of corn decreased significantly, but concentrations of Cd and Ni did not change significantly. Significant correlations were found between concentrations of Cu and Zn in corn shoot and oxide and total Cu fractions, and all chemical fractions of Zn in fly ash-stabilized sludge, respectively. Hence, ash amendment significantly reduced the availability of heavy metals by chemical modification of their chemical speciation into less available forms.

This citation is from PubMed.

65. Chlorophyll production in Acacia nilotica seedlings grown in flyash.

Kashyap, M. K.; Manjhi, R. B.; Avinash Jain; and Banerjee, S. K. *Indian Journal of Forestry* 23(1): 41-45. (2000); ISSN: 0971-9431

Descriptors: chlorophyll/ chlorosis/ fly ash/ nitrogen phosphorus fertilizers/ nutrient deficiencies/ phosphorus fertilizers/ plant nutrition/ power stations/ sand/ seedlings/ superphosphate/ urea fertilizers/ phosphate fertilizers
Abstract: The chlorophyll content was studied of *Acacia nilotica* seedlings grown from seed on fly ash from the coal fired thermal power plant at Korba, Madhya Pradesh (India), mixed with sand, N (200 or 200 ppm N as urea) and P (25 ppm P as SSP [single superphosphate]) in different combinations. The chlorophyll content differed significantly the treatments at 1, 3 and 5 months old. The amount of chlorophyll A, chlorophyll B and total chlorophyll decreased gradually during the study period for all the treatments. The chlorotic nature of nutrient deficient plants was attributed to impaired photosynthesis resulting from the direct effect of the fly ash medium on the protein level and the chlorophyll content of the chloroplast. The best treatment for increasing the chlorophyll content of the leaves of *Acacia nilotica* was fly ash + sand + N(2000 ppm) + P (25 ppm). Reproduced with permission from the CAB Abstracts database.

66. Chromium leaching and immobilization in treated soils.

Dermatas, D. and Moon, D. H. *Environmental Engineering Science* 23(1): 77-87. (2006)
 NAL Call #: TD811.5.H39; ISSN: 1092-8758
Descriptors: chromium / clay minerals/ fly ash/ immobilization/ kaolinite/ leaching/ lime/ liming/ montmorillonite/ polluted soils/ quartz/ soil pollution/ soil types

Abstract: The purpose of this study is to investigate the effectiveness of a quicklime-based stabilization/solidification (s/s) technique to reduce the leachability of Cr(III) and Cr(VI) in laboratory-prepared soil. The soils were prepared by mixing kaolinite or montmorillonite with fine quartz sand and then subjecting the samples to s/s treatment. Treatment included quicklime, fly ash, and quicklime-fly ash additions. The effectiveness of the treatment was evaluated using the Toxicity Characteristic Leaching Procedure (TCLP) test. To elucidate the controlling Cr(VI) immobilization mechanisms, slurry mixtures were prepared with potassium chromate (K_2CrO_4), quicklime, and fly ash. X-ray diffraction (XRD) analyses were performed to investigate the reaction products responsible for Cr(VI) immobilization. Experimental results indicate very low Cr(III) leachability upon quicklime treatment. All samples treated with quicklime and quicklime-fly ash show TCLP Cr(III) concentrations below the U.S. EPA TCLP limit of 5 ppm. However, neither quicklime nor fly ash treatment alone was effective in reducing Cr(VI) leachability. An effective reduction in Cr(VI) leachability was achieved only when both quicklime and fly ash were added to the laboratory-prepared soils. Previous research has attributed this reduction in Cr(VI) leachability to the fly ash-induced chemical reduction of Cr(VI) to Cr(III). However, in this study, fly ash was found to be an ineffective reducing agent. XRD analyses results for quicklime-fly ash slurries do not indicate the formation of $CaCrO_4$ or $CaCrO_4 \cdot 2H_2O$, which were identified in previous research as the reaction products responsible for Cr(VI) immobilization. A hypothesis is presented in this paper to explain these results and the effectiveness of quicklime-fly ash mixtures in reducing the leachability of Cr(VI). XRD analyses have also identified the pozzolanic compound $3CaOAl_2O_3 \cdot 0.5CaCrO_4 \cdot 0.5CaSO_4 \cdot nH_2O$ as the precipitate most likely responsible for Cr(VI) immobilization. Reproduced with permission from the CAB Abstracts database.

67. Circulating fluidized bed combustion product addition to acid soil: Alfalfa (*Medicago sativa* L.) composition and environmental quality.

Chen, L.; Dick, W. A.; and Kost, D.

Journal of agricultural and food chemistry 54(13): 4758-65. (June 2006)

NAL Call #: 381 J8223 ; ISSN: 0021-8561

Descriptors: agrochemicals: chemistry/ calcium carbonate: chemistry/ chemistry, physical/ coke: analysis/ environment/ hydrogen ion concentration/ medicago sativa: chemistry/ soil: analysis/ sulfur: chemistry/ trace elements: analysis/ water: chemistry

Abstract: To reduce S emissions, petroleum coke with a high concentration of S was combusted with limestone in a circulating fluidized bed (CFB) boiler. The combustion process creates a bed product that has potential for agricultural uses. This CFB product is often alkaline and enriched in S and other essential plant nutrients, but also contains high concentrations of Ni and V. Agricultural land application of CFB product is encouraged, but little information is available related to plant responses and environmental impacts. CFB product and agricultural lime

(ag-lime) were applied at rates of 0, 0.5, 1.0, and 2.0 times the soil's lime requirement (LR) to an acidic soil (Wooster silt loam). The 2.0x LR application rate of CFB product was equivalent to 67.2 Mg ha⁻¹. Alfalfa yield was increased 4.6 times by CFB product and 3.8 times by ag-lime compared to untreated control. Application of CFB product increased the concentration of V in soil and alfalfa tissue, but not in soil water, and increased the concentration of Ni in soil and soil water, but not in alfalfa tissue. However, these concentrations did not reach levels that might cause environmental problems.

This citation is from PubMed.

68. Clean technology for bulk utilisation of coal ash in agriculture.

Saxena, M.; Murali, S.; Asokan, P.; Mishra, C. R.; and Pal, H. K.

In: REWAS'04 - Global Symposium on Recycling, Waste Treatment and Clean Technology. Gaballah I.; Mishra B.; Solozabal R.; and Tanaka M. (eds.)

Madrid; pp. 655-664; 2005. ISBN: 8495520044

Descriptors: Agriculture/ Crops/ Power plants/ Radioisotopes/ Soils/ Trace elements/ Captive Power Plant (CPP) / Clean technology/ National Aluminium Company Limited (CO)/ Regional Research Laboratory (RRL)/ Coal ash/ Agriculture/ Ash/ Coal/ Farm Crops/ Power Plants/ Radioisotopes/ Soil/ Trace Elements

Abstract: With the primary objective of development and demonstration of clean technology for bulk utilisation of Coal ash generated by Captive Power Plant (CPP) of National Aluminium Company Limited (NALCO), Angul, Orissa, India, studies on "Long term effect of Coal ash / Pond ash on agriculture system" have been carried out by Regional Research Laboratory (RRL), Bhopal, India. Characterization of Pond ash and soil for optimization of the dose for agriculture, have been carried out for physical and chemical properties as well as trace elements and radionuclides. Randomized Block Design experiments have been conducted on wasteland plots by admixing Pond ash at the rate of 10% (280 T ha⁻¹) and 20% (560 T ha⁻¹) in 1999. Maize (*Zea mays* L.) and paddy (*Oriza sativa* L.) in kharif and onion (*Allium cepa* L.) and sunflower (*Helianthus annuus* L.) crops in rabi seasons were raised on rotation basis in two separate experimental plots during 1999-2002. The effect of trace elements like Cu, Zn, Fe, Mn, Ni, Cr, Co, Cd etc present in the soil admixed with Pond ash application were tested. No adverse effect on the soil system has been observed. The radioactivity levels like ²²⁶Ra, ²²⁸Ac and ⁴⁰K in the ash admixed soil have been analysed. Due to the Pond ash admixing in soil, no toxicity symptoms have been noticed on the crop physiology during the crop growth stages. The presence of the above trace elements and radioactivity levels in the food (grains/seeds/bulbs) grown on the ash admixed plots are within the permissible limits. In addition, this clean technology of bulk utilisation of Pond ash in agriculture has been paying dividends to the farming community in the form of 20 - 25% increased crop yields due to the favourable soil modification and micro-nutrients like Cu, Zn, Fe, Mn and Co supplied by the Pond ash to the plants.

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69. CO₂ evolution and enzyme activities (dehydrogenase, protease and amylase) of fly ash amended soil in the presence and absence of earthworms (Drawida willsi Michaelsen) under laboratory conditions.

Pati, S S and Sahu, S K

Geoderma 118(3/4): 289-301. (2004)

NAL Call #: S590 .G4; ISSN: 0016-7061

Descriptors: amylases / biological activity in soil/ carbon dioxide/ enzyme activity/ fly ash/ microbial activities/ oxidoreductases/ proteinases/ respiration/ soil amendments/ soil enzymes/ Drawida willsi/ proteases/ redox enzymes

Abstract: The CO₂ evolution and dehydrogenase, protease and amylase activities of fly ash amended soil (Orissa, India) in the presence and absence of earthworms were investigated under laboratory conditions for 2 months at 50% water-holding capacity (WHC) and 25±2 degrees C temperature. A toxicity test of different age groups (juvenile, immature and adult) of *Drawida willsi* earthworms, dominant (>80% both in number and biomass) in crop fields of India, was conducted for 14 days at different concentrations of fly ash amended soil. On the basis of the results of the toxicity test, seven concentrations of fly ash amended soil were chosen (0, 2.5, 5, 10, 15, 25 and 50%; w/w) to study the CO₂ evolution and enzyme activities in the presence and absence of *D. willsi*. The results demonstrated little or no inhibition of soil respiration and enzyme activities up to 2.5% fly ash amendment. With further addition of fly ash, all the above activities were significantly decreased. On the other hand, significant stimulation of soil respiration and microbial activities were observed up to 5% fly ash amendment when the soils contained earthworms. This may be due to increased microbial activity induced by substrates that are produced by the earthworms. Co-application of fly ash and earthworms at lower doses can thus be considered to stimulate soil biological activity and thereby improve nutrient cycling in acidic soil.

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70. Coal combustion residues: Environmental implications and recycling potentials.

Asokan, P.; Saxena, M.; and Asolekar, S. R. 43(3): 239-262. (2005); ISSN: 09213449 [RCREE].

Notes: doi: 10.1016/j.resconrec.2004.06.003.

Descriptors: building materials/ characterisation/ coal combustion residues/ conservation/ disposal/ engineering applications/ recycling/ resources/ utilisation and safe-management/ calorific value/ coal ash/ electric power generation/ environmental impact/ fossil fuels/ substitution reactions/ ash ponds/ coal combustion residues (CCR)/ electric power requirement/ environmental sound management/ coal combustion/ asbestos/ cement/ coal/ concrete/ fossil fuel/ heavy metal/ lignite/ paint/ radioactive element/ sulfur/ coal-fired power plant/ electricity generation/ recycling/ waste management/ agriculture/ ash/ chemical composition/ chemical structure/ combustion/ construction work/ ecology/ electricity/ environmental factor/ environmental reclamation/ extraction/ India/ mineralogy/ mining/ physical chemistry/ pollution/ radioactivity/ recycling/ review/ solid waste/ waste management/ Asia/ Eastern Hemisphere/ Eurasia/ India/ South Asia/ World/ Fraxinus

Abstract: To meet the electric power requirement, the world population is greatly dependent on fossil fuel. Presently in India, about 75% of the total electrical energy (i.e. ?100,000 MW) is generated from fossil fuel and about 105 million tons of coal combustion residues (CCRs) as solid waste/by-product is being released annually during combustion of pulverised bituminous, sub bituminous, and lignite coal. Indian coal typically has ash content of 30-60%, which results in low calorific value however low in sulphur, radioactive elements and heavy metals content. Mostly, the CCRs is being disposed to the ash pond as thin slurry, and more than 65,000 acres of land is occupied in India for storage of this huge quantity of ash which leads ecological and environmental problems. Presently about 27% of the total CCRs produced in India is being recycled and used in various applications. The major utilisation is in cement, concrete, bricks, wood substitute products, soil stabilisation, road base/embankment, and consolidation of ground, land reclamation and for agriculture. In this paper, an attempt has been made to assess the global generation of CCRs, present utilisation and acceptability in Indian context, implications and future potentials to achieve environmental sound management. _ 2004 Elsevier B.V. All rights reserved.

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71. Coal fly ash and lime stabilized biosolids as an ameliorant for boron deficient acidic soils.

Jiang, R. F.; Yang, C. G.; Su, D. C.; and Wong, J. W. C.

Environmental Technology 20(6): 645-649. (1999)

NAL Call #: TD1.E59; ISSN: 0959-3330

Descriptors: acid soils/ application rates/ cucumbers/ fly ash/ lime/ loam soils/ maize/ plant tissues/ soil amendments/ soil types/ toxicity/ trace element deficiencies/ trace element fertilizers/ yields/ corn/ gherkins/ micronutrient fertilizers

Abstract: Previous studies have shown that a combination of coal fly ash (10% w/w) and lime (1% w/w) amendment was effective in stabilizing biosolids (ACS) by killing the pathogens and reducing heavy metal availability, and the product contained a high B content. The suitability of ACS as a B fertilizer for a degraded B deficient acid soil (from South China) was evaluated. An acid and B deficient loamy soil was amended with the ACS at application rates of 6.4, 12.7, 25.5, 63.7 and 127.4 mg/ha, which were then compared to the same soil receiving an equivalent B fertilizer application rates of 0.9, 1.4, 2.2, 4.5 and 8.4 kg/ha, respectively. Soil hot water soluble B content and pH increased significantly with an increase in the amendment rate of the ACS mixture. Soil amended with the ACS mixture had a significantly higher dry weight yield for both cucumber and maize than the control and its counterparts of soil with B fertilizer. The highest yield was obtained in the treatment with 5% ACS mixture amendment. Boron concentrations in plant tissues increased according to the application rates of the ACS mixture and B fertilizer. Cucumber was more sensitive than maize to both B deficiency and toxicity as indicated by the insignificant effect of B fertilizer application on dry weight yields of maize. The experimental results demonstrated that the ACS mixture at an application rate of ≤63.7 mg/ha could act as a B fertilizer supplement for the acid loamy soil. Reproduced with permission from the CAB Abstracts database.

72. Coal fly ash and phospho-gypsum mixture as an amendment to improve rice paddy soil fertility.

Lee, Y. B.; Ha, H. S.; Lee, C. H.; and Kim, P. J. *Communications in Soil Science and Plant Analysis* 39(7-8): 1041-1055. (Apr. 2008)

NAL Call #: S590.C63; ISSN: 0010-3624

Descriptors: coal fly ash/ phospho-gypsum/ soil amendment/ rice paddy/ soil fertility

Abstract: Rice is a plant that requires high levels of silica (Si). As a silicate (SiO₂) source to rice, coal fly ash (hereafter, fly ash), which has an alkaline pH and high available silicate and boron (B) contents, was mixed with phosphor-gypsum (hereafter, gypsum, 50%, wt wt-1), a by-product from the production of phosphate fertilizer, to improve the fly ash limitation. Field experiments were carried out to evaluate the effect of the mixture on soil properties and rice (*Oryza sativa*) productivity in silt loam (SiL) and loamy sand (LS) soils to which 0 (FG 0), 20 (FG 20), 40 (FG 40), and 60 (FG 60) Mg ha⁻¹ were added. The mixture increased the amount of available silicate and exchangeable calcium (Ca) contents in the soils and the uptake of silicate by rice plant. The mixture did not result in accumulation of heavy metals in soil and an excessive uptake of heavy metals by the rice grain. The available boron content in soil increased with the mixture application levels up to 1.42 mg kg⁻¹ following the application of 60 Mg ha⁻¹ but did not show toxicity. The mixture increased significantly rice yield and showed the highest yields following the addition of 30-40 Mg ha⁻¹ in two soils. It is concluded that the fly ash and gypsum mixture could be a good source of inorganic soil amendments to restore the soil nutrient balance in rice paddy soil.

This citation is from AGRICOLA.

73. Coal fly ash as a soil conditioner for field crops in southern Ontario.

Cline, J. A.; Bijl, M.; and Torrenueva, A. *Journal of Environmental Quality* 29(6): 1982-1989. (2000)

NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: application rates/ boron/ crop yield/ field crops/ fly ash/ lime/ maize/ nutrients/ plant composition/ seedling emergence/ selenium/ soil/ soil conditioners/ soil pH/ soil types/ soybeans/ chemical constituents of plants/ corn/ soybeans

Abstract: Sixty-eight per cent of the 957 000 t of fly ash (FA) from coal-fired generating stations in Ontario, Canada, was landfilled in 1998. Current restrictions by government regulators prevent its use for agricultural purposes. Greenhouse and field experiments were therefore initiated to assess the effects of FA on plant growth. The objective of the greenhouse study was to evaluate various rates of FA (0-80 t ha⁻¹ equivalent) on soil pH, soil and plant nutrient levels, and plant growth using representative acidic clay and sandy soils from Southern Ontario. After 90 d of soil incubation, the highest rates of FA increased soil pH, but had no significant effect on hot-water extractable B. Dry weights of plants grown in the same soil types were unaffected by FA rates. In a 3-yr field study, FA was applied to acidic clay and sandy loam soils at rates ranging from 0 to 50 t ha⁻¹ (dry wt. basis). Lime control treatments were also included. In Year 1, maize plant emergence, grain yield, percentage moisture, and harvest index were not significantly influenced by FA applications. However, soybean yields treated with 50 t FA ha⁻¹ increased by as much as 35 and 31% in comparison with untreated and

lime control treatments, respectively. Selenium and boron, while presently the rate-limiting elements for maximum permissible loading rates of FA for soil amendments in the province, did not accumulate in plants in quantities that would be of concern for plant health or animal and human consumption.

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74. Coal fly ash as an acid-reducing soil amendment and its side effects.

McCallister, D. L.; Frank, K. D.; Stevens, W. B.; Hergert, G. W.; Renken, R. R.; and Marx, D. B.

Soil Science 167(12): 811-820. (2002)

NAL Call #: 56.8 So3; ISSN: 0038-075X

Descriptors: acid soils/ acidification/ aluminium/ application rates/ chemical composition/ coal/ combustion/ fly ash/ lime/ lime requirement/ liming materials/ loam soils/ sandy loam soils/ soil acidity/ soil amendments/ soil pH/ soil toxicity/ soil types/ aluminum/ toxic soils

Abstract: Coal combustion by-products may offer significant benefits if used properly to neutralize soil acidity, but unintended release of trace components must be considered. A study was conducted with two objectives: (i) To compare the efficacy of two different preparations of fly ash with that of conventional ag lime for their ability to raise soil pH and reduce exchangeable Al; and (ii) to determine if the Al applied in fly ash produces detrimental changes in soil properties following subsequent acidification. Either fly ash in one of two forms, or conventional ag lime, was applied to three acid soils (Anselmo loam, Valentine sandy loam, and Holdrege sandy loam) in a pot study at rates equal to 0.5, 1.0, and 1.5 times the soils' lime requirements. Soils were equilibrated in triplicate at approximately 33 kPa water potential in the greenhouse for 315 days (liming phase), during which pH and exchangeable aluminium (Al) were measured. The soils were then acidified under similar conditions for 439 days (acidification phase) by adding dilute acid solution to simulate management-induced acidification, and pH and exchangeable Al were then measured again. Both fly ashes and ag lime were effective in raising soil pH by up to 1.2 units and in reducing exchangeable Al by up to 5.6 mg kg⁻¹. Two-way interactions involving soil, liming material, and rate of application produced different results for combinations of these factors. All amendments helped the soils resist subsequent acidification compared with zero-rate treatments but differed based on the 3-way combinations of soil, liming material, and rate of application. We concluded that overliming (as indicated by exceeding the target pH of 6.5) is a problem with all liming materials on the coarsest soils, suggesting that lime calibration should be re-examined. The fly ash materials seem to contribute to soil exchangeable Al after acidification, but this contribution is inconsequential if soil pH values are maintained at agronomic optima.

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75. Coal fly ash as an amendment to container substrate for *Spathiphyllum* production.

Chen, J. J. and Li, Y.

Bioresource Technology 97(15): 1920-1926. (2006)

NAL Call #: TD930.A32 ; ISSN: 0960-8524

Descriptors: arsenic/ cadmium/ calcium/ canopy/ chemical

composition/ chemical properties/ chromium/ coal/ copper/ dolomite/ electrical conductivity/ fly ash/ growing media/ iron/ lead/ leaves/ magnesium/ manganese/ mercury/ molybdenum / nickel/ nonclay minerals/ nutrient content/ ornamental plants/ pH/ phosphorus/ physical properties/ physicochemical properties/ plant composition/ plant diseases/ plant tissues/ potassium/ selenium/ shoot apices/ soil amendments/ substrates/ waste utilization/ weight/ zinc/ chemical constituents of plants/ dry weight/ hydrogen ion concentration/ leaf canopy/ Mn/ Mo/ ornamentals/ potential of hydrogen/ potting composts/ rooting media/ United States of America

Abstract: Coal fly ash, possessing alkalinity and containing some essential mineral elements, could be an alternative to lime amendment and a nutrient source of container substrates for ornamental plant growth. This study examined physicochemical properties of three fly ashes collected from Florida, Michigan, and North Carolina and container substrates formulated by incorporating commercial dolomite and the three fly ashes, respectively into a soilless basal substrate. The basal, dolomite- and fly ash-amended substrates were used to grow peace lily (*Spathiphyllum Schott 'Ty's Pride'*), a popular ornamental foliage plant, in 15-cm diameter containers in a shaded greenhouse. Electrical conductivities and pH of the substrates were monitored monthly. Plant canopy heights and widths, shoot fresh and dry weights were recorded five months after transplanting, and tissue nutrient contents were measured. Three fly ashes and the commercial dolomite were able to raise pH of the basal substrate from 3.8 to about 6.8. Canopy heights and widths as well as shoot fresh and dry weights of plants produced from fly ash-amended substrates were comparable to those produced from dolomite-amended substrate but significantly different from those produced from the basal substrate. On an average, five necrotic leaves appeared from plants produced in the basal substrate; however, less than one necrotic leaf occurred on plants produced in either dolomite- or fly ash-amended substrates. As a result, the quality grade of plants grown in the basal substrate was low, and plants were not marketable. Additionally, electrical conductivities of fly ash-amended substrates were consistently higher during the course of plant growth, suggesting that, in addition to neutralizing pH, the amended fly ashes provide nutrients for peace lily growth, which was confirmed by high nutrient contents in plant shoots. This study demonstrates that the three fly ashes can be alternatives to commercial dolomites used as amendments to soilless substrates for ornamental plant production. Utilization of fly ashes as container substrate amendments should represent a new market for the beneficial use of coal combustion byproducts.

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76. Coal fly ash as modifier of physico-chemical and biological properties of soil.

Yeledhalli, N. A.; Prakash, S. S.; Gurumurthy, S. B.; and Ravi, M. V.

Karnataka Journal of Agricultural Sciences 20(3): 531-534. (2007)

NAL Call #: S471.I42K37; ISSN: 0972-1061

Descriptors: Alfisols / alkaline phosphatase/ application rates/ application to land/ bacterial count/ base saturation/ calcium/ cation exchange capacity/ coal/ copper/ crop yield/

electrical conductivity/ enzyme activity/ exchangeable calcium/ exchangeable magnesium/ fly ash/ iron/ magnesium/ manganese/ nitrogen / NPK fertilizers/ nutrient availability/ organic carbon/ oxidoreductases/ phosphorus/ physicochemical properties/ potassium/ red soils/ soil amendments/ soil bacteria/ soil chemical properties/ soil enzymes/ soil fertility/ soil flora/ soil organic matter/ soil pH/ soil types/ sulfur/ sunflowers/ urease/ waste disposal/ waste management/ waste utilization/ yield components/ zinc/ alkaline phosphomonoesterase/ chemical properties of soil/ elemental sulphur/ land application/ Mn/ Mysore/ organic matter in soil/ red earths/ redox enzymes/ sulphur

Abstract: A field experiment was conducted to study the effect of levels of fly ash (0, 25, 50, 75 and 100 tones/ha) on physicochemical, biochemical and biological properties of alfisols, the yield parameters of sunflower, soil bacterial count and activity of soil enzymes; dehydrogenase, urease and alkaline phosphatase. Two levels of fertilizers were applied; No NPK and Recommended dose of NPK fertilizers. Physio-chemical and microbiological analysis was conducted after the harvest of sunflower. A study of graded level of coal fly ash amended alfisols revealed an increase in the content of N, P, K, Ca, Mg, S, Fe, Mn, Zn and Cu and disturbed the microbiological balance and soil enzyme activity.

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77. Coamendments to modify phosphorus extractability and nitrogen/phosphorus ratio in feedlot manure and composted manure.

Dao, T. H.

Journal of Environmental Quality 28(4): 1114-1121. (1999)
NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: aluminium sulfate/ amendments/ application rates/ calcrete/ cattle manure/ clay loam soils/ composting/ fly ash/ nitrogen/ phosphorus/ pollution/ sandy loam soils/ soil amendments/ soil types/ water quality/ aluminium sulphate/ aluminum sulfate/ calcareous crusts/ environmental pollution/ water composition and quality

Abstract: The effects of alum, caliche, and Class C fly ash on extractable P concentrations were examined in stockpiled and composted cattle manure at rates of 0, 0.10, 0.25, and 0.50 kg manure/kg. The mixtures were added to Amarillo fine sandy loam (Aridic Paleustalf) and Pullman clay loam (Torreptic Paleustoll) at the rate of 22 t/ha. Caliche, alum, and fly ash reduced water-extractable P (WP) in stockpiled manure by 21, 60, and 85% and by 50, 83, and 93% in composted manure at the 0.1 kg/kg rate. Alum and fly ash significantly reduced Bray-I P (BP) concentrations by 75 and 90% in stockpiled and composted manure, respectively, and >90% at higher rates. Fly ash decreased Mehlich III-P (MP) concentrations, and ranged from 50 to 98%. Mixing these amendments with feedlot manure widened the effective manure N:P ratio by a factor ranging from 1.5 to 18. Applying fly ash-treated stockpiled or composted manure reduced all extractable P fractions from amended soils. Alum and caliche consistently reduced the WP fraction only. Co-applications of mineral and animal byproducts stabilized manure P where uncovered storage was unavoidable or widened its effective N:P ratio, and allowed land application rates needed to fulfil plant N requirements without causing water quality impairments. Reproduced with permission from the CAB Abstracts database.

78. Comparative study on the growth of mulberry (Morus alba) plant at different levels of fly-ash amended soil.

Singh, V. K.; Behal, K. K.; and Rai, U. N.

Biological Memoirs 26(1): 1-5. (2000); ISSN: 0379-8097

Descriptors: Horticulture: Agriculture/ Waste Management: Sanitation/ Soil Science/ Moraceae: Angiosperms, Dicots, Plants, Spermatophytes, Vascular Plants

Abstract: Study was undertaken on rehabilitating fly-ash contaminated waste land and a series of experiments were carried out by growing mulberry (*Morus alba* L.) plants in 25 earthen pots in five different sets of fly-ash/soil composition including control. Various characters of the soil amended with different percentage of fly-ash (i.e., fly-ash/soil-25:75, 35:65, 50:50 and 75:25) were monitored during the experimental study. The data obtained for the various growth parameters in the mulberry plants were comparatively assessed and analyzed employing randomized block design method. The 25:75 composition of fly-ash/soil was found viable for sustaining the growth of *M. alba* plants.

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79. Comparison of biomass and metal uptake between two populations of Phragmites australis grown in flooded and dry conditions.

Ye, Z. H.; Wong, M. H.; Baker, A. J. M.; and Willis, A. J.

Annals of Botany 82(1): 83-87. (July 1998); ISSN: 0305-7364 [ANBOA4]

Descriptors: Phragmites australis/ biomass/ mine spoil/ fly ash / soil pollution/ provenance/ adaptation/ seedlings/ roots/ shoots/ water stress/ drought/ growing media/ zinc/ lead/ cadmium/ copper/ nickel/ nitrogen/ potassium/ phosphorus/ soil ph / redox potential/ metal ions/ sediments/ China/ Belgium/ flooding/ dry matter/ growth/ uptake

Abstract: The biomass and metal concentrations of two populations of *Phragmites australis* were studied by growth in a glasshouse in three ameliorated substrata [Mai Po (MP) sediment, fly ash (FA) and lead/zinc mine tailings (TL)] under flooded and dry conditions for 90 d. Plants were raised from seeds from 'clean' (Mai Po, Hong Kong) and metal-contaminated (Plombieres, Belgium) sites. Seedling growth was best in fly ash, root dry weights being higher in flooded than dry conditions, and growth poorest in tailings, in which shoot and root dry weights were higher under dry conditions for both populations. However, in the MP substratum conditions did not significantly affect shoot and root dry weights of either population. In the fly ash and tailings, more metals were generally taken up in both roots and shoots in flooded than dry conditions, but there was little difference in the MP substratum. Metal uptake was mostly similar in both populations in seedlings grown in the same substratum, there being no clear evidence of ecotypic differentiation.

This citation is from AGRICOLA.

80. Comparison of different amendments for alleviating iron toxicity in rice.

Nayak, S. C.; Sahu, S. K.; Mishra, G. C.; and Sandha, B.

International Rice Research Notes 29(1): 51-53. (2004)

NAL Call #: SB191.R5I6; ISSN: 0117-4185

Descriptors: antagonism/ chemical composition/ crop yield/ fly ash/ iron/ leaves/ lime/ phytotoxicity/ plant composition/ potassium/ rice/ rice straw/ soil amendments/

straw/ toxicity/ varieties/ zinc/ chemical constituents of plants/ paddy

Abstract: Field experiments were during 1999, 2000 and 2001 wet seasons in Orissa, India, to study the efficacy of various amendments for Fe toxicity amelioration. The treatments include application of lime (0.5 and 0.25 lime requirement), fly ash (20 and 10 tonnes/ha), K (66 kg/ha), Zn (10 and 5 kg/ha) and foliar spray of MnSO₄ (0.6%). Two rice varieties, Mahsuri (tolerant of Fe toxicity) and Jajati (susceptible to Fe toxicity), were used. Symptoms of Fe toxicity such as reddish brown spots at the tips of the lower leaves with bronzing spreading over the entire leaf, appeared in the control treatment 25 days after planting the susceptible variety. Bronzing symptoms were recorded at 40 DAT. These symptoms decreased upon application of the different amendments. The application of Zn and lime at higher doses resulted in minimum toxicity. Jajati gave higher toxicity values than Mahsuri. Grain and straw yield of both varieties increased with application of the different amendments. Application of Zn showed the highest yield because of antagonism between Zn and Fe. Except for straw yield in 2001, Mahsuri produced higher yield than Jajati. Fe concentration in leaves was higher in the control treatment. A minimum concentration of Fe in leaves was observed in the Zn treatment, followed by the lime treatment. Jajati showed a higher Fe concentration in leaves than Mahsuri.

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81. Comparison of heavy metal contents between different reclaimed soils and the control soil.

Dong, J. H.; Bian, Z. F.; and Wang, H. F. 36(4): 531-536. (2007); ISSN: 10001964 [ZKDXE].

Notes: Language of Original Document: Chinese.

Descriptors: coal mining waste/ fly ash/ heavy metal pollution/ reclaimed soil/ accident prevention/ coal ash/ fly ash/ heavy metals/ pollution control/ soil pollution/ soil pollution control/ coal mining waste/ heavy metal pollution/ mining wastes/ reclaimed soil/ land reclamation

Abstract: To keep the ecological safety of the reclaimed lands filled with mining wastes and fly ash used as agricultural purpose, the contents of heavy metals As, Hg, Pb, Cu, Cd, Cr, Zn in different soils, including the reclaimed soils and control soil with different depths and the roots of wheat, were tested. The result shows that the contents of Pb and Cu in the fly ash and Cu and Zn in mining wastes are higher than that in the control soil, but only Zn in the covered soil with 20 cm depth and Zn and Cu in the covered soil with 20 cm and 40 cm depth on mining wastes filled sites are markedly higher than that in the control soil with the same depth. However, there are not remarkable differences for the contents of heavy metals in the roots of wheat on different reclaimed sites and the control site.

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82. Competitive adsorption behavior of selected heavy metals in three soil types of India amended with fly ash and sewage sludge.

Veeresh, H.; Tripathy, S.; Chaudhuri, D.; Hart, B. R.; and Powell, M. A.

Environmental Geology 44(3): 363-370. (June 2003)

NAL Call #: QE1.E5; ISSN: 1073-9106 [ENGOE9]

Descriptors: Alfisols / Vertisols/ genetic soil types/ soil amendments/ physicochemical properties/ soil properties/

India/ red alfisol/ black vertisol/ acid laterite

Abstract: Laboratory batch experiments were carried out to study the competitive sorption behavior of metals in three types of Indian soils, differing in their physicochemical properties: acid laterite (SL1), red alfisol (SL2) and black vertisol (SL3) treated with different proportions of fly ash and sewage sludge mixture. Representative samples were equilibrated with 10 to 200 micromolar L(-1) concentrations of metals simultaneously containing Cd, Cu, Ni, Pb and Zn in 5 mM of Ca(NO₃)₂ solution. In most of the cases the affinity sequence of metals was Pb>Cu>Zn>Ni>Cd based on their amount of sorption, which varied little with either metal equilibrating concentrations or the soil/mixture type. The observed metal affinity sequences in different soils amended with mixtures were compared to the predicted affinity sequences based on metal properties and a good match was found with those predicted by metal hydrolysis constants. This indicated that formation and subsequent sorption of metal hydrolysis products on soil surface is the predominant mechanism for sorption. In all the cases, Pb and Cu showed higher affinity followed by Zn, Ni or Cd. The increase in the metal additions further enhanced the competition among metals for exchange sites. Adsorption isotherms showed that metal sorption was linearly related to its concentration in the equilibrium solution. The distribution coefficients (K(D)) computed from the slopes of linear regression for different metals were higher in SL3 than in both SL2 and SL1. All the mixture amended soils produced higher K(D) values than their respective controls. Selectivity between metals resulted in the following affinities based on their K(D) values-Pb>Cu>Zn>Ni or Cd-which was in line with the value of the hydrolysis constant of the metals under study.

This citation is from AGRICOLA.

83. Competitive anion sorption effects on dairy wastewater dissolved phosphorus extraction with zeolite-based sorbents.

Dao, T. H.

Journal of Food, Agriculture and Environment 1(3/4): 263-269. (2003); ISSN: 1459-0255

Descriptors: anions/ dairy effluent/ dairy wastes/ desorption/ fly ash/ models/ nonclay minerals/ phosphates/ phosphorus/ sorption/ sorption isotherms/ waste water/ waste water treatment/ zeolites

Abstract: Dairy waste water is often used to irrigate field crops. Soluble and colloidal phosphorus (P) must be removed from the supernatant liquid to avoid further P loading of high-P fields. Information is needed on P sorption capacity of natural and synthetic zeolites and fly ash in a complex wastewater and on how the spent products release sorbed PO₄-P. Sorption isotherms were determined in single and multi-anion standard solutions and dairy waste water to quantify the sorption capacity of modified zeolites and fly ash and increase our understanding of underlying mechanisms of oxyanion retention. Solution anion concentrations were determined by high-performance ion chromatography. The results show that natural zeolites have negligible affinity for NO₃- or PO₄³⁻ anions. Surfactant-modified (SMZ) and synthetic (SZBP) zeolites and fly ash exhibit significant capacities to bind PO₄-P. Phosphate sorption on SMZ and SZBP was described by the Langmuir equation, with sorption maxima, S_{max},

averaging 0.71 and 0.31 mmol g⁻¹, respectively. Class C fly ash strongly sorbs and removes PO₄-P from solution. Sorption maxima increase by 4-fold and Langmuir K constants indicate a higher bonding energy than those of SMZ and SZBP. Competitive sorption is evident in PO₄-P sorption from mixed solutions of SO₄-S, NO₃-N, and PO₄-P. All sorbents removed dissolved PO₄-P from multi-ion dairy waste water suspensions containing 10 to 100 g solid litre⁻¹. The order of efficacy is fly ash >= SZBP > SMZ.

Although differences in affinity and desorption exist, the zeolite-based sorbents prove valuable as temporary sinks and offer promise in the development of reversible recovery treatments of P-laden animal waste water.

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84. Composition, biomass and activity of microflora, and leaf yields and foliar elemental concentrations of lettuce, after in situ stabilization of an arsenic-contaminated soil.

Ascher, J.; Ceccherini, M. T.; Landi, L.; Mench, M.; Pietramellara, G.; Nannipieri, P.; and Renella, G.

Applied Soil Ecology 41(3): 351-359. (2009)

NAL Call #: QH541.5.S6 A67; ISSN: 09291393 [ASECF].

Notes: doi: 10.1016/j.apsoil.2009.01.001.

Descriptors: coal fly ash/ soil biochemical activity/ soil microbial diversity/ soil remediation/ zerovalent iron grit

Abstract: Beringite (B) and zerovalent iron grit (Z), singly and in combination (BZ), were added to a loamy sand soil contaminated by trace elements (Reppel, Belgium), mainly by arsenic (As), to reduce As labile fractions and phytoavailability. An uncontaminated sandy soil was studied for comparison. Soils were placed in large lysimeters cultivated with maize and vegetables for 6 years. pH, organic C and total N content increased in amended soils. The Z and BZ treatments reduced the Ca(NO₃)₂-extractable soil As and As uptake by lettuce. The BZ lettuces had also the lowest foliar Pb, Cd, Zn, and Mn concentrations. All amendments had positive effects on the soil microbial biomass and reduced the qCO₂. Glucose mineralization was increased in Z and BZ amended soils. Acid phosphomonoesterase activity was higher in the untreated soil than in the other soils; the alkaline phosphomonoesterase, phosphodiesterase and protease activities were increased by Z and BZ treatments, whereas B amendment had less positive effects. Genetic fingerprinting using Denaturing Gradient Gel Electrophoresis (DGGE) revealed shifts in the composition of eubacterial and fungal communities of the amended soils. Microbial species richness decreased rather than increased in the treated soils, regardless of reduced trace element availability and increased soil microbial biomass and activity. © 2009 Elsevier B.V. All rights reserved. © 2009 Elsevier B.V. All rights reserved.

85. The composition of coal combustion by-products: Examples from a Kentucky power plant.

Kolker, Allan; Finkelman, Robert B.; Affolter, Ronald H.; and Brownfield, Michael E.

In: Use and disposal of coal combustion by-products at coal mines; A technical interactive forum. Morgantown, WV.)

Vories, Kimery C. and Throgmorton, Dianne (eds.); 2000.

Notes: References: 22; illus. incl. 1 table.

Descriptors: ash/ chemical composition/ coal/ coal combustion byproducts/ combustion/ environmental effects/ geochemistry/ heavy metals/ Kentucky/ leaching/ mass balance/ mineral composition/ pH/ pollutants/ pollution/ power plants/ sedimentary rocks/ sludge/ United States/ waste disposal/ Environmental geology/ Geochemistry of rocks, soils, and sediments
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86. Compressibility and hydraulic conductivity of a chemically treated expansive clay.

Nalbantoglu, Z. and Tuncer, E. R.

Canadian Geotechnical Journal 38(1): 154-160. (2001); ISSN: 0008-3674

Descriptors: cation exchange/ compressibility/ expansive soils/ permeability coefficient/ soil properties/ soil tests/ testing procedures/ Cyprus

Abstract: The paper presents a series of laboratory tests and evaluates the effect of lime and fly ash on the compressibility and hydraulic characteristics of an expansive soil in Cyprus. The tests were performed at different percentages of lime (0-7%) and fly ash (15 and 25%) by dry weight of soil, and additional tests were also performed on soils treated with 15% fly ash plus 3% lime. Previously published research reveals that few data are available concerning the compressibility and hydraulic conductivity of lime-treated soils. The results of this study indicate an increase in the vertical effective yield stress (apparent preconsolidation pressure) and a decrease in the compressibility characteristics of the treated soils.

Moreover, unlike some of the findings in the literature, higher hydraulic conductivity values were obtained with time. This finding has been substantiated by the reduced cation exchange capacity (CEC) values, which indicate that the pozzolanic reaction causes the soils to become more granular in nature, resulting in higher hydraulic conductivity. Original Abstract: L'article present une serie d'essais en laboratoire et evalue l'effet de la chaux et de la cendre volante sur la compressibilite et les caracteristiques hydrauliques d'un sol gonflant de Chypre. Les essais ont ete realises a differents pourcentages de chaux (0-7%) et de cendre volante (15% et 25%) par rapport au poids sec des sols, et des essais additionnels ont aussi ete realises sur des sols traites avec 15% de cendres volante et 3% de chaux. Des recherches publiees anterieurement revelent qu'il y a tres peu de donnees disponibles sur la compressibilite et la conductivite hydraulique de sols traites a la chaux. Les resultats de l'etude indiquent une augmentation de la contrainte verticale effective a la limite d'elasticite (pression apparente de preconsolidation) et une diminution des caracteristiques de compressibilite des sols traites. De plus, contrairement aux donnees disponibles dans la litterature, des valeurs plus elevees de la conductivite hydraulique ont ete obtenues en fonction du temps. Cette constatation a ete appuyee par les valeurs de capacite d'echange de cations (CEC) qui indiquent que la reaction pozzolanique a pour consequence que les sols evoluent vers une condition plus granulaire, resultant en une plus grande conductivite hydraulique.

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87. Concentration of heavy elements and radionuclides in crops grown on coal fly ash amended red and black soils.

Yeledhalli, N. A.; Prakash, S. S.; and Ravi, M. V.

Karnataka Journal of Agricultural Sciences 21(1): 125-127. (2008)

NAL Call #: S471.I42K37; ISSN: 0972-1061

Descriptors: Alfisols / arsenic/ black soils/ fly ash/ groundnuts/ heavy metals/ lead/ maize/ polluted soils/ pollution/ radionuclides/ red soils/ residual effects/ selenium/ soil types/ sunflowers/ uptake/ Vertisols/ corn/ environmental pollution/ Mysore/ peanuts/ radioactive isotopes/ radioactive nuclides/ radioisotopes/ red earths
Abstract: Field experiments were conducted during 2004 at Regional Agricultural Research Station, Raichur, University of Agricultural Sciences, Dharwad, Karnataka, India, to study the effect of fly ash application on heavy metal and radionuclides concentration in crops grown on an Alfisol Typic Chromustalf (red soil) and Vertisol Typic Pellusterfs (black soil). The concentration of heavy metals in sunflower seeds in red soils increased due to application of 40 tonnes fly ash/ha. The Se content of sunflower seed in control was 0.2 mg/kg, which increased to 0.21 mg/kg due to application of 40 tonnes fly ash/ha. Similarly, As content increased from 0.29 to 0.32 mg/kg and that of Pb from 0.73 to 0.78 mg/kg due to application of 40 tonnes fly ash/ha. The uptake of Se, As and Pb by sunflower seed was 0.11, 0.17 and 0.42 g/ha in control, respectively, which increased to 0.2, 0.32 and 0.74 g/ha due to application of 40 tonnes fly ash/ha. Similar trend of results were observed in black soil. The residual effect of fly ash on the concentration and uptake of toxic elements by groundnut in red soil and maize in black soil showed increasing trend with increasing rate of ash application. The alpha activity in sunflower seeds was below detectable limit in both red and black soils. The results of the study clearly indicated that the edible part of sunflower and groundnut contain heavy metals: Se, As and Pb and radionuclides are below the levels of human health concern.

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88. Concentration of some heavy metals in both oat varieties growing in the soil at different content of fly-ash.

Gregorczyk, A.

Folia Universitatis Agriculturae Stetinensis, Agricultura 88: 49-56. (2001); ISSN: 1506-1973.

Notes: Original title: Koncentracja wybranych metali ciezkich u dwu odmian owsa rosnacego na glebie o zroznicowanej zawartosci popioiu lotnego.

Descriptors: cadmium/ chemical composition/ copper/ cultivars/ fly ash/ heavy metals/ lead/ manganese/ nickel/ oats/ plant composition/ zinc/ chemical constituents of plants/ cultivated varieties/ Mn

Abstract: A pot experiment was conducted during 1999 in Roslin, Poland to evaluate heavy metal accumulation in naked (Akt) and hulled (Bajka) oat cultivars after application of 5% fly ash. The contents of Cu, Cd, Mn, Zn, Pb and Ni in the straw, root and grain were determined using the AAS method. Cu, Mn and Ni contents in the grains of ash-treated plants were within the natural limit for these metal

elements, while Cd, Zn and Pb contents in the grains of ash-treated plants exceeded the natural limit for these elements.

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89. Contaminant mobility in soils amended with fly ash and flue-gas gypsum: Intact soil cores and repacked columns.

Ishak, C. F.; Seaman, J. C.; Miller, W. P.; and Sumner, M. *Water, Air and Soil Pollution* 134(1/4): 287-305. (2002)
NAL Call #: TD172 .W36; ISSN: 0049-6979

Descriptors: application to land/ arsenic/ boron/ dispersion/ electrical conductivity/ environmental impact/ fly ash/ gypsum/ leaching/ saturated hydraulic conductivity/ soil amendments/ soil ph/ soil pollution/ turbidity/ Ultisols/ water holding capacity/ environmental effects/ land application/ United States of America

Abstract: The impact of the land application of coal combustion by-products, fly ash (FA) and flue-gas desulfurization gypsum (FDG), to coarse-textured soils of the southeastern USA was investigated using batch and dynamic column techniques. Two FA samples, one an alkaline FA (Alk-FA) and the other an acidic FA (Acid-FA), were evaluated alone and in combination with FDG as soil amendments to an Appling loamy sand (Typic Hapludults). The effects of these waste products on clay dispersion, soil hydraulic conductivity (K_{sat}) and the migration of contaminants such as Arsenic (As) and Boron (B) were studied using intact soil cores and repacked soil columns. FA or combinations of FA+FDG were applied to the surface of intact soil cores (10 t ha⁻¹) and repacked soil columns or incorporated within repacked soil columns. The columns were saturated and then leached for a prescribed number of pore volumes to simulate leaching conditions in the field. Effluent pH, electrical conductivity (EC), and turbidity were monitored and leachate fractions were collected for B, As, Ca, Mg, K and Na analysis. Both FA materials were ineffective at decreasing the inherent dispersibility of clay from the A_p horizon in batch tests. In fact, high application rates of the Alk-FA induced some clay dispersion in the well-flocculated B_t soil materials, and column results suggest that incorporating the Alk-FA within the surface soil may actually reduce K_{sat} . In contrast, treatments with FDG were highly effective at inducing rapid clay flocculation in batch tests and eliminating effluent turbidity for intact and repacked soil columns. Boron was readily mobile from both intact and repacked soil columns, a majority of which leached from the columns within the first three pore volumes. Boron leaching was greater for combined treatments (FA+FDG), possibly indicative of enhanced solubilization in the presence of FDG or sulfate (SO₄₂₋) competition for sorption sites. Arsenic levels present in the leachates from FA and FDG columns were generally lower than control columns and roughly correlated with effluent turbidity. Combined treatments (FA+FDG) enhanced Mg and K leaching due to the added competition of Ca for cation exchange sites. Following leaching, the intact soil cores were sectioned at 5 cm intervals and the pH and EC of the soil, as well as the vertical distribution of As and B, were determined. Levels of residual As were only slightly higher in the upper section of the FA-amended columns, showing little downward movement, but no clear trend in

residual B was observed due to its greater mobility. Reproduced with permission from the CAB Abstracts database.

90. Contamination and assessment of heavy metals in fly ash reclaimed soil.

Hu ZhenQi; Qi JiaZhong; and Si JiTao
Transactions of the Chinese Society of Agricultural Engineering 19(2): 214-218. (2003)

NAL Call #: S671.N8; ISSN: 1002-6819

Descriptors: arid lands/ arsenic/ assessment/ cadmium/ chromium/ copper/ dry farming/ fluorine/ fly ash/ heavy metals/ lead/ mercury/ nickel/ polluted soils/ reclaimed soils/ reclamation/ selenium/ soil pollution/ soil types/ tillage/ zinc/ dryland farming/ soil cultivation

Abstract: Soil samples were taken from fly ash reclaimed to soil to determine the contamination of 10 heavy metals, viz., As, Cd, Ch, Hg, Pb, Cu, Se, Zn, Ni and F. It was found that the soil reclaimed by fly ash was polluted by Cd, Se, Zn and F according to common soil assessment standards. Furthermore, the reclaimed soil was found to be suitable for dryland cultivation rather than wetland cultivations, and that the contamination of heavy metals on the soil surface was increased with cultivation time.

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91. Contamination character analysis of filling reclaimed soil with fly ash in subsided land.

Hu ZhenQi; Wei ZhongYi; and Qin Ping
China Environmental Science 24(3): 311-315. (2004);
ISSN: 1000-6923

Descriptors: absorption/ bioavailability/ fly ash/ heavy metals/ leaching/ nutrient content/ polluted soils/ reclaimed land/ reclaimed soils/ reclamation/ soil amendments/ soil analysis/ soil pollution/ soil types/ solubility/ uptake/ wheat

Abstract: The contamination potential of filling reclaimed soil with fly ash was revealed based on the analysis of fly ash pollution potential and through the analysis of reclaimed soil, leaching experiment and planting test. Solubility of heavy metals in fly ash was poor, and the crop absorption of heavy metals was restrained due to high pH value. The leaching test also showed poor leaching ability of heavy metal elements. The analysis of crop (wheat) seed sample cultivated in the fields and greenhouse pots showed that the contents of heavy metals coincided with the related national standard that the reclaimed land could be planted with certain crops, even when the soil was polluted with heavy metals.

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92. The content, uptake and utilization coefficient of sulphur by plants from waste activated sludges composted with CaO or brown coal ash.

Kalembasa, S.; Wysokinski, A.; and Cichuta, R.
Journal of Elementology 10(2): 325-332. (2005); ISSN: 1644-2296.

Notes: Original title: Zawartosc, pobranie i wspoczynniki wykorzystania siarki przez rosliny z osadow sciekowych kompostowanych z CaO lub popioem z wegla brunatnego.

Descriptors: activated sludge/ ash/ brown coal/ calcium oxide/ chemical composition/ composts/ farmyard manure / lime/ plant composition/ soil amendments/ sulfur/ uptake/

chemical constituents of plants/ elemental sulphur/ FYM/ sulphur

Abstract: The content, uptake and utilization coefficient of sulfur (S) by plants from waste activated sludges composted during 3 months with CaO or brown coal ash were investigated. Generally, a higher concentration of S was observed in plants fertilized with waste activated sludges and farmyard manure (FYM) without CaO and brown coal ash addition than with CaO and brown coal ash. The plants fertilized with mixtures of waste activated sludges with brown coal ash contained less S. The amount of S taken up by the plants in waste activated sludges and FYM with CaO and brown coal ash addition plots was lower than those in without CaO and brown coal ash addition. The plants took higher amount of S from the mixtures of waste activated sludges and FYM with brown coal ash addition than those with CaO. The values of utilization coefficient of S during the 3-year study period was higher in the mixtures of waste activated sludges and FYM with CaO addition than with brown coal ash. Reproduced with permission from the CAB Abstracts database.

93. The content variation of harmful elements in fly ash soil and vegetables and their environmental significance.

Tan Qulin; Zhai Jianping; Zhou Weike; and Qian Qin
Geological Journal of China Universities 5(3): 298-305. (Sept. 1999); ISSN: 1006-7493.

Notes: Original title: Gaoxiao Dizhi Xuebao. Language: Chinese. References: 7; illus. incl. 1 table.

Descriptors: agricultural waste/ ash/ Asia/ chemical elements/ China/ Far East/ geochemical indicators/ geochronology/ heavy metals/ Jiangsu China/ migration of elements/ Nanjing China/ pollutants/ pollution/ soils/ variations/ waste disposal/ yields/ environmental geology
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94. Copper stabilization by zeolite synthesis in polluted soils treated with coal fly ash.

Terzano, R.; Spagnuolo, M.; Medici, L.; Vekemans, B.; Vincze, L.; Janssens, K.; and Ruggiero, P.
Environmental Science and Technology 39(16): 6280-6287. (2005)

NAL Call #: TD420.A1E5; ISSN: 0013-936X

Descriptors: agricultural soils/ copper/ copper hydroxide/ fly ash / nonclay minerals/ polluted soils/ soil types / spatial distribution/ zeolites

Abstract: This study deals with the process of zeolite formation in an agricultural soil artificially polluted by high amounts of Cu (15 mg of Cu/g of soil dry weight) and treated with fused coal fly ash at 30 and 60 degrees C and how this process affects the mobility and availability of the metal. As a consequence of the treatment, the amount of dissolved Cu, and thus its mobility, was strongly reduced, and the percentage of the metal stabilized in the solid phase increased over time, reaching values of 30% at 30 degrees C and 40% at 60 degrees C. The physicochemical phenomena responsible for Cu stabilization in the solid phase have been evaluated by EDTA sequential extractions and synchrotron radiation based X-ray microanalytical techniques. These techniques were used for the visualization of the spatial distribution and the speciation of Cu in and/or on the neo-formed zeolite particles. In particular, micro XRF (X-ray fluorescence)

tomography showed direct evidence that Cu can be entrapped as clusters inside the porous zeolitic structures while μ -XANES (X-ray absorption near edge structure) spectroscopy determinations revealed Cu to be present mainly as Cu(II) hydroxide and Cu(II) oxide. The reported results could be useful as a basic knowledge for planning new technologies for the on site physicochemical stabilization of heavy metals in heavily polluted soils. Reproduced with permission from the CAB Abstracts database.

95. Corn and soil response to application of ash generated from gasified alfalfa stems.

Mozaffari, M.; Rosen, C. J.; Russelle, M. P.; and Nater, E. A.

Soil Science 165(11): 896-907. (Nov. 2000)

NAL Call #: 56.8 So3; ISSN: 0038-075X [SOSCAK]

Descriptors: Medicago sativa/ stems/ gasification/ fly ash/ soil amendments/ Zea mays/ dry matter accumulation/ nutrient uptake/ nutrient content/ potassium/ magnesium/ phosphorus/ nitrogen content/ mineral content/ sandy soils/ clay loam soils/ soil ph/ exchangeable cations/ trace elements/ application rate/ fuel crops

This citation is from AGRICOLA.

96. Creation of soil amendments containing Type A humic acid-like substances I. Creation of Type A humic acid-like substances by using rice straw and coal ashes.

Ikumi, Y.; Yahata, Y.; Suzuki, T.; Fujitake, N.; and Otsuka, H.

Japanese Journal of Soil Science and Plant Nutrition 75(6): 641-649. (2004); ISSN: 0029-0610

Descriptors: carbon/ coal/ fertilizer technology/ fixation/ fly ash/ humic acids/ humification/ production/ rice/ rice straw/ soil amendments/ straw/ paddy

Abstract: An attempt to create a soil amendment containing Type A humic acid-like substances was done by means of thermal incubation of a mixture of rice straw (RS) and coal fly ash (CFA). The specific objectives of the study are the following: (1) To make an effective use of CFA, a by-product of coal-fired power stations, and (2) To fix carbon in the soil for a long term period as Type A humic acids which are known to be hard to decompose. Optimal incubation conditions to create Type A humic acid-like substances were examined. Furthermore, the chemical properties of the created samples were analysed. The results obtained can be summarized as follows: (1) It was found that among the three temperature conditions imposed (60, 75 and 90 degrees C), 90 degrees C was the most suitable for the progress of humification, and that a water supply was very necessary; (2) Since the humic acid-like substances extracted from the incubated sample showed a high degree of humification at the pH range of 3-4, the increase in the degree of humification of the humic acid-like substances may be accelerated by maintaining a low pH condition during incubation; (3) The highest RF value was observed in the mixture with a dry weight ratio of 1:1 (CFA:RS) after 180 d incubation at 90 degrees C with water. The $\Delta \log K$ and RF values of the humic acid-like substances extracted with the mixed solution (pH 7) of 0.1 mol L⁻¹ Na₄P₂O₇ and 0.1 mol L⁻¹ H₄P₂O₇ was 0.686 and 94.2 respectively, and these humic acid-like substances corresponded to Type A humic acids; (4) The yields of Type

A humic acid-like substances from the incubated mixture of CFA and RS (dry weight ratio of 1:1 and 1:2) were estimated to be at least 13.6% and 14.6% of the carbon contents of the samples at the start of the incubation, respectively, and (5) The contents of nutrients, such as nitrogen and phosphorus in the incubated sample were smaller than those reported for other soil amendments such as rice straw compost. Therefore, additional application of nitrogen and phosphate fertilizers would be needed in the actual scene for agronomical application of this soil amendment.

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97. Crop response to SLASH (mixture of sewage sludge and fly ash) and on soil properties of red and black soils as influenced by soil texture and fertility.

Yeledhalli, N. A.; Ravi, M. V.; and Prakash, S. S. *Environment and Ecology* 26(2A): 934-942. (2008)

NAL Call #: TD172.E5; ISSN: 0970-0420

Descriptors: black soils/ boron/ crop production/ crop yield/ fly ash/ groundnuts/ maize/ NPK fertilizers/ red soils/ sewage sludge/ soil amendments/ soil chemical properties/ soil fertility/ soil properties/ soil texture/ sulfur/ sunflowers/ trace elements/ chemical properties of soil/ corn/ elemental sulphur/ microelements/ Mysore/ peanuts/ red earths / sulphur

Abstract: Prime agricultural land is declining day after day and the cost of nutrients inputs escalating. It is therefore necessary to overcome the deficiency of nutrients and disturbed soil to feed the burgeoning population. Using conventional methods are costly and not sustainable. An attempt was made to mix the sewage sludge and fly ash in different proportion on wt/wt basis called SLASH material. Field experiments were conducted to determine the effect of SLASH on crop yields. Soil chemical properties of red and black soil were also monitored. SLASH treatments were compared with absolute and NPK control. The results illustrated the improvement in the crop yields. Sunflower, groundnut and maize yields on SLASH treatment were 28, 41 and 36% better than the NPK control. Soil chemical properties were also improved. The available NPK and S content in both the soils increased with increasing proportion of sewage sludge in SLASH. Similar trend was noticed in micronutrients. The higher level of hot water soluble boron was maintained up to 1:1 (wt/wt) ratio in SLASH, thereafter it decreased. The SLASH application was beneficial in minimizing the load of toxic heavy metals in the soil.

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98. Crop responses to SLASH (mixture of sewage sludge and fly ash) as influenced by soil texture and fertility.

Yeledhalli, N. A.; Ravi, M. V.; and Prakash, S. S. *Environment and Ecology* 26(3): 971-977. (2008)

NAL Call #: TD172.E5; ISSN: 0970-0420

Descriptors: clay loam soils/ crop yield/ fly ash/ heavy metals/ nutrient content/ nutrient uptake/ sandy loam soils/ sewage sludge/ soil amendments/ soil fertility/ soil texture/ soil types/ sunflowers/ Mysore

Abstract: The use of mixtures of sewage sludge and fly ash (SLASH) as a soil ameliorant has a tremendous potential, which has high quantities of waste materials. An attempt

was made to investigate the feasibility of converting waste disposal problems into a soil beneficiation strategy. Field experiments were conducted in Raichur, Karnataka, India, during kharif 2005 to determine the effect of SLASH under different conditions (sandy loam and clay loam soils, with optimal or sub-optimal fertilization) on sunflower yield as well as nutrient content and uptake. Sunflower yield differed in their response to soil texture and fertility. The augmentation with SLASH improved the sunflower yield. With SLASH at 3:1 ratio, the yield of sunflower was 28% higher than the NPK control. However, no evidence was found of heavy metal translocation from the soil to the biomass. The experiments showed the potential soil ameliorative properties of SLASH, which might benefit crop production.

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99. Cropping highbush blueberry in coal ash compost mixtures.

Black, Brent L. and Zimmerman, Richard H. In: 97th Annual International Conference of the American Society for Horticultural Science. Lake Buena Vista, Florida, USA.; Vol. 35(3).; pp. 434; 2000.

NAL Call #: SB1.H6

Descriptors: Horticulture: Agriculture/ Waste Management: Sanitation/ Soil Science/ Ericaceae: Angiosperms, Dicots, Plants, Spermatophytes, Vascular Plants/ Coal Ash Compost Mixtures/ Meeting Abstract/ Meeting Poster

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100. Current pollution and odor control technologies for poultry production.

Naah, K. H.

Avian and Poultry Biology Reviews 14(4): 151-174. (2003); ISSN: 1470-2061

Descriptors: air quality/ ammonia/ animal wastes/ chemicals/ diet/ dust/ enzymes/ filters/ fly ash/ heavy metals/ litter/ nitrogen/ odours/ ozone/ phosphorus/ pollution/ pollution control/ poultry farming/ reviews/ vitamin D/ water pollution/ environmental pollution/ livestock wastes/ odors/ smells

Abstract: Concentrated poultry production has resulted in pollution of water by nitrogen (N) and phosphorus (P), and air due to ammonia (NH₃), odors and dust within the poultry barns. Chemical additives containing calcium (Ca), aluminium (Al), or iron (Fe) reduce NH₃ emissions 35 to 99% and soluble P 31 to 95%, depending on the chemical and concentration used. Poultry feed manipulation methods for reducing N and P contents in poultry manure involve reducing protein contents and supplementing with synthetic amino acid to reduce N excretion up to 29.14%. Reducing soluble P contents in broiler diets (40% of NRC requirements) during the withdrawal period reduced soluble P contents in the manure. Enzyme supplements in poultry feed improve dry matter digestibility and phytic P utilization from grain diets, thereby reducing P content in manure. Litter materials increase carbon content of manure and sawdust has specifically been found to reduce the nitrogen in manure by 21%. Covers reduce odour production (impermeable covers by 70-85% and permeable covers by 45-85%) from manure storage areas. Filter systems reduce dust production and accompanying odors by 80% from poultry barns. Certain land application techniques of manure reduce odour and ammonia by 90%. Ozone lowers

NH₃ levels in poultry buildings up to 25% and also eliminates pathogens. Mixing fly ash with manure reduces soluble P contents in stockpiled manure up to 85% and composted manure up to 93%. Addition of vitamin D alone to poultry feed improves phytate P retention from 31 to 68%, while use with phytase improved retention to 79%. Using combinations of the methods would maximize their effectiveness.

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101. Dechlorination and sorption of TCE and PCE in soil amended with fly ash.

Uddin, M. Momin K.; Mills, Gary L.; and Seaman, John C. In: Abstracts with Programs: Geological Society of America. Denver, CO, United States.; Vol. 34 (6).; pp. 189; 2002.

Notes: Geological Society of America, 2002 Annual Meeting.

Descriptors: ash/ chlorinated hydrocarbons/ dechlorination/ degradation/ dehalogenation/ effluents/ gas chromatograms/ halogenated hydrocarbons/ lime/ mass spectra/ organic compounds/ pollutants/ pollution/ sampling/ soils/ sorption/ spectra/ testing/ tetrachloroethylene/ textures/ trichloroethylene/ volatiles/ environmental geology

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102. Design fertilisers from coal waste.

Elliot, Alex

Australasian Science (Hawksburn) 26(9): 24-26. (2005); ISSN: 1442-679X

Descriptors: agriculture/ ash/ cation exchange capacity/ coal/ combustion/ energy conservation/ fertilizers/ framework silicates/ nutrients/ sedimentary rocks/ silicates/ soil quality/ sustainable development/ utilization/ waste management/ water quality/ zeolite group/ environmental geology

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103. Determination of adsorption efficiency based on cation exchange capacity related to red earth, bone meal and pulverised fly ash as ameliorants to lead contaminated soils.

Gatima, E.; Mwinyihija, M.; and Killham, K.

International Journal of Environmental Science and Technology 3(3): 269-280. (2006); ISSN: 1735-1472

Descriptors: absorption/ adsorption/ agricultural soils/ bioavailability/ biosensors/ bone meal/ cation exchange capacity/ contamination/ determination/ fly ash/ leachates/ leaching/ lead/ metal ions/ polluted soils/ red soils/ soil amendments/ soil pollution/ soil toxicity/ soil types/ topsoil/ Britain/ red earths/ remediation/ toxic soils/ United Kingdom

Abstract: Efficient treatment strategies to reduce the toxicity of metal-contaminated soil using cost effective techniques such as naturally available ameliorants and industrial waste have emerged. The effect of 3 easily available soil amendments (bone meal, red earth/mud and pulverized fly ash) on the lability and bioavailability of lead, were determined. The soil used in the experiments were collected from an agricultural field on the Craibstone estate, located northwest of Aberdeen (UK). The application of ameliorants offered a possible alternative in situ remediation of contaminated sites without disruption to the ecosystem profile. In comparison to other ameliorants red earth/mud was found to be efficient in intercepting lead

leaching from soil amended with different lead compounds based on CEC (Cmol/g). This was associated with the heterogeneous adsorbency principle in red mud which is associated with its ability to bind metal ions (M²⁺) onto one or two types of surface sites at pH<6.0. However, areas that need to be studied and assessed (for public health concerns) critically for wide spread application of all the ameliorants include off-site effects of the ameliorants. Lux-based biosensor (*Escherichia coli* HB101 pUCD607) was used to assess Pb toxicity in soil samples due to its wide pH operating range and as an environmental-based organism.

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104. Development of formulations of *Trichoderma harzianum* strain M1 for control of damping-off of tomato caused by *Pythium aphanidermatum*.

Jayaraj, J.; Radhakrishnan, N. V.; and Velazhahan, R. *Archives of Phytopathology and Plant Protection* 39(1): 1-8. (2006); ISSN: 0323-5408

Descriptors: bentonite/ biological control/ biological control agents/ biomass/ fly ash/ formulations/ fungal antagonists/ fungal diseases/ gelatin/ glycerol/ lignite/ plant disease control/ plant diseases/ plant pathogenic fungi/ plant pathogens/ polyethylene glycol/ rhizosphere/ seed treatment/ seeds/ storage life / talc/ tomatoes/ wettable powders/ biocontrol agents/ biological control organisms/ Hyphomycetes/ Madras/ Peronosporomycetes/ phytopathogens/ polyoxyethylene/ Pythiaceae/ Straminipila

Abstract: A carbendazim-resistant *T. harzianum* strain M1, inhibitory to the growth of the damping-off pathogen *P. aphanidermatum*, was used for the development of new carrier formulations. Seven formulations (talc, lignite, lignite +fly-ash-based powder formulation, wettable powder, bentonite paste, polyethylene glycol-paste and gelatin-glycerin-gel) were developed for the treatment of the seeds of tomato (cv. PKM-1). The shelf life of the formulations was evaluated under storage at 24 degrees C up to 9 months. The population of propagules was optimum in all formulations up to 3 months of storage. Seed treatment with *T. harzianum* formulations reduced the incidence of damping-off disease of tomato by up to 74% and enhanced plant biomass under greenhouse and field (Tamil Nadu, India) conditions. Active colonization of *T. harzianum* in the rhizosphere of tomato plants was observed following seed treatment with the formulations.

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105. Development of hydroponic substrates using coal fly ash.

Kim IlSeop; Li XianRi; Yun HyungKweon; Kim YoungDo; Shin KunChul; and Yoo KeunChang

Journal of the Korean Society for Horticultural Science 42(2): 171-176. (2001)

NAL Call #: SB13.H28; ISSN: 0253-6498

Descriptors: chemical composition/ clay/ coal/ crop yield/ fly ash/ fruits/ growing media/ growth/ hydroponics/ nutrient solutions/ physicochemical properties/ porosity/ shale/ substrates/ tomatoes/ water uptake/ potting composts/ rooting media

Abstract: The possible replacement of imported

horticultural medium materials by home-made materials and the possible role of coal fly ash ball as a medium component for hydroponics were studied. The effects of mixing hard coal, soft coal, coal shale and coal fly ash on the physicochemical properties and growth of tomato plants were evaluated. Water absorption and apparent porosity of coal fly ash ball were controlled by the addition of hard coal, soft coal, coal shale and clay. Hard coal, soft coal and coal shale were used to make the pores in the medium. The surface of the medium was not good (showing, for example, surface cracks or fractures) when soft coal and coal shale were added. Clay was added to give the media plasticity. Greater amounts of clay in the mixture resulted in lower water absorption and apparent porosity. On the basis of water absorption and surface state after firing, the F80H15C5 (fly ash:hard coal:clay=80:15:5, w/w/w) medium was chosen for lab tests. For the pilot plant a new formula of F80H10C10 (fly ash:hard coal:clay=80:10:10, w/w/w) was used in the medium to overcome difficulties in shaping of the ball. No differences in tomato fruit yield were observed between media, but the ash ball medium recorded high soluble solids in the fruit. The yields were 200 g and 150 g per plant when the medium was supplied with a nutrient solution of 1.4 and 0.7 litres per plant, respectively. The soluble solid contents of tomato fruit were 5.5 degrees Brix and 8 degrees Brix in plants supplied with 1.4 and 0.7 litres of nutrient solution per plant, respectively. The stability of medium pH and EC was maintained throughout the experimental period, and no significant difference was observed in the mineral content of plants. Reproduced with permission from the CAB Abstracts database.

106. Development of synthetic light weight soil aggregates utilizing coal fly ash and mine clay as waste materials.

Jayasinghe, G. Y. and Tokashiki, Y.

Tropical Agricultural Research and Extension 8(1-12)(2005); ISSN: 1391-3646

Descriptors: aggregates/ bulk density/ clay/ coal/ fly ash/ mine spoil/ permeability/ soil density/ soil strength/ waste disposal/ waste management/ waste utilization/ water holding capacity/ mine wastes/ mining spoil/ mining wastes

Abstract: This paper presents an investigation of the development, evaluation and micro-morphological observations of synthetic light weight soil aggregates utilizing coal fly ash, Okinawa mine clay and used paper as waste materials. In this study, a series of aggregates were produced by using several fly ash application percentages from 0 to 100 with other waste materials as an alternative method of waste disposal. Relationship between applied coal ash percentage and different aggregate parameters such as bulk density, water holding capacity, permeability, aggregate strength, aggregate stability and mean weight diameter were determined. The results of the study showed that fly ash addition percentage had a correlation coefficient of 0.91 with the bulk density of the aggregates. Moreover coal ash addition percentage had correlation coefficients of 0.86, 0.95 and 0.96 with mean weight diameter difference, aggregate strength and loss percentage of finer fraction less than 1 mm respectively. Coal fly ash addition percentages below 40% showed low aggregate strength values. Highest aggregate strength was given with 100% of ash application. Bulk densities of all aggregates were in between 0.68-1.02 gcm⁻¹ which is in the range of light

weight aggregates. Permeability of all aggregates showed an average value of 2.7x10⁻² cm/second. Water holding capacities of all treatments showed high values in between 0.69-0.74 litre/kg. pH values of aggregates were in the range of 5.85-8.25 and nitrogen percentages of all produced aggregates were in between 0.03-0.06%. Lowest loss percentage of finer fraction (less than 1 mm) was given at 100% of ash application after subjecting to mechanical shaking. Scanning electron microscopic (SEM) observations indicated that coal fly ash and mine clay particles are well enmeshed in the used paper matrix with starch as the binder to form stable light weight soil aggregates. Low application percentages of coal fly ash showed poor binding in SEM images. The study also revealed that aggregates produced by coal fly ash, mine clay and used paper with starch enhanced the aggregation while improving aggregate performances with increasing percentages of coal fly ash application. Reproduced with permission from the CAB Abstracts database.

107. Direct and residual effect of fertilization sources and time of application on equivalent yield of rice-potato cropping sequence and soil properties.

Rautray, S. K. and Swain, D. K.

Indian Journal of Hill Farming 16(1/2): 56-60. (2003); ISSN: 0970-6429

Descriptors: application date/ application rates/ application to land/ composts/ crop yield/ cropping systems/ farmyard manure/ fly ash/ green manures/ hyacinths/ nitrogen fertilizers/ NPK fertilizers/ nutrient content/ nutrient requirements/ organic amendments/ organic fertilizers/ phosphorus fertilizers/ potatoes / residual effects/ rice/ rice straw/ sandy loam soils/ soil fertility/ soil types/ straw/ superphosphates/ urea fertilizers/ dietary standards/ Filicopsida/ food requirements/ FYM/ land application/ nutritional requirements/ paddy/ phosphate fertilizers

Abstract: Field experiment was conducted at the experimental farm of Indian Institute of Technology, Kharagpur, West Bengal, India, during 1996-98 to investigate the direct effect of application of organic materials under integrated nutrient management with fly ash supplement on yield of rice and residual effects on yield of potato and properties of sandy loam soil. Paddy straw (PS), farmyard manure, water hyacinth compost (WH), green manure (*Sesbania rostrata*) and Azolla were the organic materials used. Equivalent nutrient level of 90:26:33 kg NPK/ha was supplied to rice crop through organic material and chemical fertilizer (CF, urea, single superphosphate and muriate of potash). However, in case of treatments involving PS, equivalent K level of 33 kg/ha could not be maintained because a higher dose (66.5 kg/ha) was added through 5 t PS. Organic materials and PA were incorporated into soil at 15 cm depth in three times of application, viz., 30 days before planting (DBP), 15 DBP and at planting. Direct effect of time of application on rice grain yield revealed that incorporation of organic materials at 15 DBP resulted in highest yield while application at planting resulted in lowest grain yield. Incorporation of organic materials in between 30 DBP of rice was equally beneficial on equivalent rice grain yield or rice-potato cropping sequence. Integrated nutrient management involving organic material and CF with fly ash at 10 t/ha as supplement applied to rice crop followed by recommended CF to potato crop was superior to continuous use of CF on

equivalent nutrient basis. Maximum equivalent rice yield of 12.6 t/ha was realized under integrated use of PS (5 t), complimentary CF (57.5 kg N and 18.5 kg P) and fly ash (10 t) for rice followed by 125:46:104 kg NPK through CF for potato.

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108. Direct and residual effect of flyash application to soil on crop yields and soil properties.

Grewal, K. S.; Yadav, P. S.; Mehta, S. C.; and Oswal, M. C. *Crop Research Hisar* 21(1): 60-65. (2001)

NAL Call #: SB4.C66 ; ISSN: 0970-4884

Descriptors: fertilizers/ fly ash/ residual effects/ soil properties/ soil temperature/ soil water/ wheat/ soil moisture

Abstract: The direct and residual effect of fly ash application/mixing on crop yields and soil properties was studied on a sandy loam soil at the Soil Research Farm of CCSHAU, Hisar. Fly ash collected from Thermal Power Plant, Faridabad in Haryana, was mixed @ 0, 5, 10 and 20% (w/w basis) in the plough layer (0-15 cm) of the soil. Also a 2.5 cm fly ash layer (equivalent to 10.6% w/w basis) was applied on the soil surface as a separate treatment. Pearl millet was grown in the kharif [monsoon] season and the residual effect was determined in wheat in rabi [winter]. Application of fly ash to soil increased both grain and straw yields of pearl millet (direct) and subsequent wheat (residual) crops significantly at all application rates. The maximum increase (32.9% in grain and 39.5% in straw of pearl millet and 32.4% in grain and 43.9% in straw of wheat over their respective controls) was observed with 20% fly ash mixed into the soil. Addition of fly ash to soil increased both the mean daily minimum and maximum soil temperatures during the emergence period of both the crops; however, these effects were more pronounced and beneficial during the winter (wheat) season. Fly ash application also resulted in greater moisture storage in the plough layer of soil at all the stages of crop growth. The uptake of N, P and K, both in grain and straw of pearl millet and wheat crops, was higher in fly ash treated plots than in controls.

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109. Direct and residual effects of agro-industrial wastes on a rocket salad (*Eruca sativa* Mill.) sorghum [*Sorghum bicolor* (L.) Moench] sequence.

Sharma, D. K.; Rana, D. S.; Kaushik, R.; Kumar, S.; and Joshi, H. C.

Acta Agronomica Hungarica 56(1): 99-106. (2008); ISSN: 0238-0161

Descriptors: composts / crop residues/ crop yield/ distillery effluent/ filter cake/ fly ash/ industrial wastes / leaves/ mineral uptake/ nitrogen content/ nitrogen fertilizers/ NPK fertilizers/ nutrient availability/ nutrient uptake/ phosphorus/ phosphorus fertilizers/ plant nutrition/ potassium/ potassium fertilizers/ residual effects/ seeds/ soil fertility/ sulfur/ sulfur fertilizers/ Capparales/ clarification mud/ elemental sulphur/ New Delhi/ phosphate fertilizers/ potash fertilizers/ sulphur/ sulphur fertilizers

Abstract: A field study was conducted during 2002-04 in New Delhi, India, to determine the effect of agro-based industrial wastes on rocket salad (*E. sativa*) and soil

properties, and how they can best be integrated with chemical fertilizers. The seed yield (1.80 t ha⁻¹) of rocket salad obtained by applying 5 t pressmud compost ha⁻¹ based on distillery effluent+half the recommended dose of NPKS (recommended dose: 60 kg N, 13 kg P 25 kg K and 20 kg S ha⁻¹) was on par with the seed yield (1.69 t ha⁻¹) recorded with the recommended dose of NPKS. However, the seed yield recorded with the former treatment significantly exceeded that obtained with 5 t ha⁻¹ of a 1:1 mixture of fly ash and distillery effluent+half the recommended dose of NPKS (by 30.4%) or 5 t ha⁻¹ of dry *Jatropha curcas* leaves+1/2 NPKS (by 24.1%). On the average, the distillery effluent-based pressmud compost+1/2 NPKS induced a perceptible increase in the soil available N, P and K, after the harvest of rocket salad, compared to the initial fertility status. The uptake of N, P, K and S in the seed and stover of rocket salad was the highest after the application of pressmud compost, closely followed by the recommended dose of NPKS, and the lowest in the control. The residual effect of the treatments given to rocket salad was significant on the fodder yield of succeeding sorghum (*Sorghum bicolor*). The fodder yield recorded with pressmud compost+1/2 NPKS was significantly higher than the other treatments. The application of pressmud compost alone was also significantly superior to the same rate of fly ash+effluent mixture or dry *J. curcas* leaves with respect to the seed yield of rocket salad, residual fertility after the harvest of rocket salad, and the fodder yield of succeeding sorghum. Reproduced with permission from the CAB Abstracts database.

110. Direct and residual effects of fly ash integrated with FYM and chemical fertilizers on growth, yield and nutrient (major) uptake by crops on rice-groundnut cropping system in acid soils of Orissa.

Pradhan, K. C. and Sahu, S. K.

Environment and Ecology 22(2): 332-336. (2004)

NAL Call #: TD172.E5; ISSN: 0970-0420

Descriptors: acid soils/ crop yield/ farmyard manure/ fly ash/ groundnuts/ growth/ nitrogen fertilizers/ nutrient uptake/ phosphorus fertilizers/ potassium fertilizers/ residual effects/ rice/ soil types/ yield components/ FYM/ paddy/ peanuts/ phosphate fertilizers/ potash fertilizers

Abstract: A field investigation was undertaken to evaluate the direct and residual effects of fly ash on the growth, yield and uptake of some nutrients in a rice (cv. Lalat)-groundnut (cv. AK-12-24) cropping system in Orissa, India. Treatments comprised: T1, control; T2, 100% NPK at 80:40:40 kg/ha; T3, 10 t farmyard manure (FYM)/ha; T4, 20 t fly ash/ha; T5, 40 t fly ash/ha; T6, 20 t fly ash/ha + 50% NPK (40:20:20 kg/ha); T7, 40 t fly ash/ha + 50% NPK; T8, 20 t fly ash/ha + 50% NPK + 5 t FYM/ha; T9, 40 t fly ash/ha + 50% NPK + 5 t FYM/ha. Positive and significant direct and residual effects of fly ash applied alone or in combination with FYM or 50% recommended NPK were observed on the growth, yield and uptake of NPK by rice, followed by groundnut. T9 recorded the maximum grain yield, yield attributes and NPK uptake by rice. T9 was at par with T8. Similar results on groundnut were obtained in terms of the residual effects of these two treatments. Reproduced with permission from the CAB Abstracts database.

111. Direct and residual supply of available sulphur and its balance sheet in rice-rice cropping sequence.

Sriramachandrasekharan, M. V.; Bhuvaneshwari, R.; and Ravichandran, M.

Advances in Plant Sciences 18(2): 699-703. (2005)

NAL Call #: QK1.A38; ISSN: 0970-3586

Descriptors: application rates/ clay loam soils/ crop yield/ dry matter accumulation/ farmyard manure/ filter cake/ fly ash/ green manures/ lignite/ nutrient availability/ organic amendments/ rice/ sequential cropping/ soil amendments/ soil fertility/ soil types/ sulfur/ Vertisols/ clarification mud/ elemental sulphur/ FYM/ Madras/ paddy/ sulphur

Abstract: A field experiment was conducted during kharif 2001 in an S-deficient clay loam soil (Typic Haplusterts) in Tamil Nadu, India, to investigate the direct and residual supply of S from different sources and its effect on rice-rice sequence. Treatments comprised 4 levels of S (0, 20, 40 and 60 kg/ha) with or without *Sesbania aculeata*, farmyard manure, sulfitation pressmud and lignite fly ash each applied at 12.5 t/ha. Results indicated that the organic amendments improved S availability and dry matter production of rice. To maintain sulfur fertility and higher dry matter production, application of 40 kg S/ha alone is needed. However, in combination with organic amendments, it is sufficient to apply 20 kg S/ha through gypsum.

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112. Distribution of exchangeable cations and trace elements in the profiles of soils amended with coal combustion by-products.

Kukier, U.; Sumner, M. E.; and Miller, W. P.

Soil Science 166(9): 585-597. (2001)

NAL Call #: 56.8 So3; ISSN: 0038-075X

Descriptors: Alfisols / arsenic/ boron/ calcium/ clay fraction/ coal / desulfurization/ exchangeable aluminium/ exchangeable calcium/ exchangeable cations/ exchangeable magnesium/ exchangeable potassium/ fly ash/ gypsum/ leaching/ lead/ magnesium/ nutrient availability/ nutrient deficiencies/ potassium/ sandy soils/ soil amendments/ soil fertility/ soil profiles/ soil types/ subsoil/ trace elements/ Ultisols/ desulphurization/ exchangeable aluminum/ microelements/ United States of America

Abstract: The flue gas desulfurization process employing forced oxidation technology generates an almost pure gypsum (FGD), which may substitute for mined gypsum used as a soil amendment in the southeastern USA. Under specific conditions, a mixture of FGD and fly ash (FA) may be produced by an electric power plant. A field experiment was conducted to study the effect of FGD applied both singly and as a 1:1 mixture with fly ash (AFGD) on the distribution of the exchangeable cations Ca, Mg, K, and Al and the trace elements B, As, and Pb in the profiles of soils having various textures. Lime was not applied in this study. The experiment was conducted in Tifton, Watkinsville, and Calhoun, Georgia, USA, on Pelham (loamy, siliceous, thermic Arenic Paleaquult), Cecil (clayey, kaolinitic, thermic Typic Kanhapludult), and Tupelo (fine mixed, thermic Vertic Paleudalf) highly weathered soils. The total amount of rainfall plus irrigation at these locations during the experimental period was 1385, 1418, and 1406 mm, respectively. Soil cores were collected to a depth of 70 or 80 cm ~13 months after by-product application. FGD

application increased exchangeable Ca levels in the subsoil. Exchangeable K levels were significantly decreased by FGD application only in a sandy soil. FGD promoted release of Mg from the soil sorptive complex and increased leaching of this element. Cations were transported most effectively in the profiles of a sandy soil. FA application increased plant available As in the surface layer of a sandy soil and plant available B in the zone of incorporation in the soils containing more clay, but it only partially alleviated deficiencies of this element. FA did not sufficiently supplement K and Mg losses induced by FGD application. The results of this study demonstrate that the FGD material had greater agronomic value than the mixed AFGD by-product.

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113. [Distributions and environmental impacts of selenium in wastes of coal from a power plant].

Xu, W. D.; Zeng, R. S.; Ye, D. N.; and Quero, X.

Huan Jing Ke Xue 26(2): 64-8. (Mar. 2005); ISSN: 0250-3301 .

Notes: Original language of article: Chinese.

Descriptors: air: analysis/ air pollutants: analysis/ carbon/ coal: analysis/ particle size/ particulate matter/ power plants/ selenium: analysis

Abstract: Samples of coals, fly ashes, slags and tiny fly ashes with different sizes, collected from a large power plant, were studied. It shows that Se tends not to be enriched in coarse fly ash and slag, but to be enriched in fine fly ashes especially in fine fly ash with size > 19.0 microm. This kind of distribution is shaped by: 1) volatility and organic-occurrence of Se in coal; 2) residence time in flue gases; 3) morphology of particles [holes on the surface of particles (> 19.0 microm) may adsorb more Se]. Sequence leaching test shows that Se is mainly organic-bonded (69.7%) in coal. Mass balance calculation of burned coal indicates that 16.5% of Se in coal may be disposed into air directly. The environmental impacts of Se in fine fly ashes can be ignored because of its small proportion and distributional character (mainly in particles with sizes > 19.0 microm). Se in slag may cause little environmental impacts. Se in coarse fly ash is partially mobile and may be used to benefit the soil which is lack of Se.

This citation is from PubMed.

114. Ecotoxicological hazard and risk assessment of heavy metal contents in agricultural soils of central Germany.

Manz, M.; Weissflog, L.; Kuhne, R.; and Schurmann, G.

Ecotoxicology and Environmental Safety 42(2): 191-201.

(Feb. 1999); ISSN: 0147-6513 .

10051370

Descriptors: Acid Rain/ Agriculture/ Germany/ Hydrogen-Ion Concentration/ Metals, Heavy: toxicity/ Models, Statistical/ Risk Assessment/ Safety Management/ Soil: analysis/ Soil Pollutants: toxicity/ Triticum: chemistry

Abstract: Heavy metal content of agricultural topsoils has been experimentally determined at 14 areas in the German Leipzig-Halle-Bitterfeld region covering ca. 3700 km². For most of the locations and elements, the contamination levels are comparable to those of other agricultural sites in Germany and Europe. Application of a sequential extraction technique revealed relatively low contamination levels in

the mobile fractions, which indicates a correspondingly low degree of bioavailability of the heavy metals under the current milieu conditions. In contrast, acidification of the soil due to a drastic decrease in the deposition of calciferous fly ash would lead to a significantly increased ecotoxicological hazard potential, as is analyzed by a probabilistic distribution method that quantifies the overlap of normalized exposure and effect data. The discussion includes recommendations for further improvement of risk assessment schemes addressing soil contamination. This citation is from PubMed.

115. Effect of a fly ash and gypsum mixture on rice cultivation.

Lee YongBok; Ha HoSung; Park BumKi; Cho JuSik; and Kim PilJoo

Soil Science and Plant Nutrition 48(2): 171-178. (2002)

NAL Call #: 56.8 SO38 ; ISSN: 0038-0768

Descriptors: boron/ calcium/ crop yield/ exchangeable calcium/ fly ash/ gypsum/ liming/ liming materials/ nutrient availability/ nutrient balance/ nutrient uptake/ paddy soils/ phosphate/ plant nutrition/ rice/ silicates/ silt loam soils/ soil amendments/ soil fertility/ soil types/ paddy/ South Korea

Abstract: Paddy soil in Korea generally required the addition of silicate to enhance rice productivity. Even though a silicate fertilizer has been applied at 4-year intervals by the Korean government, the quantity has not been sufficient, due to financial constraints, and an alternative source of cheaper silicate is required. Fly ash, which has a high silicate content, was selected as an alternative in the present study. To improve fly ash, which is highly alkaline and has a high boron content, the material was mixed with a by-product of gypsum (hereafter, described as gypsum) and the pH changes were monitored in water using an incubation test. The initial pH of the water suspension was compatible with the optimum range (~6.5-7.0) for rice using a mixture of 75% fly ash and 25% gypsum. A field experiment was carried out to evaluate the productivity of rice (*Oryza sativa*) on silt loamy soil to which 0 (FG 0), 20 (FG 20), 40 (FG 40), or 60 (FG 60) t ha⁻¹ of the mixture were added. Silicate and lime treatments were selected as a control. The highest rice yield was achieved following the addition of 40 t ha⁻¹ of the mixture to the soil. The mixture of fly ash and gypsum increased the uptake of silicate and phosphate and the amount of exchangeable calcium in the soil. The plant elemental uptake revealed that the application of the fly ash and gypsum mixture did not result in an excessive uptake of heavy metals by the rice in the submerged paddy soil. The amount of available boron increased with the increase in the amount of fly ash up to 0.62 mg kg⁻¹ following the application of 60 t ha⁻¹ of the mixture, but did not reach toxicity levels for rice, probably due to the dilution and leaching effects under the submerged growing conditions. It is concluded that the fly ash and gypsum mixture could be a good alternative to inorganic soil amendments to restore the soil nutrient balance in paddy soil.

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116. The effect of alkaline-stabilized sludge application on the microbiological quality of soil and leachate.

Kocaer, F. O.; Alkan, U.; and Baskaya, H. S.

Journal of Plant Nutrition and Soil Science 167(6): 704-712. (2004)

NAL Call #: 384 Z343A ; ISSN: 1436-8730

Descriptors: application to land/ artificial precipitation/ coliform bacteria/ fly ash/ heterotrophic microorganisms/ leachates/ leaching/ microbial flora/ population density/ sewage sludge/ soil bacteria/ soil profiles/ solutes/ spatial distribution/ transport processes/ land application/ microflora/ soil transport processes/ transport processes in soil systems

Abstract: The influences of fly ash and fly-ash-quicklime-treated-sludge mixtures (with fly-ash doses of 40%, 80%, and 120% on dry-weight basis) on the microbial numbers in soil and leachate were investigated by using 60 cm soil columns. Heterotrophic bacteria and total coliform numbers were determined in soil and leachate samples following an artificial rainfall event. The results indicated that land application of untreated sludge and fly-ash-sludge mixtures appear to introduce large numbers of bacteria to leachates and soil. Although the numbers in leachates and soils were found to decrease with increasing ash ratios, they were still all significantly above the control levels. Application of alkaline-stabilized and pasteurized sludge did not increase bacterial numbers significantly in soil and leachate. Distribution of heterotrophic bacteria through soil profile clearly showed no increase in soils amended with alkaline-stabilized and pasteurized sludges. Additionally, no significant inhibitory effect of lignite fly ash on soil microbial population was observed.

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117. Effect of cellulose decomposing fungi, cowdung slurry and fly ash on the decomposition and mineralization of rice straw.

Saha, H. and Hajra, J. N.

Environment and Ecology 22(Spl 4): 714-718. (2004)

NAL Call #: TD172.E5; ISSN: 0970-0420

Descriptors: ammonium nitrogen/ carbon dioxide/ cattle manure/ cellulose/ citric acid/ composting/ decomposition/ fly ash/ mineralization/ phosphorus/ rice/ rice straw/ soil fungi/ straw/ Acrophialophora/ Acrophialophora fuispora / ammonia nitrogen/ Hyphomycetes/ paddy/ Trichuriella/ Trichurus/ Trichurus spiralis

Abstract: The effect of two cellulose decomposing fungi, cowdung slurry and fly ash on the decomposition and mineralization of rice straw was studied in two related incubation experiments. In the first incubation study, rice straw (RS) was inoculated with *Trichurus spiralis* (TS), *Paecilomyces fuisporus* [*Acrophialophora fuispora*] (PF) as cellulose decomposing fungi and cowdung slurry (CDS) as natural harborer of different enzymes and microorganisms, alone and in different combinations. In the second incubation study, rice straw along with best inoculum combination (TS+PF+CDS), selected from the first experiment, was treated with different levels of fly ash, viz. 5, 10 and 25%. In the first incubation study, maximum amount of CO₂ was evolved in the inoculum combination of TS+PF+CDS (7144.6 mg) followed by TS+PF (6420.1 mg), IS (5008.9 mg), PF (4560.8 mg), CDS (4180 mg) and control, i. e., rice straw only (2987.0 mg). Though CO₂ values of TS+PF+CDS and TS+PF were found statistically at par, mineralization studies indicated significantly higher values of NH₄-N (40 ppm), NO₃-N (72 ppm), total P (0.71%) and citric acid soluble P (0.41%) in TS+PF+CDS treatment compared to those in TS+PF treatment. In the second incubation study, application of fly ash irrespective of levels

decreased significantly the decomposition of rice straw inoculated with TS+PF+CDS over control in terms of CO₂ evolution and weight loss as well as mineralization with respect to NH₄-N, NO₃-N, total P and citric acid soluble P. Highest CO₂ evolution was recorded in control i. e., rice straw without fly ash (6936.5 mg) followed by FA at 5% (6262.3 mg), 10% (5775.8 mg) and 15% (5259.4 mg). Considering both the parameters of decomposition and mineralization, *Trichurus spiralis*, *Paecilomyces fusciporus* along with cowdung slurry can be used as inoculum in large scale composting. Further, fly ash should not be used in composting system as an additive.

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118. Effect of certain cultural practices on nematode management in a small-scale farming system.

Berry, S.; Cadet, P.; and Spaul, V. W. Kwa Shukela, Mount Edgecombe, South Africa.); pp. 149-164; 2005.

Descriptors: aldicarb / bagasse/ chemical control/ crop production/ crop yield/ cropping systems/ cultural control / farming systems/ farmyard manure/ fly ash/ free living nematodes/ green manures/ groundnuts/ integrated control/ intercropping/ intercrops/ Lima beans/ manures/ nematicides/ nematode control/ organic amendments/ pest control/ plant parasitic nematodes / plant pests/ roots/ sets/ shoots/ sweet potatoes/ agricultural systems/ eelworms/ FYM/ integrated plant protection/ peanuts/ setts

Abstract: Field trials were conducted on a small-scale grower farm in Amatikulu (under rainfed conditions) and Boschfontein (under irrigation), South Africa. The treatments comprised: organic amendments (bagasse, kraal manure and fly ash) applied around the cane set at planting; and intercropping between the sugarcane rows with velvet beans (*Mucuna deeringiana*), sweet potatoes (*Ipomoea batatas*), sugarbeans (*Phaseolus limensis* [*P. lunatus*]) and groundnuts (*Arachis hypogaea*). These treatments were compared with the control and nematicide (aldicarb at 150 g/kg)-treated plots. In the plant crop, intercropping with velvet beans, sweet potatoes and groundnuts increased nematode infestation in the sett and shoot roots. Conversely, nematicide and bagasse treatments decreased sett, shoot and root infestations. Bagasse, kraal manure and fly ash increased the multiplication of free-living nematodes, which are important in improving overall soil health. The two treatments that resulted in increased yield, relative to the control, were applying nematicide at planting (average increase of 18 and 20% cane and ERC yields, respectively) and applying kraal manure below and above the sett at planting (average increase of 21 and 20% cane and ERC yields, respectively). Kraal manure is a particularly useful amendment for small-scale farmers as it can be produced on the farm by the grower and has been shown to improve sett root germination and provides nutrients through decomposition. These results show that there are alternative control methods (other than nematicides) available to small-scale farmers to improve their productivity on poor soils.

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119. Effect of co-application of fly ash and sewage sludge on growth, yield of okra (*Abelmoschus esculentus* L.) and some soil properties.

Yeledhalli, N. A. and Ravi, M. V.

Asian Journal of Soil Science 3(1): 71-75. (2008); ISSN: 0973-4775

Descriptors: application to land/ biomass/ bulk density/ crop yield / fly ash/ growth/ nutrient availability/ nutrient uptake/ okras/ organic carbon/ sewage sludge/ soil amendments/ soil density/ soil organic matter/ soil physical properties/ solid wastes/ use efficiency/ waste utilization/ land application/ Mysore/ organic matter in soil/ physical properties of soil

Abstract: Field study was conducted in the new orchard of the Division of Horticulture, Raichur, Karnataka, India, with the objective of improving physical condition of soil, nutrient use efficiency and uptake by the okra (*Abelmoschus esculentus*) on addition of fly ash and sewage sludge. The study examined the nutrient solubility and availability resulting from land application of fly ash and sewage sludge. The nutrient uptake was monitored in different plant parts of the okra. The results of field experiments indicated that application of 52 tonnes ha⁻¹ fly ash or sewage sludge individually or together in 50:50 proportion increased the pod yield of okra by 18.48, 61.88 and 64.00% over no solid waste control. There was efficient use of nutrient during the early stage of crop up to 45 days after sowing, which contributed for higher pod yield and biomass. Further, incorporation of solid waste along with varied levels of recommended dose of fertilizers significantly increased the organic carbon content, nutrient availability and decreased the bulk density of the soil. The results support the use of solid waste as amendment and nutrient source for land application.

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120. Effect of co-application of organics with fly ash on productive parameters and nutrient uptake by cowpea (*Vigna unguiculata* L.).

Yeledhalli, N. A.; Prakash, S. S.; and Ravi, M. V.

Environment and Ecology 26(3): 996-1000. (2008)

NAL Call #: TD172.E5; ISSN: 0970-0420

Descriptors: biogas slurry/ cowpeas/ crop yield/ farmyard manure/ fly ash/ nitrogen fertilizers/ NPK fertilizers/ nutrient uptake/ organic amendments/ phosphorus fertilizers/ plant nutrition/ potassium fertilizers/ poultry manure/ sewage sludge/ soil amendments/ soil conditioners/ trace elements/ vermicompost/ black eyed peas/ FYM/ microelements/ Mysore/ phosphate fertilizers/ potash fertilizers/ poultry litter/ southern peas

Abstract: A pot culture study was conducted Raichur, Karnataka, India, in 2001 to evaluate the co-application of organics with fly ash on the productive parameters and nutrient uptake by cowpea. The seed yield of cowpea increased significantly due to co-application of fly ash at 30 t/ha with sewage sludge at 20 t/ha, poultry manure at 5 t/ha, vermicompost at 2.5 t/ha, biogas sludge at 5 t/ha and farmyard manure at 20 t/ha with or without the recommended dose (25:30:25 kg/ha) of N:P:K fertilizers (RDF). The seed yield of cowpea increased by 6-12% over the RDF and was maximum (16.02 g/pot) in the treatment

receiving poultry manure as a biosolid along with fly ash. The uptake of macro and micronutrients by cowpea plant parts at different growth stages increased significantly due to combined application of biosolids and fly ash. The mutual beneficial effect of the mixture compared to fly ash alone act as a good soil conditioner and show better fertilization value for agriculture utilization.

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121. Effect of coal fly ash on pigeon pea (*Cajanus cajan* L.).

Das, R. K. and Jha, B.

Journal of Ecotoxicology and Environmental Monitoring 10(3/4): 253-257. (2000); ISSN: 0971-0965

Descriptors: chromosome aberrations/ fly ash/ mitosis/ phytotoxicity/ pigeon peas/ seed germination/ seedling growth/ soil amendments/ toxicity/ chromosome abnormalities

Abstract: Healthy pigeonpea seeds were germinated in experimental pots or Petri dishes and subjected to different concentrations (15-75%) of fly ash in water. Increasing concentration of fly ash (45% or greater) decreased percentage germination and seedling growth, while there was a slight stimulation of plant height and root length at 15-30% fly ash. High concentrations of fly ash decreased mitotic index and increased mitotic abnormalities.

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122. Effect of different combinations of flyash and soil on growth attributes of forest and dryland fruit crops.

Malewar, G. U.; Adsul, P. B.; and Syed Ismail

Indian Journal of Forestry 21(2): 124-127. (1998); ISSN: 0250-524X

Descriptors: fertilizers/ fly ash/ forest trees/ fruit trees/ growing media/ multipurpose trees/ pot experimentation/ seedling growth/ trees/ waste utilization/ woody plants/ neem/ potting composts/ rooting media

Abstract: A pot experiment was conducted using 5 fly ash and soil levels (T₁, fly ash alone; T₂, 3:1 fly ash and soil; T₃, 1:1 fly ash and soil; T₄, 1:3 fly ash and soil; and T₅, soil alone) to grow nilgiri (*Eucalyptus globulus*), neem (*Azadirachta indica*), custard apple (*Annona squamosa*) and jamun (*Syzygium cumini*) at Marathwada Agricultural University, Parbhani, Maharashtra (India) during 1995-96. All the treatments were given NPK fertilizer at the time of transplanting to the pots. Growth measurements were made over 6 months. Plant height, number of leaves, number of branches, root weight and shoot weight of the plants were affected significantly by the different fly ash and soil combinations. Overall, soil alone was the best growing medium, but some of the fly ash treatments performed better for some growth parameters for some species.

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123. Effect of fertilizer application on development of potato gangrene II. Effect of boron and calcium fertilizer application.

Kondo, F.; Ushiki, J.; Fukuda, Y.; Ueda, M.; and Naito, S.

Japanese Journal of Soil Science and Plant Nutrition 72(2): 230-236. (2001); ISSN: 0029-0610

Descriptors: boron fertilizers/ calcium fertilizers/ crop yield/ desulfurization/ fly ash/ fungal diseases/ industrial wastes/

necroses/ plant diseases/ plant pathogenic fungi/ plant pathogens/ postharvest decay/ potatoes/ Regosols/ sandy soils/ soil types/ tubers/ waste utilization/ Coelomycetes/ desulphurization/ phytopathogens/ rhegosols

Abstract: Previous study showed that spent flue gas desulfurization absorbent residue (SGDAR), which consists of gypsum and coal ash which contain a large amount of Ca and B, respectively, suppressed development of gangrene during storage of potatoes grown on sandy soil (Volcanic Regosols) in Hayakita-cho, Hokkaido, Japan. A field experiment was conducted in this area in 1998 which showed that application of Ca as gypsum (1.6 tonnes Ca/ha) suppressed development of gangrene. Application of B (1.6 kg B/ha) as coal ash or fitted trace element did not suppress it. The results indicated that Ca eluted from gypsum in SGDAR increased the resistance of the tuber from the infection of *Phoma exigua*, thus, SGDAR and gypsum promoted the growth of the tuber and increased the tuber yield, and coal ash and FTE increased the number of tubers.

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124. Effect of flue gas desulfurization residue on plant establishment and soil and leachate quality.

Punshon, T.; Adriano, D. C.; and Weber, J. T.

Journal of Environmental Quality 30(3): 1071-80. (May 2001-June 2001)

NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: Agriculture/ Air Pollution: prevention & control / Coal/ Gases/ Gossypium/ Hydrogen-Ion Concentration/ Incineration/ Plants: growth & development/ Power Plants/ Soil Pollutants/ Soybeans/ Sulfur: chemistry/ Sulfur Dioxide: chemistry/ Trace Elements: analysis: pharmacokinetics/ Zea mays

Abstract: Effects on soil quality and crop establishment after incorporation of flue gas desulfurization by-product (FGD) into soil as an amendment was assessed in a mesocosm study. Mesocosm units received applications equivalent to 0, 2.5, 5.0, 7.5, and 10% FGD residue [0, 25, 50, 75, and 100 tons acre(-1)]. Germination, biomass production, and elemental composition of corn (*Zea mays* L. var. Dekalb DK-683), soybean [*Glycine max* (L.) Merr. var. Haskell Pupa 94], radish (*Raphanus sativus* L. var. Sparkler), and cotton (*Gossypium hirsutum* L. var. Deltapine 51) were determined. The quality of leachates and soil were also determined periodically. Flue gas desulfurization residue did not affect germination and all application rates stimulated aboveground biomass. Plants grown in FGD-amended soil contained significantly elevated tissue concentrations of As, B, Se, and Mo. The FGD residue elevated surface soil pH from 5.5 (Control) to 8.1 (at 10% FGD). Leachate pH was unaffected by FGD, but salinity rose sharply with increasing application rates of FGD. Leachates contained higher concentrations of B, with small increases in Se and As. Flue gas desulfurization residue application caused an increase in total B, As, Mo, Se, and extractable Ca in the soil, but decreased Mn and Zn. Using FGD residues could have beneficial effects on crop establishment without detrimental effects on soil or leachate quality, at an optimum rate of approximately 2.5%. This material could alleviate surface acidity, and B and Mo deficiencies in plants.

This citation is from PubMed.

125. Effect of fly ash alone or in combination with organic material and mineral fertiliser on crop yield and economics of rice-peanut cropping system.

Swain, D. K.; Mittra, B. N.; and Ghosh, B. C.

Fertiliser News 49(5): 51-55. (2004)

NAL Call #: 57.8 F4123; ISSN: 0015-0266

Descriptors: acid soils/ application date/ application methods/ application rates/ crop yield/ cropping systems/ economic analysis/ farmyard manure/ fly ash/ groundnuts/ lateritic soils/ NPK fertilizers/ organic amendments/ rice/ sandy loam soils/ soil types/ FYM/ paddy/ peanuts

Abstract: The field experiment with rice-groundnut cropping system was conducted in Research Farm of Agricultural and Food Engineering Department, Indian Institute of Technology, Kharagpur, West Bengal, India during 1997 to 1999 to investigate the effect of fly ash (FA) alone or in combination with organic material and mineral fertilizer on crop yield and economics of rice-groundnut cropping system. Rice (cv. IR 36) crop was grown during wet season (June-October) of 1997 (first season) and 1998 (third season) and groundnut (cv. AK 12-24) during dry seasons (January-May) of 1998 (second season) and 1999 (fourth season). The soil was acid lateritic and sandy loam in texture. FA was applied at 10, 20 and 40 t ha⁻¹ either in one season or in equal splits in two or four seasons. Besides, there was a control where no FA was applied. Seven modes of FA application were tried with recommended fertilizer level (F₁) and without fertilizer (F₀-control). The recommended fertilizer levels 90:26.2:33.3 and 30:26.2:33.3 kg ha⁻¹ of N:P:K for rice and groundnut respectively were maintained through integrated fertilizer application involving farmyard manure (FYM) and mineral fertilizer (CF). The quantity of FYM was decided at 30 kg N ha⁻¹ to rice and half of the dose to groundnut crop. Application of FA at 40 t ha⁻¹ in the first season and no application for the following three seasons (FA₄₀₋₀₋₀₋₀), 20 t ha⁻¹ in the first and third seasons (FA₂₀₋₀₋₂₀₋₀) and 10 t ha⁻¹ in all the four seasons (FA₁₀₋₁₀₋₁₀₋₁₀) were comparable for increasing the rice grain yield. For groundnut, in the absence of fertilizer, the application modes of FA at 40 t ha⁻¹ were at par whereas, in presence of fertilizer, split application modes (FA₂₀₋₀₋₂₀₋₀ and FA₁₀₋₁₀₋₁₀₋₁₀) were significantly better than single application (FA₄₀₋₀₋₀₋₀) in increasing pod yield during the fourth season. The trend remained the same in rice grain equivalent yield. Fly ash applied at lower level (FA₂₀) in single mode had higher agro-economic efficiency as compared to its split mode, whereas, at higher level (FA₄₀) split mode was better than single mode. The effect of FA was more discernible when this was applied in combination with FYM and CF as an integrated fertilizer application.

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126. Effect of fly ash amended soil on the development of root-knot nematode.

Tanweer Azam; Hisamuddin; Niyaz, T.; and Robab, M. I.

Indian Journal of Nematology 37(2): 119-122. (2007)

NAL Call #: QL391.N415; ISSN: 0303-6960.

Notes: Original title: Meloidogyne incognita and growth of ivy gourd, *Coccinea cordifolia*.

Descriptors: chemical composition/ chlorophyll/ crop yield/ cultural control/ fly ash/ fruits/ medicinal plants/ nematode control/ pest control/ plant composition/ plant development/ plant nutrition/ plant parasitic nematodes/ protein content/

chemical constituents of plants/ drug plants/ eelworms/ medicinal herbs/ officinal plants/ Secernentea/ Tylenchida

Abstract: *Coccinea cordifolia* [*Coccinia grandis*], a wildly growing cucurbit plant having medicinal properties, was tested on plant growth, biochemical and pathological characteristics in fly ash (0, 10, 20, 30, 40 and 50%) amended soil infested with the root-knot nematode, *M. incognita*. The length, fresh weight and dry weight of the plants in comparison to control were significantly decreased in all the treatments except in treatment that received 30% fly ash. The number of flowers, fruits per plant, and the average leaf area exhibited the same pattern. Amount of chlorophyll and protein content of plants decreased significantly in all the treatments of 0 to 50% fly ash levels except 30% fly ash level. Number of gall and number of egg masses per plant decreased in 10 to 50% fly ash levels, when compared with 0% fly ash level amended plants. Reproduced with permission from the CAB Abstracts database.

127. Effect of fly-ash amended soil on the growth and yield of (chickpea), *Cicer arietinum* (L.).

Pandey, V. C.; Verma, S. C.; and Tewari, D. D.

Flora and Fauna Jhansi 11(1): 71-73. (2005); ISSN: 0971-6920

Descriptors: application rates/ biomass/ biomass production/ branches/ chickpeas/ crop yield/ fly ash/ growth/ plant development/ pods/ root nodules/ shoots

Abstract: A study was conducted to assess the growth performance of chickpea (*Cicer arietinum*) under the stress of fly ash (FA)-amended soil in Uttar Pradesh, India. The plants raised from certified seeds were treated with various concentrations of FA (25, 50 and 100%) and an untreated control (100% soil). Low concentrations FA showed better growth performance compared to high concentrations of FA. However, in some cases, low FA concentration promoted biomass only. FA inhibited shoot growth in dose- and time-dependent manner. Plants grown in 100% FA showed less number of branches compared to plants grown in the control. In case of the number of nodules, lower FA concentrations (25 and 50%) showed better performance than the control. Treatment with 50% FA recorded higher number of pods per plant than the other FA treatments, although the control treatment produced the highest number of pods per plant among all treatments. Reproduced with permission from the CAB Abstracts database.

128. Effect of fly-ash amendment on germination behavior and seedling survival on certain cultivated legumes.

Prasad, B. K.; Banerjee, S. K.; and Roy, H.

Environment and Ecology 18(1): 210-216. (2000)

NAL Call #: TD172.E5; ISSN: 0970-0420

Descriptors: acid soils/ calcareous soils/ fly ash/ fruit vegetables/ green gram/ legumes/ loam soils / mung beans/ peas/ seed germination/ seedlings/ soil amendments/ survival/ vegetable legumes/ vegetables/ mung bean/ pea/ vegetable crops

Abstract: The effects of fly ash on seed germination and seedling survival of *Vigna radiata* cv. K-851 and peas cv. Azad P-1 in acid loam soil and calcareous soil were investigated. Germination percentage in *V. radiata* was highest with 20% fly ash (wt./wt.) in acid loam soil and 60% fly ash in calcareous soil. Germination of peas was highest

with 60% fly ash in both soil types. Seedling survival not generally affected even by the highest rates of fly ash. Reproduced with permission from the CAB Abstracts database.

129. Effect of fly ash and farmyard manure on soil enzyme activities and yield of rice grown on an inceptisol.

Reddy, T. P.; Devi, M. U.; Rao, P. C.; and Bhanumurthy, V. B.

Crop Research Hisar 34(1/3): 27-31. (2007)

NAL Call #: SB4.C66 ; ISSN: 0970-4884

Descriptors: acid phosphatase/ alkaline phosphatase/ ammonium/ application rates/ cellulase/ crop yield/ enzyme activity/ enzymes/ farmyard manure/ fly ash/ Inceptisols/ oxidoreductases/ rice/ urease/ acid phosphomonoesterase/ alkaline phosphomonoesterase/ FYM/ paddy/ redox enzymes

Abstract: A field experiment was conducted in a fine loamy mixed hyperthermic Typic Haplustept soil during rabi 2004-05 to study the effect of fly ash and FYM on rice yield and soil enzyme activities. The grain and straw yield of rice was significantly increased with fly ash, FYM and their interactions. The highest grain (5.84 t/ha) and straw yield (7.87 t/ha) was recorded by combined application of fly ash @ 10 t/ha and FYM @ 10 t/ha which was on par with fly ash @ 15 t/ha alongwith FYM @ 10 t/ha. Application of fly ash @ 15 t/ha alongwith FYM @ 10 t/ha has resulted in highest urease, dehydrogenase and cellulase activity at 30 DAT (4.48 micro g of NH₄⁺ released/g soil/h, 5.37 mg of TPF produced/g/soil/d and 3.50 mg of glucose released/g soil/d), 60 DAT (4.80 micro g of NH₄⁺ released/g soil/h, 5.47 mg of TPF produced/g soil/d and 3.32 mg of glucose released/g soil/d) and at harvest (2.53 micro g of NH₄⁺ released/g soil/h, 3.07 mg of TPF produced/g soil/d and 2.16 mg of glucose released/g soil/d), respectively, which was on par with application of fly ash @ 10 t/ha alongwith FYM @ 10 t/ha and significantly higher over control. The acid and alkaline phosphatase activity was not influenced by fly ash levels at all the stages viz., 30, 60 DAT and at harvest. However, it was significantly influenced by FYM application and their interactions. Reproduced with permission from the CAB Abstracts database.

130. Effect of fly ash and fertilizer levels on yield and trace metal uptake by soybean and wheat crops.

Arvind Kumar; Sarkar, A. K.; Singh, R P; and Sharma, V. N. *Journal of the Indian Society of Soil Science* 47(4): 744-748. (1999)

NAL Call #: 56.9 IN2; ISSN: 0019-638X

Descriptors: animal health/ application rates/ cereal grains/ cobalt/ fertilizers/ fly ash/ grain/ hazards/ incorporation/ lead/ metals/ nickel/ NPK fertilizers/ residual effects/ sequential cropping/ soyabeans/ toxicity/ trace elements/ uptake/ wheat/ yields/ microelements/ soybeans

Abstract: Field experiments were conducted in Bihar state, India, to study the effect of fly ash incorporation in soil on yield and quality of soyabean and wheat crops. Results indicate that fly ash incorporation in soil increased the grain yield of both soyabean and wheat crops. The percentage increase in grain yield with graded levels of fly ash (4 to

16%) ranged from 55 to 90 in soyabean and from 60 to 84 in wheat. Application of graded levels of fertilizers (50 and 100% NPK) showed similar results especially at higher levels of fly ash incorporation. A considerable residual effect of fly ash was apparent on yield of wheat, but levels of fly ash incorporation did not vary significantly in this regard. Content of trace metals in soyabean and wheat grain showed considerable increase when grown in fly ash incorporated soil. Trace metal uptake by crops was significantly increased by fly ash and fertilizer application in soil. Higher uptake of Pb (29 to 141 g ha⁻¹), Ni (18 to 86 g ha⁻¹) and Co (23 to 109 g ha⁻¹) by wheat grown in fly ash incorporated soil can cause plant and animal health hazards.

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131. Effect of fly ash and FYM on nutrient availability in soil and yield of sweet potato.

Birajdar, R. R.; Chalwade, P. B.; Badole, S. B.; Hangarge, D. S.; and Shelage, B. S.

Journal of Soils and Crops 10(2): 248-251. (2000); ISSN: 0971-2836

Descriptors: calcium/ fly ash/ magnesium/ manures/ soil amendments/ soil chemistry/ sweet potatoes/ yield

Abstract: The effects of fly ash (0,5,10 and 15 t/ha) and farmyard manure (FYM) (10 and 15 t/ha) on yield of sweet potatoes and available contents of nutrients in the soil after harvest were studied in a randomized block design trial on vertisol during the rabi season in 1996-97. Application of both fly ash and FYM increased tuber yield significantly, with FYM having the greater effect. Nutrient availability and exchangeable Ca and Mg were also found to be significantly greater in plots with FYM than with fly ash or the control.

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132. Effect of fly ash and FYM on nutrient uptake and yield of onion.

Patil, P. V.; Chalwade, P. B.; Solanke, A. S.; and Kulkarni, V. K.

Journal of Soils and Crops 15(1): 187-192. (2005); ISSN: 0971-2836

Descriptors: application rates/ crop yield/ farmyard manure/ fly ash/ nitrogen/ nutrient uptake/ onion harvesters/ onions/ phosphorus/ plant nutrition/ potassium/ FYM

Abstract: Studies were conducted at the Department of Horticulture, MAU, Parbhani, Maharashtra, India, during the cropping season of 1999 to investigate the effect of fly ash and farmyard manure (FYM) on nutrient uptake and yield of onion. The treatments include four levels each of fly ash and FYM (0, 5, 15 and 30 t ha⁻¹) with their sixteen combinations. Results indicated that with the increasing level of fly ash and FYM, there was a corresponding increase in the uptake of nitrogen, phosphorus and potassium. Onion yield was also increased by increasing levels of fly ash and FYM, later having more influence on yield of onion bulbs. Thus, fly ash can also be used at 30 tonnes ha⁻¹ without affecting the crop yield.

Reproduced with permission from the CAB Abstracts database.

133. Effect of fly ash and FYM on physico-chemical properties of Vertisols.

Patil, P. V.; Chalwade, P. B.; Solanke, A. S.; and Kulkarni, V. K.

Journal of Soils and Crops 13(1): 59-64. (2003); ISSN: 0971-2836

Descriptors: bulk density/ calcium carbonate/ electrical conductivity/ farmyard manure/ fly ash/ infiltration/ organic carbon/ physicochemical properties/ porosity/ soil chemical properties/ soil ph/ soil physical properties/ soil types/ Vertisols/ water holding capacity/ chemical properties of soil/ FYM/ physical properties of soil

Abstract: A field experiment was conducted in Parbhani, Maharashtra, India during summer season of 1998-99 to investigate the effect of fly ash and farmyard manure (FYM) on the physicochemical properties of Vertisols. The soil was clayey in texture dominated by montmorillonite clay with high coefficient of expansion and shrinkage. The fly ash treatments were: fly ash at 0 t/ha (F0); fly ash at 5 t/ha (F1); fly ash at 15 t/ha (F2); fly ash at 30 t/ha (F3) and FYM treatments at 0, 5, 15 and 30 t/ha designated as M0, M1, M2, and M3, respectively. Results showed that bulk density, porosity, infiltration rate and water holding capacity of soil were significantly affected due to application of different levels of fly ash and FYM. Fly ash at 30 t/ha showed reduction in bulk density and water holding capacity and increased in porosity and infiltration rate. Soil pH decreased with the increased of fly ash and FYM. Electrical conductivity increased with increasing level of fly ash and the similar effect of FYM was also observed. The amount of calcium carbonate decreased with the increasing levels of fly ash and FYM. Organic carbon was decreased with the increasing levels of fly ash and increased with the increasing levels of FYM.

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134. The effect of fly ash and the product left after purification of waste gases on yield and chemical composition of spring rape.

Gregorczyk, A.

Folia Universitatis Agriculturae Stetinensis, Agricultura 81(181-186)(2000).

Notes: Original title: Wpyw popiou lotnego i produktu powstaego z oczyszczania gazow odlotowych na plon i skad chemiczny rzepaku jarego.

Descriptors: application rates/ chemical composition/ crop yield/ fertilizers/ fly ash/ gases/ heavy metals / industrial wastes/ nitrogen fertilizers/ purification/ rape/ swede rape/ canola/ Capparales/ oilseed rape

Abstract: A trial of the use of fly ash from Dolna Odra power station along with the product of removing SO₂ and NO_x from waste gas coming from power station Kaweczyn, Poland as a source of fertilizer for crops was undertaken. A pot experiment was conducted with spring rape cv. Evita grown in sandy soil. Fly ash was applied at 0.3 or 0.6 kg per 9-kg capacity Mitscherlich pot and N was applied at 0.5, 1.5 or 3.0 g per pot. No significant differences were found in the yield of the seeds in the different treatments. The application of 0.6 kg ash per pot reduced dry matter yield compared with the control. Heavy metal content was within the limits of concentrations found under normal growing conditions.

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135. Effect of fly ash application on forage productivity, nutrient content and physiology of sorghum-cowpea intercrops.

Das, S. K.; Bhatt, R. K.; Yadava, R. B.; Suresh, G.; Kareemulla, K.; Rai, A. K.; Mojumder, A. B.; Pathak, P. S.; Singh, D. K.; and Singh, M. K.

Range Management and Agroforestry 28(2B): 406-408. (2007); ISSN: 0971-2070

Descriptors: black soils/ clay loam soils/ cowpeas/ crop yield / forage/ nutrient content/ organic fertilizers/ photosynthesis/ plant physiology/ red soils/ sandy loam soils/ soil amendments/ soil types/ biofertilizers/ black eyed peas/ carbon assimilation/ carbon dioxide fixation/ red earths/ southern peas

Abstract: A field experiment was conducted during kharif 2006 at Jhansi, Uttar Pradesh, India, using fly ash at two sites having sandy clay loam red (pH 7.1, available N 110 kg/ha, available P 16.5 kg/ha, available K 118.4 kg/ha) and clay loam black soils (pH 7.2, available N 129.6 kg/ha, available P 12.1 kg/ha, available K 260.3 kg/ha) to determine its influence on forage productivity and nutrient content with special emphasis on physiological changes on sorghum + cowpea. Ammendments applied were: T1 - no fly ash + sole organic fertilizer; T2 - no fly ash + 50:50 inorganic-organic fertilizer; T3 - no fly ash + 25% inorganic + 50% organic + biofertilizer; T4 - 50 tonnes/ha fly ash + sole inorganic fertilizer; T5 - 50 tonnes/ha fly ash + 50:50 inorganic:organic fertilizers; T6 - 50 tonnes/ha fly ash + 25% inorganic + 50% organic + biofertilizers; T7 - 100 tonnes/ha fly ash + sole inorganic fertilizers; T8 - 100 tonnes/ha fly ash + 50:50 inorganic:organic fertilizers; and T9 - 100 tonnes/ha fly ash + 25% inorganic + 50% organic + biofertilizers. Results showed significant effect of application of fly ash in combination with manure, fertilizer and biofertilizers on green forage yield (GFY). Fly ash applications at 50 tonnes/ha registered significantly higher forage yield than no fly ash counterpart in kharif 2006. In red soil, barring treatment T9, further increased in the fly ash dose was not much effective and the total GFY obtained were statistically at par with respective treatments receiving fly ash at 50 tonnes/ha. Among the different treatments, significant increase in the fodder yield was recorded in T5. There was an increase in the rate of photosynthesis in sorghum as grown in fly ash amended red and black soil. Similarly, the rate of transpiration significantly improved in sorghum and cowpea in fly ash amended red and black soils. It was evident that fly ash application had a beneficial effect on nutrient content of sorghum in both the soil types.

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136. Effect of fly ash application on growth and yield attributes and yield of groundnut genotypes.

Bonge, R. T.; Wayal, G. R.; Jadhav, G. S.; Dahiphale, R. S.; Shaikh, A. K.; and Thombre, R. F.

Journal of Soils and Crops 14(1): 108-111. (2004); ISSN: 0971-2836

Descriptors: application rates/ black soils/ branches/ clay soils/ crop yield/ cultivars/ dry matter accumulation/ fly ash/ genotypes/ groundnuts/ leaves/ plant height/ soil types/ Vertisols/ yield components/ cultivated varieties/ peanuts

Abstract: A field experiment was conducted on medium black (clayey) soil (Vertisol) during post-monsoon (rabi) season of the year 1998-99 at the Department of Agronomy

Farm, Marathwada Agricultural University, Parbhani (Maharashtra, India). The experiment was laid out in a split plot design with three replications, comprising 4 levels (0, 5, 10 and 15 t/ha) of fly ash in main plots and 4 genotypes of groundnut (ICGV 92004, ICGS 44, TAG 24 and LGN 1) in subplots. Growth parameters like plant height, number of branches per plant, number of leaves per plant, leaf area per plant, and total dry matter per plant were not significantly influenced by the application of fly ash. Application of fly ash at 5 t/ha improved the yield attributes and produced significantly higher dry pod yield (1872 kg hectare⁻¹). Genotype TAG-24 with favourable yield attributes recorded a significantly higher dry pod yield (2279 ha⁻¹).
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137. [Effect of fly ash-filtered mud mixture on soil properties and radish yield and quality].

Xing, S.; Zhao, Z.; Zhou, B.; and Wu, X.

Ying Yong Sheng Tai Xue Bao 12(1): 121-5. (Feb. 2001); ISSN: 1001-9332 .

Notes: Original language of article: Chinese.

Descriptors: agriculture/ brassicaceae: physiology/ carbon: chemistry/ metals, heavy: chemistry/ particulate matter/ soil: analysis/ soil microbiology

Abstract: Based on pot culture experiment, the effect of fly ash-filtered mud mixture on soil biochemical properties, radish yield and its quality, and heavy metal accumulation in both soil and radish was examined. The mixture was made by mixing fly ash and filtered mud in proportion 1:1(w/w) and adding small amount of inorganic fertilizer. Its Cd, Pb, Cr, As and Hg contents were much lower than those requested by state control criteria. After applying this mixture in a definite amount, no significant accumulation of heavy metals was found in both soil and radish, the pollution index of heavy metals was < 1, the quantities of soil bacteria increased notably, and the activities of soil urease, phosphates and cellulase also raised significantly. The application of the mixture promoted radish growth and its development and metabolism. The reducing sugar and vitamin C in radish also increased markedly. The results indicated that the use of adequate amounts of the mixture did not cause any obvious heavy metal pollution in both soil and radish, but could improve soil fertility, and raise radish yield and its quality remarkably. This citation is from PubMed.

138. Effect of fly ash on clayey soil.

Mohini Saxena; Asokan, P; and Aparna Chauhan

Clay Research 17(2): 109-114. (1998); ISSN: 0255-7193

Descriptors: clay soils/ conductivity/ drainage/ fly ash/ heavy metals/ interactions/ nutrients/ porosity/ soil amendments/ soil chemical properties/ soil physical properties/ soil types/ sorption/ chemical properties of soil/ physical properties of soil

Abstract: The changes in the quality of clayey soil mixed with fly ash was studied by measuring the adsorptive and desorptive properties of the soil and fly ash and their interaction. The physical and chemical properties of soil, fly ash and the mixture of the two (in various ratios) were studied in order to understand the mobility of nutrients in the soil. The results indicated the possibility of the use of fly ash as a soil amendment due to the presence of essential plant nutrients, e.g. Ca²⁺, Mg²⁺, Cu²⁺, Zn²⁺, Mn²⁺, SO₄,

PO₃-₄, Cl- etc. Addition of fly ash to clayey soil improved the soil porosity and thus improved drainage. The conductivity of the soil decreased upon addition of fly ash. The heavy metal content of the ash, in terms of essential and non essential metals, was within the permissible limit. Reproduced with permission from the CAB Abstracts database.

139. Effect of fly ash on emergence of crops under artificial crusted soils.

Singh, C. B. and Oswal, M. C.

Indian Journal of Soil Conservation 31(2): 192-198. (2003); ISSN: 0970-3349

Descriptors: crusts/ emergence/ fly ash/ loam soils/ sandy loam soils/ seasonal variation/ soil amendments / soil strength/ soil temperature/ soil types/ wheat/ Argisols/ Capparales/ seasonal changes/ seasonal fluctuations

Reproduced with permission from the CAB Abstracts database.

140. The effect of fly ash on growth and yield in both oat varieties .

Gregorczyk, A.

Folia Universitatis Agriculturae Stetinensis, Agricultura 88: 39-47. (2001); ISSN: 1506-1973.

Notes: Original title: Wpyw popiou lotnego na wzrost i plon dwu odmian owsa.

Descriptors: crop yield/ cultivars/ fly ash/ growth/ growth rate/ leaf area/ leaves/ oats/ cultivated varieties

Abstract: The effect of fly ash (0 and 0.45 kg/pot) on the growth and yield of a naked (Akt) and hulled (Najka) oat cultivar was investigated in pot experiments conducted during 1999 in Roslin, Poland. Data were recorded for relative growth rate (RGR), unit leaf rate (ULR), leaf area ratio (LAR), leaf weight ratio (LWR) and specific leaf area (SLA). For Bajka, significantly higher yield was recorded in the control treatment (no fly ash) compared with the fly ash treatment. RGR values were influenced by changes in LAR, while LAR values were influenced by changes in LWR. Reproduced with permission from the CAB Abstracts database.

141. Effect of fly ash on growth and yield of cauliflower.

Bharud, R. W.; Gavhane, V. N.; Rasal, P. N.; Kusalkar, D. V.; and Karanjikar, P. N.

Agricultural Science Digest 22(1): 30-32. (2002); ISSN: 0253-150X

Descriptors: cauliflowers/ chlorophyll/ crop yield/ fly ash/ leaf area/ leaves/ maturity/ trace element fertilizers/ Capparales/ heading broccoli/ micronutrient fertilizers

Abstract: Fly ash at 5, 10, 15, 25, 30, 35, 40, 45 and 50 g/m²/day was applied to cauliflower cv. Kuari No. 3 in a field experiment conducted during the kharif season of 1994, in Maharashtra, India. Fly ash did not affect the duration of physiological maturity. Leaf area per plant, number of leaves per plant, chlorophyll content and yield increased with increasing fly ash levels.

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142. Effect of fly ash on growth characteristics of chickpea.

Shazia Siddiqui; Era Upadhyay; and Shazia Alvi
Bionotes 2(2): 35-36. (2000); ISSN: 0972-1800

Descriptors: chickpeas/ fly ash/ plant development/ trace element fertilizers/ micronutrient fertilizers
Abstract: Chickpea cv. Pusa 408 seeds were sown in pots filled with 1000 g soil; 800 g soil+200 g fly ash; 600 g soil+400 g fly ash; and 400 g soil+600 g fly ash, to determine the effect of different levels of fly ash on the growth characteristics of chickpea. The growth of chickpea plants was significantly affected by fly ash amendments. The maximum response was induced by a 40% level (400 g) of fly ash, wherein an increase in all the parameters of growth was highest. Fly ash at 60% level (600 g) was harmful for plant growth. The study demonstrated that lower concentrations of fly ash were beneficial for the growth of chickpea plants which may ultimately increase crop yield. Reproduced with permission from the CAB Abstracts database.

143. Effect of fly-ash on metal composition and physiological responses in *Leucaena leucocephala* (Lamk.) de Wit.

Meetu Gupta; Avanish Kumar; and Yunus, M.
Environmental Monitoring and Assessment 61(3): 399-406. (2000)

NAL Call #: TD194 .E5 ; ISSN: 0167-6369

Descriptors: carotenoids/ chlorophyll/ copper/ enzyme activity/ fly ash/ foliage/ heavy metals/ iron/ leaves/ manganese/ nitrate reductase/ nodulation/ plant composition/ plant physiology/ protein content/ proteins/ reclamation/ root nodules/ roots/ seedling growth/ seedlings/ soil amendments/ zinc/ chemical constituents of plants/ Mn/ press mud/ tetraterpenoids

Abstract: Seedlings of *Leucaena leucocephala* were grown in pots in 100% soil (pH 7.6, as control), 100% fly ash (pH 9.6, obtained direct from the pipelines of Feroz Gandhi Unchahar Thermal Power Project in Raebareilly, Uttar Pradesh, India) and fly ash amended with 50% press mud (pH 7.2) for 80 days. They were analysed with respect to plant growth, nodulation, elemental composition of the roots and leaves, and physiological changes in the leaves. Plants grown in fly ash exhibited reduced growth and nodulation, reduced chlorophyll, carotenoid and protein contents, and reduced nitrate reductase activity. Amending the fly ash with press mud enhanced all these responses to near the levels found in control plants, with nodulation actually increased over the control value. The elements Fe, Zn, Cu and Mn (all found in high concentrations in fly ash) accumulated in large quantities in plants grown in 100% fly ash (in the order Fe > Zn > Cu > Mn, with greater accumulations in the roots than the leaves), and these accumulations were mostly reduced in the amended fly ash treatment. The results of this study indicate that ash amended with press mud may provide more favourable conditions for the growth of this tree species. Reproduced with permission from the CAB Abstracts database.

144. Effect of fly ash on physical properties of lateritic soil.

Sahoo, S. and Kar, S.
Journal of the Indian Society of Soil Science 46(2): 291-293. (1998)
 NAL Call #: 56.9 IN2; ISSN: 0019-638X

Descriptors: fly ash/ lateritic soils/ soil/ soil physical properties/ physical properties of soil
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145. Effect of fly ash on physical properties of Ultisols from subtropical China.

Lu ShengGao and Zhu Lei
Communications in Soil Science and Plant Analysis 35(5/6): 703-717. (2004)
 NAL Call #: S590.C63; ISSN: 0010-3624

Descriptors: acid soils/ application rates/ available water/ clay loam soils/ fly ash/ microaggregates/ particle size distribution/ soil amendments/ soil physical properties/ soil strength/ soil types/ soil water content/ soil water retention/ subtropical soils/ subtropics/ Ultisols/ Chekiang/ modulus of rupture/ physical properties of soil/ subtropical zones

Abstract: Fly ash from coal-fired power generating plant was mixed with two acid clay loams (Typic Plinthudult and Typic Hapludults) from Zhejiang Province, China, at rates of 0, 5, 10, 20, 30, and 50% by weight. The physical properties of fly ash-amended soils, including soil particle size distribution, microaggregate composition, water retention curve and modulus of rupture, were determined to evaluate the effect of fly ash application on soil physical properties. The application of fly ash affected the measured physical properties of soils. At the application rate of 50% fly ash, there was a significant increase in the percentage of 0.15-0.01 mm particles and decrease in clay content (<0.002 mm). Application of fly ash at high rates (30 and 50%) to the Typic Plinthudult caused a significant change in the microaggregate size distribution of soil, while non-significant differences were observed in the rates of 5, 10, and 20% fly ash. However, no apparent effect of fly ash application on soil microaggregate size distribution was noted for the Typic Hapludult with high organic matter and free iron oxide contents. Fly ash application not only increased the water content at tensions of 0-0.1 MPa but also increased plant available water held at tensions of 0-1.2 MPa. Tests on fly ash-amended soils exceeding 10% showed that it significantly reduced the values of modulus of rupture in the soils. The presence of spherical cenosphere in fly ash, which have larger specific surface and characteristic hollow structure, resulted in increased water-holding capacity and reduction of modulus of rupture in the fly ash-amended soils. All these results suggest that fly ash is useful in improving certain physical properties of Ultisols by changing soil structure, increasing the amount of plant available water and decreasing the cohesiveness of soil particles. Reproduced with permission from the CAB Abstracts database.

146. Effect of fly ash on physico-chemical properties of vertisol and yield of green gram.

Bharti Bhaisare; Matte, D. B.; Badole, W. P.; Anjali Deshmukh; and Shalini Pillewan
Journal of Soils and Crops 9(2): 255-257. (1999); ISSN: 0971-2836
Descriptors: calcium/ cation exchange capacity/ crop yield/ fertilizers/ fly ash/ green gram/ magnesium/ nitrogen fertilizers/ NPK fertilizers/ phosphorus fertilizers/

physicochemical properties/ plant nutrition/ soil amendments/ soil types/ Vertisols/ mung bean/ phosphate fertilizers

Abstract: Summer green gram [*Vigna radiata*](K-851) was grown during 1993-94 on Vertisol with three levels of N and P fertilizers (0:0, 25:50 and 18.75:37.50 kg/ha) and four levels of fly ash (0, 5, 10 and 15 t/ha). Application of fly ash up to 10 t/ha was more effective in terms of yield and improved the physicochemical properties of soil. The cation exchange capacity, available NPK, exchangeable Ca²⁺, Mg²⁺ and availability of micronutrients increased with increasing levels of fly ash, while bulk density recorded the opposite trend. Green gram responded well to higher doses of N and P for yield while combination fertilizers and fly ash were non-significant.

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147. Effect of fly ash on release behaviour of potassium in soils of an arid region.

Grewal, K. S.; Mehta, S. C.; Oswal, M. C.; and Yadav, P. S. *Journal of the Indian Society of Soil Science* 46(2): 203-206. (1998)

NAL Call #: 56.9 IN2; ISSN: 0019-638X

Descriptors: amendments/ arid lands/ arid soils/ fly ash/ loam soils/ potassium/ release/ sandy soils/ soil

Abstract: The effects of fly ash on the release behaviour of exchangeable (1N NH₄OAc-K) and non-exchangeable (boiling 1N HNO₃-K) K⁺ were studied in laboratory in sandy and loamy soils by mixing fly ash at 0, 25, 50, 75 and 100% (w/w). A major portion (68 to 76%) of exchangeable K⁺ (NH₄OAc-K) was extracted in the first extraction from the sandy soil. The subsequent extractions decreased the K⁺ release. In the loamy soil, only 38 to 42% of exchangeable K⁺ was released in the first extraction. The magnitude of K⁺ release was slower in loamy soil than the sandy soil. The release of non-exchangeable K⁺ was almost similar in both the soils in the first extraction. Addition/mixing of successive levels of fly ash had little effect on the release pattern of K⁺ in these soils.

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148. Effect of fly ash on soil microbial population in groundnut crop.

Patil, C. P. and Patil, C. V.

Karnataka Journal of Agricultural Sciences 14(1): 164-167. (2001)

NAL Call #: S471.I42K37; ISSN: 0972-1061

Descriptors: farmyard manure/ fly ash/ groundnuts/ NPK fertilizers/ populations/ soil bacteria/ soil fungi/ FYM/ peanuts

Abstract: The effect of fly ash, a major solid waste of coal and steel industries, on microbial inoculants and soil microbial population in groundnut crop was studied. Recommended dose of NPK fertilizers was applied as basal dose. An increase in soil bacteria and fungi population at 30 and 60 days over control in all treatments with soil + fly ashes FYM was observed. On the other hand, a drastic reduction in soil actinomycetous population treated with fly ash was observed. Maximum stimulation of bacteria (52.86 x 10³ CFU/g) fungi (12.33x10³ CFU/g) at 30 days of planting was noticed in the treatments soil + WFA and soil + WFA + FYM, respectively. Weathered fly ash mixed with soil had maximum stimulatory effect on soil

rhizobial population at 30 and 60 days (2.93x10³ and 9.87x10³ CFU/g) followed by soil + WFA + FYM, and soil + DFA + FYM, respectively. The soil rhizobial population was drastically reduced over control at 30 days and however, it had increased by three to four times at 60 days when compared to the population at 30 days. The nodule number was slightly higher in the treatment soil + FYM (92.99 g/plant) compared to the treatments soil + DFA + FYM (89.44 g/plant) and soil + WFA + FYM (84.33 g/plant), weight of nodules was highest in treatment soil + DFA + FYM (0.663 g/plant) followed by soil + WFA + FYM (0.538 g/plant). It is concluded that fly ash with or without organic matter (FYM) promotes good microbial growth and increased soil fertility thus, increasing plant growth. Reproduced with permission from the CAB Abstracts database.

149. Effect of fly ash on the availability of Zn, Cu, Ni and Cd to chicory.

Scotti, I. A.; Silva, S.; and Botteschi, G.

Agriculture, Ecosystems and Environment 72(2): 159-163. (1999)

NAL Call #: S601.A34 ; ISSN: 0167-8809

Descriptors: acid soils/ availability/ cadmium/ chicory/ clay loam soils/ clay soils/ copper/ EDTA/ ethylene/ fly ash/ metals/ nickel/ plant composition/ salts/ silt loam soils/ soil amendments/ soil types/ variation/ zinc/ chemical constituents of plants/ edetic acid/ ethylenediaminetetraacetic acid

Abstract: Chicory (*Cichorium Intybus*) was grown in two soils, a silt loam at pH 5.7 and a silty clay loam at pH 7.0, augmented with fly-ash and/or metals as salts. In acid soil the ash addition caused a decrease of Zn, Cu, Cd and Ni concentration for all treatments; for neutral soil this was true for Zn, but for Cu and Cd, only for treatments with salts. The added metals are more available to plants than those naturally occurring in soils. Extractions carried out with ethylene diamine tetra acetate (EDTA) pH 4.65 or diethyltriaminepentaacetic (DTPA) pH 7.3 showed no variation in extractable metal concentration over time. Reproduced with permission from the CAB Abstracts database.

150. Effect of fly ash on the growth of sunflower (H annuus).

Jaya Dwivedi; Khan, S. A.; Jha, A. K.; and Alpana Ram

Vaniki Sandesh 27(1): 3-7. (2003); ISSN: 0972-5598

Descriptors: acid soils/ aluminium/ branches/ chlorophyll/ crop yield/ fly ash/ growth/ leaf area/ leaves/ magnesium/ manganese/ microbial activities/ nitrogen/ nutrient availability/ phosphorus/ plant height/ seed germination/ seeds/ soil acidity/ soil amendments/ soil types/ sulfur/ sunflower oil/ sunflowers/ toxicity/ trace elements/ zinc/ aluminum/ Chattisgarh/ elemental sulphur/ microelements/ Mn/ sulphur

Abstract: Fly ash, the major industrial residue (waste) in Chhattisgarh (India) faces serious disposal problem. At the same time, it is found to be a rich source of micronutrients and salts and has high alkalinity as where soil of this region is normally acidic. Acidic soil causes metal toxicity, reduced microorganism activity, reduced N, P, S, Mg, Mn availability, and Al toxicity resulting in poor crop yield and oil quality of sunflower. This paper presents the results of the study conducted to improve soil condition by ameliorating acidic soil by the application of fly ash and to

investigate the effect on the growth of sunflower. Seed germination and other plant growth parameters (plant height, number of branches per plant, leaf area and chlorophyll content per leaf) were studied. Reproduced with permission from the CAB Abstracts database.

151. Effect of fly ash on the physico-chemical properties of the soil and seed germination, growth and metals uptake of barley and wheat plants.

Khan, S.; Khan, J. A.; and Jabin, S. 7(1): 41-46. (2001); ISSN: 0971765X [EECOF]

Descriptors: barley/ fly ash/ metals uptake/ wheat/ physicochemical property

Abstract: Pot experiments were conducted to evaluate the physiology and metals uptake of barley (*Hordeum vulgare* L.) and wheat (*Triticum aestivum* L.) plants grown on fly ash amended soil. The beneficial effect on physiological development were noticed at lower doses of fly ash (pH 6.72) upto 30 and 20 g kg⁻¹ soil in case of barley and wheat, respectively, thereafter a phytotoxic behaviour was observed. The results of plants analysis showed an increase in the concentration of K, Mg, Fe and Zn metals upto 30 to 20 g fly ash kg⁻¹ soil thereafter, they tend to decline on increasing doses of fly ash. On the other hand, the contents of Na, Cr, Mn, Co, Cu, Ni, Cd and Pb uptake were found to remain enhance throughout the entire range of fly ash

amendments in both plants. The variation in physico-chemical properties, due to the addition of fly ash in soil, have indicated a decrease in pH (from 8.5 to 7.95) and composition of sand and clay and increase in electrical conductivity and composition of silt and organic matter. © 2009 Elsevier B.V. All rights reserved.

152. Effect of fly ash on VAM formation and growth response of pulse crops infested with *Glomus aggregatum* in sterile soil.

Reddy, C. N. and Garampalli, H. R. *Frontiers in Microbial Biotechnology and Plant Pathology*: 205-212. (2002)

Descriptors: adverse effects/ bioremediation/ chickpeas/ endomycorrhizas/ fly ash/ industrial wastes/ mycorrhizal fungi/ mycorrhizas/ pigeon peas/ pollutants/ vesicular arbuscular mycorrhizas/ adverse reactions/ Glomaceae

Abstract: The effect of fly ash amendment at 3 concentrations (10, 20 and 30%) on the infectivity and efficacy of *G. aggregatum* was studied by conducting a pot culture experiment with sterile low fertile soil using pigeon pea (*Cajanus cajan*) cv. Maruti and chickpea (*Cicer arietinum* [Cicer arietinum]) cv. Annigeri, the two major pulse crop cultivars of this region. It is evident from the present investigation that the percent VAM colonization in both the crops significantly decreased with the increase of fly ash content in the soil. The formation of VAM fungal structures (vesicles and arbuscules) inside the host root was also found completely suppressed at higher concentrations of fly ash. The effectiveness of *G. aggregatum* under the influence of fly ash was found significantly affected compared to the control, when judged by the growth response of pigeon pea. However, in chickpea, VAM association could slightly increase the growth over its control. Fly ash amendment alone also has shown positive influence on the growth of both the crops over their controls (without VAM association). This

influence of fly ash amendment together with the usefulness of VAM fungi, as bioremediation agents can be exploited suitably in the reclamation of waste lands and soils over burdened with fly ash. Reproduced with permission from the CAB Abstracts database.

153. Effect of fly ash on yield and nutrient uptake in rice and its impact on soil properties.

Brahmachari, K.; Debnath, A.; and Mondal, S. S. *Journal of Interacademia* 3(3/4): 293-300. (1999)
Descriptors: application rates/ fly ash/ mineral uptake/ nitrogen fertilizers/ nutrient uptake/ phosphorus fertilizers/ potassium fertilizers/ rice/ soil pH/ soil water retention/ sulfur fertilizers/ trace element fertilizers/ micronutrient fertilizers/ paddy/ phosphate fertilizers/ potash fertilizers/ sulphur fertilizers

Abstract: In a field trial during kharif 1994 and 1995 on an Entisol in Kalyani, West Bengal, India, rice cv. IR 36 was given no fertilizer, fly ash, N, NP, NPK or NPKS. Grain yields were in the order: NPKS > NPK > NP > N = fly ash > control. N, P and K uptake followed the same pattern. Studies with different fly ash concentrations showed that soil pH and water-holding capacity increased with increase in concentration of fly ash.

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154. Effect of fly ash, organic wastes and chemical fertilizers on yield, nutrient uptake, heavy metal content and residual fertility in a rice-mustard cropping sequence under acid lateritic soils.

Rautaray, S. K.; Ghosh, B. C.; and Mitra, B. N. *Bioresource Technology* 90(3): 275-283. (2003)
NAL Call #: TD930.A32; ISSN: 0960-8524

Descriptors: acid soils/ application rates/ cadmium/ chemical composition/ crop yield/ farmyard manure/ fertilizers/ fly ash/ food grains/ green manures/ heavy metals/ lateritic soils/ nickel/ nitrogen/ nutrient uptake/ nutrients/ organic wastes/ phosphorus/ plant composition/ plant nutrition/ potassium/ residual effects/ residues/ rice/ rice straw/ sandy loam soils/ soil chemical properties/ soil fertility/ soil organic matter/ soil pH/ soil types/ straw/ Capparales/ chemical constituents of plants/ chemical properties of soil/ FYM/ organic matter in soil/ paddy
Abstract: A field experiment was conducted for two years in sandy loam acid lateritic soil to study the direct effect of fly ash, organic wastes and chemical fertilizers on rice (*Oryza sativa*) and their residual effect on mustard (*Brassica napus* var *glauca*) grown in sequence. Rice yields were higher when fly ash, organic wastes and chemical fertilizers were used in an integrated manner as compared to sole application of chemical fertilizers. Yields of mustard were also higher under the residual effect of the former rather than the latter. However, this beneficial residual effect under integrated nutrient sources was inadequate for the mustard crop in the low fertility test soil. Hence, direct application of fertilizers was needed, in addition to residual fertility. The effect of fly ash on mean rice equivalent yield of the rice-mustard cropping sequence was highest (up to 14%) when it was used in combination with organic wastes and chemical fertilizers. While the yield increase was 10% when it was used in combination with only chemical fertilizers. The minimum yield advantage, 3%, occurred when fly ash was applied alone. The equivalent yield of the

rice-mustard cropping sequence was equally influenced by either of the organic wastes. Cadmium and Ni content in rice grain and straw were less under the direct effect of fly ash. The residual effect on mustard was similar for Ni content in seed and stover; however, Cd content was increased. Beneficial residual soil chemical properties in terms of pH, organic carbon and available N, P and K were noted for integrated nutrient treatments involved fly ash, organic wastes and chemical fertilizers as compared to continuous use of only chemical fertilizers. Application of fly ash alone was effective in raising soil available P. Thus, integrated use of fly ash, organic wastes and chemical fertilizers was beneficial in improving crop yield, soil pH, organic carbon and available N, P and K in sandy loam acid lateritic soil.

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155. Effect of fly ash, press mud cake and phosphorus solubilizing bacteria (PSB) on yield, growth and quality of sugarcane.

Saini, S. K.; Rajesh, A.; Vijender Singh; and Sinha, S. K. *Indian Sugar* 56(4): 25-28. (2006); ISSN: 0019-6428
Descriptors: application rates/ brix/ crop quality/ crop yield/ fly ash/ germination/ growth/ NPK fertilizers/ phosphate solubilizing bacteria/ shoots/ sucrose/ sugar content/ sugarcane/ yield components/ biofertilizers/ integrated crop management/ saccharose

Abstract: A field experiment was conducted during 2004-05, in Pantnagar, Uttar Pradesh, India, to evaluate the effect of integrated nutrient management on the growth, yield and quality of sugarcane. Fourteen treatment combinations were evaluated, including 100% of the recommended NPK dose as control as well as 50 and 100% of the recommended NPK dose supplemented with press mud cake (PMC), fly ash (FA) and/or phosphate solubilizing bacteria (PSB). Application of 75% of the recommended NPK dose along with PMC, FA and/or PSB gave significantly higher values for cane yield and its attributes (germination percentage, number of shoots, number of millable canes, cane weight, cane girth, cane length) as well as juice quality parameters (corrected brix, sucrose percentage, available sugar percentage and commercial cane sugar yield) compared with 100% NPK alone. Application of 75% NPK + 13.4 t FA/ha + 6.6 t PMC/ha and 75% NPK + 6.6 t FA/ha + 13.4 t PMC/ha were the best treatments in increasing the values of the growth and yield attributes. However, application of 75% NPK + 10 t FA/ha + 10 t PMC/ha + PSB recorded the highest values for the quality attributes.

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156. Effect of fly ash waste on some properties of an acid soil, elemental composition and yields of crops.

Khandkar, U. R.; Gangwar, M. S.; and Srivastava, P. C. *18(1):* 101-107. (1999); ISSN: 02578050 [PORS]D
Descriptors: Acid soil/ Elemental composition of crops/ Fly ash/ acid soil/ crop yield/ fly ash/ soil amendment/ soil nutrient/ India

Abstract: The effect of soil application of a thermal power station fly ash (2 to 20 per cent of soil weight) was investigated on properties of an acid soil, elemental composition and yields of rice, soybean and blackgram crops. The application of fly ash altered the soil texture and

increased water holding capacity, pH and electrical conductivity and extractable amount of P, Ca, Mg, S, Fe, Mn, Zn, Cu, B and Al but decreased soil particle density and available soil N. Soil application of fly ash increased the concentration of all the nutrients, Na and Al in seed and straw of all the three crops except N in all the cases and P and K in rice. The application of fly ash increased the seed and straw yield of all the three crops with no adverse effect on yields even at 20 per cent level. Fly ash can be used to correct S and B deficiency in acid soils.

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157. Effect of flyash incorporation on soil properties of texturally variant soils.

Naveen Kalra; Harit, R. C.; and Sharma, S. K. *Bioresource Technology* 75(1): 91-93. (2000)
 NAL Call #: TD930.A32 ; ISSN: 0960-8524

Descriptors: clay loam soils/ clay soils/ electrical conductivity/ field capacity/ fly ash/ organic carbon/ sandy loam soils/ sandy soils/ soil amendments/ soil organic matter/ soil ph/ soil physical properties/ soil texture/ soil types/ soil water/ wilting point/ organic matter in soil/ physical properties of soil/ soil moisture

Abstract: Modifications in soil properties caused by flyash incorporation in clayey, sandy-clay-loam, sandy and sandy-loam soils were evaluated. Flyash was collected from the National Capital Power Project, Dadri, Ghaziabad, UP. Ash incorporation treatments were 10%, 20%, 30% and 40% ash by weight in the soil-ash mixtures. Moisture retained at field capacity increased with ash content in sandy-clay-loam, sandy and sandy-loam soils, whereas the reverse trend was noted for clayey soil. Moisture retained at wilting point increased with ash content for all the soils. The changes in moisture retention constants associated with ash incorporation were due to macro- and micro-particle size modifications. The pH of soil-ash mixtures decreased with ash content for clayey, sandy and sandy-loam soils, whereas the reverse trend was noted for sandy-clay-loam soil. Electrical conductivity of the mixtures increased with the ash content for all the soils. Organic carbon values increased with ash content for sandy and sandy-loam soils, whereas they decreased for clayey and sandy-clay-loam soils. Modifications to the soil environment with incorporation of flyash need to be investigated on a long-term basis.

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158. Effect of flyash on micronutrients uptake by plants grown on an acid soil.

Ajaya Srivastava and Chhonkar, P. K. *Journal of the Indian Society of Soil Science* 50(4): 484-488. (2002)

NAL Call #: 56.9 IN2; ISSN: 0019-638X
Descriptors: acid soils/ Alfisols/ application rates/ bioavailability/ fly ash/ lime/ liming/ liming materials/ nutrient availability/ nutrient uptake/ oats/ phytotoxicity/ plant nutrition/ pot experimentation/ soil acidity/ soil ph/ soil types/ trace elements/ microelements

Abstract: A pot culture study was conducted to evaluate the effect of fly ash (0, 33, 66 and 100 g kg⁻¹ soil) and lime (0, 0.33, 0.66 and 1.0 lime requirement) on micronutrient uptake by Sudan grass (*Sorghum sudanense*) and oats (*Avena sativa*) grown on an acid soil (Alfisols), and micronutrients availability in soil. All levels of flyash and

lime significantly increased the pH, decreased the availability of micronutrients in soil, and also significantly decreased the micronutrients' uptake by both the crops. Results indicate that fly ash is as effective as lime in reducing the micronutrients toxicity to the plants grown on an acid soil. It is also indicated that fly ash is a feasible alternative to lime for treating acid soils. Reproduced with permission from the CAB Abstracts database.

159. Effect of flyash on the performance of wheat on Ustochrepts of sub-humid plains of India.

Totawat, K. L.; Nagar, G. L.; Jat, S. L.; and Jangir, R. K. In: 17th World Congress of Soil Science. Bangkok, Thailand.; pp. 215; 2002.

Descriptors: application rates/ clay loam soils/ crop yield/ farmyard manure/ fly ash/ Inceptisols/ incorporation/ nutrients/ plains/ sandy loam soils/ soil chemical properties/ soil toxicity/ soil types/ uptake/ wheat/ chemical properties of soil/ FYM/ toxic soils

Reproduced with permission from the CAB Abstracts database.

160. Effect of flyash on uptake of phosphorus, potassium and sulphur by Sudan grass and oats grown on an acid soil.

Ajaya Srivastava and Chhonkar, P. K.

Journal of the Indian Society of Soil Science 48(4): 850-853. (2000)

NAL Call #: 56.9 IN2; ISSN: 0019-638X

Descriptors: acid soils/ biomass production/ fly ash/ lime/ nutrient uptake/ oats/ phosphorus/ plant composition/ potassium/ soil/ soil acidity/ soil types/ sulfur/ chemical constituents of plants/ elemental sulphur/ sulphur

Abstract: The effects of coal fly ash and lime in alleviating the acidity of acid soil, and the effects of fly ash on nutrient uptake by crops were investigated in a pot experiment conducted during kharif (monsoon) season with Sudan grass (*Sorghum sudanense*) and in rabi (winter) season with oats. The P, K and S contents of *S. sudanense* and oats increased with graded levels of fly ash incorporation in soil up to 100 g/kg. It was found out that fly ash was as effective as lime in acid soil. Fly ash application improves the pH, and the availability of P, K and S. These amendments result in a significantly larger biomass production. However, because of the variability in soils and fly ash characteristics, specific site conditions need to be considered before deciding on the quantity of fly ash to be applied.

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161. Effect of flyash on yield, uptake of nutrients and quality of green gram grown on Vertisol.

Bharti Bhaisare; Matte, D. B.; Badole, W. P.; and Anjali Deshmukh

Journal of Soils and Crops 10(1): 122-124. (2000); ISSN: 0971-2836

Descriptors: crop production/ crop yield/ fertilizers/ fly ash/ green gram/ nitrogen fertilizers/ nutrient content/ nutrient uptake/ nutrients/ phosphorus fertilizers/ plant nutrition/ seasonal variation/ soil amendments/ straw/ mung bean/ phosphate fertilizers/ seasonal changes/ seasonal fluctuations

Abstract: A field experiment was conducted in Nagpur, India, during the summer of 1993-94 on green grams (K-851) with three levels of N (0, 18.75, 25 kg/ha) and P (0, 37.50, 50 kg/ha) and four levels of fly ash (0, 5, 10 and 15 t/ha) on Vertisols. Results showed that the highest yield of grain and straw along with highest content and uptake of nutrients were recorded with the increasing levels of fly ash upto 10 t/ha. The highest content of crude protein and test weights were recorded by the same level of fly-ash.

Amongst the fertilizers, green gram responded well to higher doses of N and P fertilizers for yield, quality and nutrient uptake and content. The combined effect of fly ash and fertilizers was not significant.

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162. Effect of flyash pollution on biomass, primary productivity and characteristics of grains of maize.

Pandey, D. D. and Madhu Sinha

Environment and Ecology 18(3): 738-741. (2000)

NAL Call #: TD172.E5; ISSN: 0970-0420

Descriptors: crop yield/ fly ash/ maize/ pollution/ power stations/ corn/ environmental pollution

Abstract: Maize was grown 100 m downwind of the Thermal Power Station, Patratu, Bihar, to assess the effect of fly ash pollution on biomass, primary productivity and grain characteristics. Pollution decreased primary productivity of maize. Number of grains per cob, weight and volume of 100 grains, moisture, protein, total ash, fat, crude fibre, iron, phosphorus, calcium and calorific value of polluted grains were lower than in controls.

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163. Effect of foliar application of lignite fly ash on the management of papaya leaf curl disease.

Eswaran, A. and Manivannan, K.

Acta Horticulturae 740: 271-275. (2007)

NAL Call #: 80 Ac82; ISSN: 0567-7572

Descriptors: application date/ application rates/ crop yield/ crude protein/ cultural control/ disease resistance/ disease vectors/ fly ash/ fruits/ induced resistance/ insect control/ insect pests/ leaves/ lignite/ nitrogen content/ pawpaws/ pest control/ phenols/ plant disease control/ plant diseases/ plant pathogens/ plant pests/ plant viruses/ sugar content/ Madras/ papayas/ phytopathogens/ resistance to disease

Abstract: Studies were conducted on the effect of foliar application of lignite fly ash (LFA) dust on papaya leaf curl virus disease and vector (*Bemisia tabaci*) population. The treatments include various concentrations of LFA administered at different days after planting (DAT). LFA is the by-product from the combustion of pulverized coal/lignite in thermal power plants of India and has high silica content. The study revealed that foliar application of LFA dust at 2 kg per plant at 90 and 120 DAT was very effective in controlling papaya leaf curl virus disease and its vector. Application of LFA two times at 90 and 120 DAT was more effective over single applications at 30, 60 and 90 and 120 DAT. The fly ash stuck to leaf surface for a period of 9 to 12 days. Further application of lignite fly ash reduces the population of vector, thereby resulting in relatively disease free papaya crop. Plants treated with LFA dust at 2 kg/plant on 90 and 120 DAT also increased phenol and crude protein contents but reduced sugar and

amino nitrogen contents of the leaves. It is evident from this study that the application of LFA dust profoundly increased the resistance mechanism of the plant and ultimately enhanced the fruit yield. Reproduced with permission from the CAB Abstracts database.

164. Effect of four sources of silicon on the resistance of sugarcane varieties to *Eldana saccharina* (Lepidoptera: Pyralidae).

Keeping, M. G. and Meyer, J. H.

Proceedings of the Annual Congress South African Sugar Technologists' Association 77: 99-103. (2003); ISSN: 1028-3781

Descriptors: application rates/ calcium silicate/ chemical composition/ crop damage/ cultivars/ fly ash/ insect pests/ internodes/ leaves/ nutrient content/ nutrient uptake/ plant composition/ plant nutrition/ plant pests/ silicon/ silicon fertilizers/ stems/ sugarcane/ varietal reactions/ varietal resistance/ varietal susceptibility/ chemical constituents of plants/ crop injury/ cultivated varieties

Abstract: The effects of USA calcium silicate, local calcium silicate, Slagment and fly ash on the resistance of sugarcane cultivars N 26 (susceptible), N 21 (susceptible), N21 (resistant) and N33 (resistant) to *E. saccharina* were studied under greenhouse conditions. Calcium silicates and Slagment were applied at 5000 or 10 000 kg/ha (62 or 124 g per pot, respectively), whereas fly ash was applied at 15 000 or 30 000 kg/ha (186 or 372 g per pot). The silicon fertilizers were incorporated into the sand medium before planting. Significant variation in leaf and stalk silicon uptake was observed. The greatest increase in plant silicon content (particularly in stalks) was recorded for plants treated with local calcium silicate. Silicon uptake did not significantly vary between the susceptible and resistant cultivars, although the resistant cultivars had inherently higher silicon content than the susceptible cultivars. Treatment with silicon, except with 30 000 kg fly ash/ha in N33, significantly reduced damage by *E. saccharina* in terms of stalk length and internodes bored. The reduction in damage was directly proportional to the amount of silicon applied. On average, the higher silicon rate reduced damage by 34.4% in the susceptible cultivars and by 25.7% in the resistant cultivars.

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165. Effect of freezing and thawing processes on some physical properties of saline-sodic soils mixed with sewage sludge or fly ash.

Sahin, Ustun; Angin, Ilker; and Kiziloglu, Fatih M.

Soil and Tillage Research 99(2): 254-260. (June 2008)

NAL Call #: S590.S48; ISSN: 0167-1987

Descriptors: freezing / thawing/ saline-sodic soils/ sewage sludge/ fly ash

Abstract: Dispersion of saline-sodic soils was rather difficult to leach. Therefore, negative effects of freeze-thaw on soil physical properties should be reduced by inexpensive and practical methods. This study investigates the effect of freeze-thaw cycles (3, 6, and 9) on wet aggregate stability, bulk density, and permeability coefficient in three soils with different electrical conductivity and exchangeable sodium percentage levels (soil I:

5.30dSmp#, 47.51%; soil II: 42.80dSmp#, 55.45%; soil III: 36.30dSmp#, 59.34%) which consist of different proportions of sewage sludge and fly ash by volume (10%, 20%, and 30%). The experiment was conducted under laboratory conditions using disturbed and non-cropped soil samples mixed with sewage sludge and fly ash. Soils mixed with sewage sludge produced higher aggregate stability and permeability coefficients and lower bulk density values as compared to the soils mixed with fly ash. Sewage sludge added with a rate of 30% eliminated the negative effects of freeze-thaw processes on wet aggregate stability. Freeze-thaw processes did not affect the bulk density of the soils II and III, which were mixed with sewage sludge. However, fly ash addition decreased the bulk density of these soils very significantly after nine freeze-thaw cycles. Addition of sewage sludge or fly ash with rates of 20% and 30% significantly increased the permeability coefficients in soil I after nine freeze-thaw cycles. Results indicated that addition of sewage sludge and/or fly ash to saline-sodic soils could be alternative way for reducing negative effects of freezing-thawing on soil wet aggregate stability, bulk density, and permeability coefficient. This citation is from AGRICOLA.

166. Effect of FYM and industrial wastes on productivity of *Phyllanthus amarus*.

Arumugam Shakila and Rajeswari, R.

Advances in Plant Sciences 19(2): 525-529. (2006)

NAL Call #: QK1.A38; ISSN: 0970-3586

Descriptors: application rates/ branches/ farmyard manure/ fly ash/ leaves/ plant height/ FYM/ Madras

Abstract: The effects of farmyard manure (FYM) pressmud and lignite fly ash (0, 5 or 10 t/ha each) on the yield of *P. amarus* [*P. niruri*] were studied in Annamalaiagar, Tamil Nadu, India. All treatments significantly enhanced plant height, number of branches and leaves, and herbage yield. The application of FYM + pressmud + lignite flyash at 10 t/ha each resulted in the greatest plant height (118.09 cm), number of branches per plant (45.04), number of leaves per plant (1165.87), and herbage yield per plant (39.69 g).

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167. Effect of graded levels of fly ash and NPK on soil properties and yield of wheat.

Deshmukh, A. S.; Matte, D. B.; and Kene, D. R.

Journal of Soils and Crops 10(2): 260-264. (2000); ISSN: 0971-2836

Descriptors: calcium/ carbon/ fertilizers/ fly ash/ magnesium/ nitrogen fertilizers/ NPK fertilizers/ phosphorus fertilizers/ potassium fertilizers/ soil amendments/ soil chemistry/ soil ph/ soil physics/ wheat/ phosphate fertilizers/ potash fertilizers/ soil bulk density/ yield

Abstract: Field trials were conducted in Nagpur, India, on wheat cv. AKW-381 during 1993-94 with 0, 5, 10 and 15 t fly ash/ha along with three levels of NPK (none, 100:50:50 and 75:37.5:37.5 kg/ha) to study the effects on soil physicochemical properties and wheat yield. Application of 10 t fly ash/ha alone and in combination with 100:50:50 NPK was produced highest dry matter production, grain yield and improvement of the nutrient status and physicochemical properties of the soil. Although the soil

amendments had some effects on soil bulk density, CEC, available micronutrients and slight improvement in exchangeable Ca and Mg, they did not have an effect on soil pH, soil EC, organic C content and available NPK status of the soil.
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168. Effect of gypsum and lignite fly ash as sources of sulphur on ragi.

Naveen Saviour, Raghupathy, B.; Poonkodi, P.; and Angayarkanni, A.
Agricultural Science Digest 21(1): 5-8. (2001); ISSN: 0253-150X

Descriptors: calcium/ crop yield/ dry matter accumulation/ fly ash/ gypsum/ magnesium/ mineral uptake/ nitrogen/ nutrient availability/ nutrient uptake/ phosphorus/ plant nutrition/ potassium/ soil fertility/ sulfur/ elemental sulphur/ Madras/ sulphur

Abstract: The effects of gypsum and lignite fly ash (LFA) on the yield and nutrient uptake of ragi [*Eleusine coracana*] cv. CO 12 were investigated in Annamalai, Tamil Nadu, India [date not given]. The treatments were: (T1) control; (T2) gypsum at 80 kg/ha; (T3) gypsum at 160 kg/ha; (T4) gypsum at 240 kg/ha; (T5) LFA at 2.1 t/ha; (T6) LFA at 4.2 t/ha; and (T7) LFA at 6.3 t/ha. T4 gave the highest values for total dry matter production (3569 kg/ha), grain yield (1231 kg/ha) and straw yield (2338 kg/ha). This treatment also resulted in the highest uptake of N (60.66 kg/ha), P (14.27 kg/ha), K (71.44 kg/ha), Ca (17.92 kg/ha), Mg (16.13 kg/ha) and S (14.54 kg/ha), and increased the available nutrients in the soil.

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169. Effect of gypsum and lignite fly ash as sources of sulphur on the synthesis of protein and oil in soybean.

Poonkodi, P.; Raghupathy, B.; Angayarkanni, A.; and Boobalan, G. S.
Mysore Journal of Agricultural Sciences 35(1): 32-36. (2001)

Descriptors: application rates/ chemical composition/ crop yield/ fly ash/ gypsum/ methionine/ mineral uptake/ nitrogen content/ nutrient availability/ nutrient uptake/ plant composition/ plant nutrition/ pods/ protein content/ soybeans/ sulfur/ sulfur fertilizers/ Vertisols/ yield components/ chemical constituents of plants/ elemental sulphur/ soybeans/ sulphur/ sulphur fertilizers

Abstract: The effects of gypsum and lignite fly ash (LFA) on the performance of soybean cv. CO-1 were studied in a pot experiment using a clayey soil (Typic Chromustert). The treatments consisted of 250.0 kg gypsum/ha, 4.0 t LFA/ha, 187.5 kg gypsum + 1.0 t LFA/ha, 125.0 kg gypsum + 2.0 t LFA/ha and 62.5 kg gypsum + 3.0 t LFA/ha. The application of 125.0 kg gypsum + 2.0 t LFA/ha resulted in the highest number of pods per plant (28), grain yield per pot (8.80 g), oil content (21.80%), protein content (41.75%), methionine content (0.106%), total N content (6.68%), total S content (0.42%), N (1.28 g per pot) and S (0.080 g per pot) uptake, and soil available N (85.1 mg/kg) and S (9.8 mg/kg). The highest N:S ratio was recorded for the control (25.2).
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170. Effect of hard coal ash on the level of physiologically active compounds present in leaves of cultivated crops.

Zalewski, K and Login, A.
In: *Acta Physiologiae Plantarum. Fourth International Conference on Ecophysiological Aspects of Plant Responses to Stress Factors.* Cracow, Poland.; Vol. 23(3 Supplement); pp. 107; 2001. ISBN: 0137-5881
Descriptors: agronomy/ agriculture/ waste management: sanitation/ Gramineae: angiosperms, monocots, plants, spermatophytes, vascular plants/ Leguminosae: angiosperms, dicots, plants, spermatophytes, vascular plants/ hard coal ash: agricultural application
© Thomson Reuters

171. Effect of industrial and organic wastes on groundnut in typic ustifluent soil.

Sriramachandrasekharan, M. V.
Annals of Agricultural Research 22(3): 436-438. (2001)
NAL Call #: S471.14A56; ISSN: 0970-3179

Descriptors: chemical composition/ crop yield/ farmyard manure/ filter cake/ fly ash/ groundnut oil/ groundnuts/ gypsum/ haulms/ humic acids / kernels/ lignite/ mineral uptake/ nutrient uptake/ organic amendments/ plant composition/ plant nutrition/ pods/ protein content/ seed weight/ seeds/ yield components/ arachis oil/ chemical constituents of plants/ clarification mud/ FYM/ peanut oil/ peanuts

Abstract: The effects of lignite fly ash (LFA at 2.4 t/ha), gypsum (200 kg/ha), biodigested pressmud (BP at 7.5 t/ha), farmyard manure (FYM at 12.5 t/ha) and lignite humic acid (LHA at 40 kg/ha), applied singly or in combination, on groundnut cv. VRI 2 were investigated in Cuddalore, Uttar Pradesh, India in 1995. All treatments significantly enhanced the number of pods per plant, 100-kernel weight, seed and haulm yields, protein content and nutrient uptake compared to the control. The application of 7.5 t BP/ha+1.2 t LFA/ha+200 kg gypsum/ha recorded the highest number of pods per plant (26.1), 100-kernel weight (42.2 g), pod yield (2941 kg/ha), haulm yield (4756 kg/ha), oil (48.6%) and protein (24.2%) contents, and N (267.8 kg/ha), P (43.1 kg/ha) and K (281.5 kg/ha) uptake.

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172. Effect of industrial wastes as manure for rice.

Angayarkanni, A. and Poonkodi, P.
Journal of Ecobiology 16(4): 303-305. (2004)
NAL Call #: QH540.J56 ; ISSN: 0970-9037

Descriptors: crop yield/ filter cake/ fly ash/ grain/ industrial wastes/ nitrogen fertilizers/ nutrient uptake/ phosphorus fertilizers/ potassium fertilizers/ rice/ soil fertility/ soil ph/ straw/ waste utilization/ clarification mud/ Madras/ paddy/ phosphate fertilizers/ potash fertilizers

Abstract: A field experiment was conducted in Tamil Nadu, India during Rabi season to evaluate the effect of industrial wastes viz., pressmud and lignite fly ash (LFA) on the performance of rice (*Oryza sativa*) cv. ADT 43 and the residual soil fertility status. The treatments were control, pressmud (PM) at 6.25 tonnes/ha, LFA at 4 tonnes/ha, Recommended Dose of Fertilizers (150:50:50 kg N, P₂O₅ and K₂O/ha), 75% RDF + PM + LFA and 50% RDF + PM + LFA. The results showed that application of PM and LFA

along with 75% RDF recorded the highest grain and straw yield. LFA and PM when applied individually recorded relatively lesser grain and straw yield. A similar trend was observed with respect to nutrient uptake by grain. The soil fertility status at the post harvest stage revealed that 75% RDF + PM + LFA registered high N content in soil and was comparable with 100% RDF. However, application of 100% RDF recorded higher soil P₂O₅ and K₂O than other treatments. Application of LFA resulted in significantly high residual soil pH compared to other treatments. Reproduced with permission from the CAB Abstracts database.

173. Effect of integrated nutrient management on sabaigrass groundnut intercropping system under lateritic soils of South West Bengal.

Manisha Basu; Sanjib Das; and Mahapatra, S. C.
Environment and Ecology 24S(Special 1): 190-192. (2006)
NAL Call #: TD172.E5; ISSN: 0970-0420

Descriptors: application rates/ biomass production/ crop yield/ cropping systems/ dry matter accumulation / farmyard manure/ fibre plants/ fly ash/ groundnuts/ integrated systems/ intercropping/ intercrops/ lime/ NPK fertilizers/ organic amendments/ soil amendments/ tillers/ yield components/ fiber plants/ fibre crops/ FYM/ peanuts
Abstract: Sabaigrass (*Eulaliopsis binata*) is a commercial crop of marginal and submarginal rainfed upland areas. This crop is useful for its thin and long leaves containing high quality fibre, which is a good raw material for paper industries as well for marking rope and various rope-based utility items. A field experiment was conducted to evaluate the effect of integrated nutrient management on the growth and yield of sabaigrass-groundnut intercropping system for one year (2002-03) on the acid lateritic soils under the rainfed conditions of West Bengal, India. The treatments comprised three doses of chemical fertilizers (CF), i.e. 15:10:10 (CF₁), 30:20:20 (CF₂) and 60:40:40 kg of N:P₂O₅:K₂O/ha (CF₃), along with farmyard manure (FYM), lime (L) and fly ash (FA). Thus, altogether 13 treatment combinations, viz. CF₁, CF₁+FYM, CF₁+FYM+FA, CF₁+FYM+L, CF₂, CF₂+FYM, CF₂+FYM+FA, CF₂+FYM+L, CF₃, CF₃+FYM, CF₃+FYM+FA, CF₃+FYM+L and untreated control, were tested under field condition. It revealed that all treatments increased leaf length (cm), number of tillers per plant, dry matter accumulation (g/m²) and yield of both crops. The integrated use of CF, FYM and FA resulted in higher yields for both crops compared with CF alone or other combinations. There was no significant difference between FA and L, also between CF₂ and CF₃ doses. Among all the treatment combinations, CF₃+FYM+FA resulted in the best performance of both crops. Reproduced with permission from the CAB Abstracts database.

174. Effect of integration of fly ash with fertilizers and organic manures on nutrient availability, yield and nutrient uptake of rice in Alfisols.

Selvakumari, G.; Baskar, M.; Jayanthi, D.; and Mathan, K. K.

Journal of the Indian Society of Soil Science 48(2): 268-278. (2000)

NAL Call #: 56.9 IN2; ISSN: 0019-638X

Descriptors: alfisols / analysis/ application rates/ availability/ calcium/ composts/ crop production/ fertilizers/ fly ash/ heavy metals/ integration/ lignite/ magnesium/

manures/ nutrient availability/ nutrient uptake/ nutrients/ phosphorus/ physicochemical properties/ potassium/ properties/ rice/ seasons/ silica/ sodium/ soil/ soil ph/ sulfur/ summer/ treatment/ uptake/ yield increases/ yields/ elemental sulphur/ Madras/ paddy/ sulphur

Abstract: Field experiments were conducted for four seasons from summer 1997 to rainy season 1998 in Tamil Nadu, India, on Alfisols to study the effect of long-term application of fly ash alone and in combination with fertilizer, compost and Azospirillum on yield and uptake of rice and physicochemical properties and nutrient availability of the soil. The results of the pooled mean analysis for four seasons indicated that the treatments which received fly ash at 20 and 40 t ha⁻¹ recorded yield increases of 10.3 and 16.6%, respectively over the treatments without any fly ash addition. The treatments receiving N, P and K as fertilizers or fertilizers plus compost or fertilizers plus Azospirillum recorded 117, 125 and 131% increases in yield over the treatments without any manurial addition. The highest yield (6.90 t ha⁻¹) was recorded when fly ash applied was at 40 t ha⁻¹ in combination with fertilizer, compost and Azospirillum. The significant increase in the uptake indicated that fly ash could serve as a source of plant nutrients. Under integrated plant nutrient supply system with fly ash, its effect was pronounced. The continuous addition of lignite fly ash resulted in significant increase in pH, EC [electrical conductivity], exchangeable Na, available P, K, Ca, Mg, S and Si in the post-harvest soil after fourth crop of rice. The increase in pH was not significant. The results also confirmed that even after continuous addition of fly ash for three seasons, there was no hazardous level of heavy metal content. Reproduced with permission from the CAB Abstracts database.

175. Effect of lignite fly ash on growth, yield performance and quality attributes of blackgram.

Poonkodi, P. and Deepa, B.

Advances in Plant Sciences 15(2): 491-493. (2002)

NAL Call #: QK1.A38; ISSN: 0970-3586

Descriptors: application rates/ black gram/ chlorophyll/ crop quality/ crop yield/ fly ash/ growth/ haulms/ nitrogen/ nitrogen content/ plant height/ pods/ protein content/ seeds/ yield components

Abstract: A pot experiment was conducted on clay loam soil to study the effect of lignite fly ash (1, 2, 3, 4, and 5 t/ha applied as basal dressing) on the growth, yield, and quality of black gram cv. ADT3. At 60 days after sowing, lignite fly ash at 4 and 5 t/ha gave the tallest plants (25.23 and 25.34 cm) and the highest chlorophyll content (36.80 and 37.02 mg/g of tissue), number of pods per plant (21.70 and 22.11), pod length (4.78 and 4.81 cm), number of seeds per pod (5.46 and 5.52), haulm yield (6.17 and 6.18 g per pot), N content (3.68 and 3.70%), and protein content (23.00 and 23.15).

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176. Effect of mode of fly ash application with organic and chemical fertilizers on yield and nutrient uptake in crops under yellow sarson (*Brassica rapa* var *glauca*) rice (*Oryza sativa*) yellow sarson cropping sequence.

Rautaray, S. K.; Ghosh, B. C.; and Mittra, B. N.

Indian Journal of Agricultural Sciences 72(8): 480-483. (2002)

NAL Call #: 22 AG83I; ISSN: 0019-5022

Descriptors: application methods/ cadmium/ chemical composition/ crop yield/ fertilizers/ fly ash/ nickel/ nutrient availability/ nutrient uptake/ organic carbon/ organic fertilizers/ plant composition/ rice/ sequential cropping/ soil pH/ Capparales/ chemical constituents of plants/ paddy
Abstract: A field experiment was conducted during 1996-98 in West Bengal, India, to study the effect of mode of fly ash application, either as full- or split-doses, alone or in combination with organic or chemical fertilizers in a yellow sarson [*Brassica campestris* var. sarson]-rice-yellow sarson cropping sequence. Yellow sarson and rice were grown in 3 seasons in sequence, namely yellow sarson during the dry season (November to March 1996/97), rice during the wet season (June to October 1997) and yellow sarson during the dry season (November to March 1997/98). Data were obtained for yield, nutrient uptake, seed contents of cadmium and nickel, and pH, available nutrient and organic carbon in the soil. The results are discussed. Reproduced with permission from the CAB Abstracts database.

177. Effect of mode of pond and fly ash application on yield and nutrient content of crops under yellow sarson, *Brassica napus* var. *glauca* and rice, *Oryza sativa* in rotation.

Rautaray, S. K.

Journal of Oilseeds Research 22(1): 190-191. (2005); ISSN: 0970-2776

Descriptors: Alfisols / ash/ calcium/ crop yield/ farmyard manure/ fly ash/ magnesium/ mineral content/ nitrogen/ NPK fertilizers/ nutrient content/ phosphorus/ plant nutrition/ potassium/ returns/ rice/ sulfur/ zinc/ Capparales/ elemental sulphur/ FYM/ paddy/ sulphur
Abstract: A field experiment was conducted during 1996/98 on an acid lateritic (Haplustalf) soil in Assam, India. Yellow sarson (*B. napus* var. *glauca* [*B. campestris* var. sarson]) and rice (*O. sativa*) were grown in 3 seasons in sequence, i.e. yellow sarson during the dry season (November-March 1996/97), rice during the wet season (June-October 1997) and yellow sarson during the dry season (November-March 1997/98). Thirty tonnes of pond and fly ash was applied in 3 modes, i.e. 30-0-0 (first season yellow sarson received 30 tonnes/ha and no application to the following crops), 20-10-0 (first season yellow sarson received 20 tonnes/ha, rice received 10 tonnes/ha and no application to the second yellow sarson crop) and 10-10-10 (each crop received 10 tonnes/ha). A uniform NPK fertilizer dose of 90-26-33 kg/ha and 60-17-33 kg/ha was applied in rice and yellow sarson, respectively, through 5 tonnes of farmyard manure and complementary dose of chemical fertilizers or chemical fertilizers alone. Yellow sarson yield, rice equivalent yield and net returns were generally highest with the application of both ash at 20-10-0 and 30-0-0 tonnes/ha. Nutrient content in yellow sarson seed showed no variation due to mode of ash application. The contents of all nutrients (N, P, K, Ca, Mg, S and Zn) were higher with ash+farmyard manure+chemical fertilizer, followed by ash+chemical fertilizers and chemical fertilizers alone. Reproduced with permission from the CAB Abstracts database.

178. Effect of organic amendments on the oxygen uptake of *Pseudomonas putida* PAPs 1 in chromium-contaminated pond ash.

Sheela, A. M.; Shanmugasundaram, R.; and Sundaram, M. D.

Soil and Sediment Contamination 14(1): 71-84. (2005)

NAL Call #: TD878 .J68; ISSN: 1058-8337

Descriptors: artificial wetlands/ bioremediation/ chromium/ coir/ enzyme activity/ enzymes/ farmyard manure/ fly ash/ nitrogen/ nutrient content/ organic amendments/ oxidoreductases/ oxygen consumption/ phosphorus/ potassium/ rice/ rice straw/ soil amendments/ straw/ coconut fibre/ constructed wetlands/ FYM/ paddy/ redox enzymes

Abstract: In this study a Cr (VI) resistant bacterium *Pseudomonas putida* was isolated from pond ash and its oxygen consumption potential at different concentrations of Cr (VI) viz., 0, 100 and 200 mg kg⁻¹ was studied using Electrolytic Respirometry. Oxygen consumption by the bacterium was noticed up to 200 mg kg⁻¹ Cr (VI) concentration. To the pond ash (inoculated with and without *Pseudomonas*) 200 mg kg⁻¹ Cr (VI) was added and incorporated with different organic amendments such as farmyard manure (FYM), coir pith, paddy straw and press mud and the cumulative oxygen consumption was studied. The cumulative oxygen consumption by the bacterium was higher when the pond ash was incorporated with organic amendments. The highest oxygen consumption of 205 mg l⁻¹ was observed when press mud was used, which was followed by FYM (198 mg l⁻¹). Furthermore, the enrichment with press mud increased the nutrient content of N (57.28 mg kg⁻¹), P (5.5 mg kg⁻¹) and K (42.7 mg kg⁻¹) of the pond ash. The maximum dehydrogenase enzyme activity of 0.63 micro g TPF formed g⁻¹ sample h⁻¹ was measured when the pond ash was inoculated with *Pseudomonas* and enriched with press mud. The results also indicated that maximum reduction of Cr (VI) (42.5%) was observed when *Pseudomonas* and press mud were used. This study evaluated the possibilities of toxicity reduction and nutrient enrichment of the ash pond using a Cr (VI) resistant bacterium and organic amendments. Reproduced with permission from the CAB Abstracts database.

179. Effect of organic manures and flyash on nutrient uptake of sugarcane.

Venkatakrishnan, D. and Ravichandran, M.

Indian Sugar 56(11): 41-46. (2007); ISSN: 0019-6428

Descriptors: brix/ cane sugar/ composts/ farmyard manure/ fly ash/ humic acids/ juice quality/ leaves/ lignite/ manures/ mineral uptake/ nitrogen/ nitrogen fertilizers/ nutrient uptake/ phosphorus / phosphorus fertilizers/ potassium/ potassium fertilizers/ reducing sugars/ stems/ sugar content/ sugarcane/ FYM/ Madras/ phosphate fertilizers/ potash fertilizers

Abstract: The effects of organic manures and fly ash on the performance of sugarcane (cv. Co 86032) were studied at Mamangalam Chidambaram Taluk, Tamil nadu, India, from 2003 to 2004. The main plot treatments consisted of 25 t farmyard manure (FYM), 25 t seasoned pressmud and 5.0 t biocompost/ha, whereas the subplot treatments consisted of 100% of the recommended NPK rates (275:60:100

kg/ha; S1), S1 + 25 t lignite fly ash/ha, S1 + 50 kg humic acid/ha, and S1 + S2 + S3 (S4). All the treatments had significant effects on nutrient uptake and juice quality. Among the organic manures, seasoned pressmud resulted in the greatest uptake of N, P and K by stems (86.42, 47.84 and 204.35 kg/ha, on average), and by tops and trashes (86.45, 38.89 and 147.04 kg/ha). Farmyard manure and seasoned pressmud registered the highest average Brix (19.52 and 20.32%) and Pol (18.64 and 19.01%) values, and lowest reducing sugar contents (0.58 and 0.52%). The highest commercial cane sugar content (13.52%) was obtained with seasoned press mud (13.52%). Among the subplot treatments, Fe, Mn, Zn and Cu uptake by stems were most pronounced in plants under S4 (6.83, 2.27, 1.24 and 0.74 kg/ha). This treatment also gave the highest Brix (19.41%) and Pol (18.56%) values, and lowest reducing sugar content (0.56%). The combination between seasoned press mud and S4 was optimum for enhancing nutrient uptake and juice quality in sugarcane. Reproduced with permission from the CAB Abstracts database.

180. Effect of organics and graded levels of sulphur on rice yield and sulphur use efficiency.

Bhuvaneshwari, R.; Sriramachandrasekharan, M. V.; and Ravichandran, M.

Journal of Interacademia 11(1): 51-54. (2007); ISSN: 0971-9016

Descriptors: application rates/ crop yield/ farmyard manure/ fly ash/ green manures/ lignite/ rice/ soil amendments/ sulfur fertilizers/ use efficiency/ FYM/ Madras/ paddy/ sulphur fertilizers

Abstract: Field experiments were conducted in Tamil Nadu, India, during the 2001 kharif season, to study the effect of sulfur (S) at varying rates, i.e. 0, 20, 40 and 60 kg/ha, with different organics, i.e. green manure, farmyard manure, sulfitation press mud and lignite fly ash, each applied at 12.5 t/ha, on yield, S use efficiency and S optimization of rice cv. ADT 43. The results revealed that rice responded significantly to the application of S and organics compared to the control. The highest grain (5065 kg/ha) and straw yields (7524 kg/ha) was obtained with 40 kg S/ha. Green manure addition caused 8.9% increase in grain yield and 10.6% increase in straw yield, closely followed by sulfitation press mud. S use efficiency was highest at 20 kg/ha and higher in the presence of organics. The physical optimum of S worked out through the Mitscherlich and Bray approach showed that 38.8 kg S/ha was needed to obtain 87.5% yield and in the presence of organics, it ranged from 14.4 to 32.3 kg S/ha, resulting in S savings of approximately 6.5-24.4 kg S/ha.

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181. The effect of pit coal fly ash from power plant "Dolna Odra" on growth and yielding of winter cereals.

Stankowski, S.; Stosio, M.; and Pacewicz, K.

Folia Universitatis Agriculturae Stetinensis, Agricultura 101: 309-318. (2006); ISSN: 1506-1973.

Notes: Original title: Wpływ stosowania popiołów lotnych z węgla kamiennego, pochodzących z elektrowni "Dolna Odra", na wzrost i plonowanie zbóż ozimych.

Descriptors: application rates/ coal/ crop yield/ fly ash/ photosynthesis/ rye/ seed weight/ triticale/ wheat/ winter

wheat/ yield components/ carbon assimilation/ carbon dioxide fixation

Abstract: A field experiment was conducted in the years 1995/96-1997/98 at Ostoja/Szczecin Agricultural Experimental Station in Poland. The treatments comprised 4 species of winter crops (rye cv. Warko, wheat cv. Almari, triticale cv. Bogo, and barley cv. Kroton in 1995/1996 and cv. Gil in 1996/97 and 1997/98), as well as 4 doses of ash (0 (control), 50, 100 and 150 t/ha). The grain yield, yield components and photosynthetic processes in plants were determined. The application of fly ash had a positive effect on the grain germination. In 1995 and 1997, the optimum dose of fly ash equalled 50 and 100 t/ha, whereas in 1996 when the conditions for the germination were unpropitious, the optimum dose equalled 150 t/ha. In either year, the plant germination was not worse on the plots with the applied ash as compared to the control object without ash. The effect of ash application on the yield of the investigated species varied. A regular increase of the yield with the growing ash dose was observed in barley (at ~40%). The yield of rye increased in two years after the application of the dose estimated on the regression line and not exceeding 55 and 88 t/ha. The increase of the triticale yield was noted only in one year. The yield of wheat was similarly independent of the ash dose. The increase of the grain yield in the investigated species due to the growing doses of ash was caused by the increase of the number of ears and the number of grains in an ear. The weight of 1000-grains varied insignificantly subject to this factor. No distinct differentiation of the chlorophyll content in the leaves nor the fluorescence induction coefficient Fv/Fm were observed.

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182. Effect of pyrite and fly ash on pH of sodic soil under submerged and field capacity conditions.

Bharat Singh and Anil Kumar

Farm Science Journal 12(2): 161. (2003); ISSN: 0972-8589

Descriptors: field capacity/ fly ash/ nonclay minerals/ pyrites/ reclamation/ saline sodic soils/ sodic soils/ soil pH/ soil types/ soil water regimes / waterlogging/ saline alkali soils

Abstract: A study was conducted to determine the effect of pyrite and fly ash on pH of sodic soil under submerged and field capacity conditions at different intervals. Seven treatments were employed, viz., waterlogged (T1); 0.50% fly ash, waterlogged (2); 1.00% fly ash, waterlogged (3); 0.75% pyrite, field capacity (T4); 0.75% pyrite, 15 days field capacity and then continuously waterlogged (T5); 0.75% pyrite, 30 days field capacity and the continuously waterlogged (T6); 0.375% pyrite + 0.50% fly ash, 15 days field capacity and then continuously waterlogged (T7). Two moisture regimes (i.e. field capacity and waterlogged conditions) were maintained up to 60 days of incubation period by addition of distilled water as and when required. The changes in pH were recorded at 0, 7, 15, 30 and 60 days on incubation. Results showed that pyrite was more efficient in decreasing the pH when it was surface broadcast and allowed to oxidize for 30 days at field capacity and then waterlogged. The addition of pyrite and fly ash in different combinations tended to decrease pH of sodic soil both under waterlogged and field capacity conditions. Fly ash was found good substitute for reclaiming

saline sodic soil when applied with pyrite under field capacity for 30 days and then waterlogged.
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183. Effect of resistant genotypes induced with organic nutrients on the feeding rate of rice brown plant hopper, Nilaparvata lugens (Stal.) (Delphacidae: Homoptera).

Rani, B. U. and Suresh, K.

Insect Environment 12(1): 42-44. (2006)

Descriptors: cultivars/ farmyard manure/ fly ash/ insect pests/ lignite/ neem seed cake/ non wood forest products/ phosphate solubilizing bacteria/ plant pests/ rice/ varietal resistance/ biofertilizers/ brown planthopper/ cultivated varieties/ FYM/ minor forest products/ neem seed oilmeal/ non timber forest products/ paddy/ rice brown planthopper
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184. [Effect of Shajiang black soil amended by coal fly ash on ecological factors and residue of heavy metal in wheat field].

Ma, X.; Wang, X.; Ding, J.; Gao, E.; and Yang, Q.

Ying Yong Sheng Tai Xue Bao 12(4): 610-4. (Aug. 2001); ISSN: 1001-9332 .

Notes: Original language of article: Chinese.

Descriptors: coal/ ecology/ metals, heavy: analysis/ soil: analysis / triticum: physiology/ water: analysis

Abstract: The effect of Shajiang black soil amended by coal fly ash on ecological factors in wheat field and residues of Cd, Cr, Pb, Hg and As were studied by pot experiment. The results showed that applying coal fly ash into Shajiang black soil could decrease soil density, soil proportion and clay content, but increase soil porosity, filtration coefficient and soil temperature. Moreover, it could promote water evaporating when soil moisture was high and keep soil water when lower than 10%. It also could facilitate activity of soil micro-organism and promote soil nutrient transforming. With (6-18) x 10(4) kg.hm⁻² coal fly ash applied in Shajiang black soil, the accumulated quantity of Cd, Cr, Pb, Hg and As in soil and in wheat grain were lower than international standard index of pollution. Therefore, Shajiang black soil amended by coal fly ash was safe and reliable within the above range.

This citation is from PubMed.

185. Effect of soil amendments on sorption and mobility of metribuzin in soils.

Kaushik Majumdar and Neera Singh

Chemosphere 66(4): 630-637. (2007)

NAL Call #: TD172 .C54; ISSN: 0045-6535

Descriptors: animal manures/ downward movement/ fly ash/ herbicide residues/ herbicides/ leachates/ leaching/ metribuzin/ organic amendments/ polluted soils/ sandy loam soils/ soil amendments/ soil pollution/ soil types/ sorption/ weedicides/ weedkillers

Abstract: Metribuzin (4-amino-6-tert-butyl-4,5-dihydro-3-methylthio-1,2,4-triazin-5-one), is weakly sorbed to soil therefore, leaches easily to lower soil profiles. Soil amendments play a significant role in the management of leaching losses of pesticides. Therefore, present study reports the effect of organic manure and fly ash amendments on metribuzin downward mobility in sandy loam soil columns. Application of animal manure [T-1(OM)

and T-2(OM)] and fly ash [T-1(FA) and T-2(FA)] at 2.5% and 5.0% levels increased the metribuzin retention in the soil. Freundlich constant [$K_f(1/n)$] values of metribuzin for treatments T-1(OM) and T-2(OM) were 0.70 and 1.11, respectively, which were significantly higher than the value (0.27) in natural soil (T-0). The respective values for treatments T-1(FA) and T-2(FA) were 1.80 and 4.61. Downward mobility of metribuzin was studied in packed soil columns [300 mm (l) x 59 mm (i.d.)]. Both the amendments significantly reduced the downward mobility of metribuzin and affected breakthrough time and maximum concentration of metribuzin in the leachate. Leaching losses of metribuzin were decreased from 97% in natural soil (T-0) column to 64% [T-1(OM)] and 42% [T-2(OM)] for animal manure-amended columns and 26% [T-1(FA)] to 100% [T-2(FA)] for fly ash-amended columns, as metribuzin did not leach out of 5% fly ash-amended column. Study indicates that both animal manure and fly ash were quite effective in reducing the downward mobility of metribuzin in packed soil columns of a sandy loam soil.

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186. Effect of solid wastes and fertilizer levels on growth and yield of okra (Abelmoschus esculentus (L.) Moench).

Nagaraja, H.; Yeledhalli, N. A.; Patil, C. V.; Halepyati, A. S.; and Patil, M. G.

Karnataka Journal of Agricultural Sciences 16(1): 134-136. (2003)

NAL Call #: S471.142K37; ISSN: 0972-1061

Descriptors: crop yield/ fly ash/ growth/ leaves/ okras/ organic amendments/ plant height/ pods/ sewage sludge/ trace element fertilizers/ micronutrient fertilizers

Abstract: A field experiment was conducted [date and location not given] to determine the effect of sewage sludge and fly ash fertilizer rates on the growth and yield of okra cv. Arka Anamika. The treatments were no solid waste application (control), 52 t 100% sewage sludge/ha, 52 t 100% fly ash/ha, and 50% fly ash+50% sewage sludge. At 45 days after sowing, the highest number of leaves (17.70) was obtained with 50:50 fly ash and sewage sludge treatment followed by sewage sludge (14.44), fly ash (12.93), and the control (9.77). The maximum plant height, number of pods per plant, and pod yield at all 3 stages was also obtained with 50:50 fly ash and sewage sludge treatments.

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187. Effect of vermicomposting on the transformation of some trace elements in fly ash.

Bhattacharya, S. S. and Chattopadhyay, G. N.

Nutrient Cycling in Agroecosystems 75(1/3): 223-231. (2006)

NAL Call #: S631 .F422; ISSN: 1385-1314

Descriptors: cadmium/ cattle dung/ chromium/ copper/ crop yield/ fly ash/ heavy metals/ iron/ lateritic soils/ lead/ manganese/ NPK fertilizers/ potatoes/ soil types/ trace elements/ vermicompost/ vermicomposting/ zinc/ microelements/ Mn

Abstract: One major constraint of the agricultural uses of fly ash (FA) is the low availability of different plant nutrients despite their high occurrence in the total amount. However,

degrading FA through increased microbial activity can improve the availability of these nutrients substantially. It has been found that intestines of epigeic earthworms contain a high concentration of different microorganisms. Therefore, in the present study we addressed the effects of vermicomposting technology on the solubility of some micronutrient cations (Fe, Mn, Cu, and Zn) and some heavy metals (Pb, Cd, and Cr) in different combinations of fly ash and organic matter, applied in the form of cow dung (CD). Various combinations of FA and CD were treated with and without an epigeic earthworm (*Eisenia fetida*) and the solubility of different trace elements in the treatments were estimated periodically. The results revealed that the inclusion of epigeic earthworm *Eisenia fetida* in different combinations of fly ash and cow dung converted a considerable amount of the micronutrients into bio-available forms. On the other hand, the solubility of heavy metals tended to be reduced by the microorganisms, presumably by formation of some organo-metallic complex. Application of these vermicomposted FA and CD combinations to a red lateritic soil was found to improve the soluble Fe, Mn, Cu, and Zn status of the soil. Furthermore, the use of vermicomposted FA and CD (1:1) in potato cultivation demonstrated that use of this mixture at 10 ton per hectare (t ha⁻¹; fresh weight) was able to compensate 80% of the recommended NPK fertiliser, along with farm yard manure application, without compromising the crop yield. Reproduced with permission from the CAB Abstracts database.

188. Effect on growth, tuber yield and quality of potato in fly ash amended soil.

Rajesh Kumar; Singh, R. P.; Arvind Kumar; Sarkar, A. K.; and Sharma, V. N.

In: Potato, Global Research and Development.

Proceedings of the Global Conference on Potato. New Delhi, India.; Vol. 2.; pp. 872-876; 2002.

Descriptors: application rates/ chemical composition/ cobalt/ copper/ crop quality/ crop yield/ dry matter/ fly ash/ growth/ industrial wastes/ lead/ leaves/ manganese/ nickel/ NPK fertilizers/ plant height/ potatoes/ soil amendments/ solid wastes/ weight/ zinc/ Mn

Abstract: The effects of 4, 8 or 16% of fly ash, an amorphous ferro-alumino silicate waste produced by steel and thermal power plants, alone or in combination with 50 or 100% recommended NPK rate, on the growth, yield and quality of potato cv. Kufri Lalima were determined in a field experiment conducted in Ranchi, Bihar, India during the rabi season of 1997-98. Application of 16% fly ash in combination with 100% recommended NPK resulted in the tallest plants (31.13 cm), highest number of leaves (41.16) and branches (5.20) per plant, and widest plant spread from east to west (48.50 cm) and from north to south (45.61 cm). The highest number of tubers per plant (15.23) was recorded with application of 8% fly ash in combination with 100% recommended NPK, whereas the heaviest tubers per plant (340.88 g) and highest dry matter (22.90%), tuber yield per plant (18.15 kg), mean tuber yield (22.41 t/ha) and tuber yield increase over the control (194.48 t/ha) were recorded with the application of 16% fly ash in combination with 100% NPK. Application of 16% fly ash resulted in the highest manganese, zinc, copper and nickel content in potato tubers. Application of 16% fly ash in combination

with 100 or either 50 or 100% recommended NPK rate resulted in the highest lead and cobalt content in the potato tubers, respectively.

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189. Effective utilisation of industrial wastes for higher yield of soybean.

Poonkodi, P. and Raghupathy, B.

Advances in Plant Sciences 14(2): 543-546. (2001)

NAL Call #: QK1.A38; ISSN: 0970-3586

Descriptors: chemical composition/ crop quality/ crop yield/ filter cake/ fly ash/ gypsum/ industrial wastes/ leaves/ methionine/ nitrogen content/ nutritive value/ plant composition/ plant height/ pods/ protein content/ pyrites/ seed oils/ seeds/ soyabeans/ sulfur/ sulfur fertilizers/ yield components/ chemical constituents of plants/ clarification mud/ elemental sulphur/ nutritional value/ quality for nutrition/ soybeans/ sulphur/ sulphur fertilizers

Abstract: A pot experiment was conducted in a clay loam soil to study the effects of various industrial wastes, i.e. pressmud (3.3 t/ha), lignite fly ash (4.0 t/ha), pyrite (228 kg/ha), gypsum (250 kg) and elemental sulfur (60 kg/ha), on the yield and quality of soybean. The greatest plant height (44.00 cm), number of leaves per plant (22.00), seed yield per pot (12.10 g), oil content (21.82%), total N (6.64%) and total S (0.40%) were obtained with the application of gypsum. This treatment was at par with lignite fly ash in relation to the number of leaves (22.00). The protein content (41.50 and 41.25%) and methionine content (0.100 and 0.103%) were highest with the application of gypsum and lignite fly ash, respectively. The control registered the highest N : S ratio (26.2), which decreased with the application of the evaluated S sources.

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190. Effective utilisation of Neyveli lignite fly ash.

Khungar, S. C.

Fertiliser News 43(11): 27-28. (1998)

NAL Call #: 57.8 F4123; ISSN: 0015-0266

Descriptors: building materials/ fly ash/ lignite/ pesticides/ soil conditioners/ trace element fertilizers/ utilization/ micronutrient fertilizers

Abstract: The utilization of fly ash (from the combustion of lignite) in building materials, in pesticide formulations, as a trace element fertilizer and soil conditioner is briefly discussed. Its potential for use in ceramics manufacture, road building and detergent production is also considered. Reproduced with permission from the CAB Abstracts database.

191. Effectiveness of coal combustion by-products in controlling phosphorus export from soils.

Stout, W. L.; Sharpley, A. N.; and Landa, J.

Journal of Environmental Quality 29(4): 1239-1244. (2000)

NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: agriculture/ arsenic/ cadmium/ coal/ combustion products/ crops/ fly ash/ flyash/ freshwater pollution/ phosphorus/ pollution (soil)/ pollution (water)/ runoff/ soil/ soil contamination/ water pollution sources/ water quality control/ water quality control/ Brassica napus

Abstract: Phosphorus (P) export from high P soils is a

major cause of eutrophication in fresh waters. Recent work has shown that the solubility of P in high P soils can be reduced with coal combustion by-products (CCBs), decreasing the potential for dissolved phosphorus (DP) export from these soils. However, the effect of such treatments on plant-available P and P export has not been quantified. We measured P uptake by canola (*Brassica napus* L.) from three high P (130-370 mg kg super(-1) Mehlich-3 P) soils treated with two CCBs, fluidized bed combustion flyash (FBC), flue gas desulfurization (FGD) CaSO sub(4) anhydride, and agricultural gypsum (GYP). We measured DP, particulate phosphorus (PP), and total phosphorus (TP) concentrations in runoff from grassed and bare soils treated with these materials and subjected to simulated runoff. Phosphorus, As, Cd, and Pb uptake by canola were unaffected by CCB treatment, and dry-matter yields were unrelated to treatment. On grassed soils, FBC, FGD, and GYP reduced DP concentration in runoff by 20, 43, and 33%, respectively, but did not affect As, Cd, or Pb concentrations in runoff. Also on grassed soils, the high application rate of FGD reduced TP in runoff by 35%. On bare soils where erosion of PP controlled P loss, CCBs and GYP had no effect on DP concentration in runoff. Application of CCBs to high P soils in zones of high surface runoff potential, where there is little erosion, has the potential to reduce P export without affecting crop production.

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192. The effectiveness of coal fly-ash to decrease phosphorus loss from grassland soils.

McDowell, R. W.

Australian Journal of Soil Research 43(7): 853-860. (2005)
NAL Call #: 56.8 Au7; ISSN: 0004-9573

Descriptors: agricultural land/ arsenic/ cadmium/ fly ash/ grassland soils/ leaching/ lead/ losses from soil/ organic carbon/ overland flow/ phosphorus/ selenium/ soil organic matter/ soil strength/ soil toxicity/ soil types/ water quality/ farmland/ losses from soil systems/ organic matter in soil/ pasture soils/ toxic soils/ water composition and quality

Abstract: Phosphorus (P) loss from soils can impair surface water quality. A study was conducted to test the efficacy of fly-ash to decrease phosphorus loss in 11 grassland soils in New Zealand. A preliminary toxicity and leaching experiment indicated that heavy metal concentrations (As, Cd, Pb, Se) in leachate and pasture from a soil treated with ash up to 50 mg/kg were not different from the control (unamended soil). Heavy metal concentrations in the ash were generally below limits for maximum concentrations in soil. Following incubation of fly ash at a rate of 20 mg/kg for 3 months with 11 grassland soils packed into boxes, overland flow was generated by simulated rainfall on each boxed soil. Analysis of overland flow indicated that in 2 semi-arid soils, P loss decreased due to decreased particulate P (PP) loss and low organic C concentration (< 20 g/kg) that facilitated soil dispersion and slaking and increased soil strength. However, in 4 other soils (including 3 volcanic-ash soils with organic C>70 g/kg), P loss increased due to increased soil pH from 6 to 7 where P is most soluble. In all soils, despite an increase in P in recalcitrant soil P fractions, increased soil pH stimulated soil C and P mineralization (decreased organic

C by, on average, 4.1 g/kg), decreased soil organic P, and increased inorganic P in labile fractions. It is concluded that the application of fly-ash from this source should not be used as an amendment to decrease P loss in pastures where soil pH is commonly <6.0, but could provide useful both as a supplement to lime and in mitigating P loss in cropping soils.

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193. Effectiveness of indigenous and non-indigenous isolates of arbuscular mycorrhizal fungi in soils from degraded ecosystems and man-made habitats.

Enkhtuya, B.; Rydlova, J.; and Vosatka, M.

Applied Soil Ecology 14(3): 201-211. (2000)

NAL Call #: QH541.5.S6 A67

Descriptors: acid rain/ ash/ chemical properties/ degradation/ disturbed soils/ ecosystems/ fly ash/ habitats/ heavy metals/ indicators/ maize/ mycelium/ mycorrhizal fungi/ mycorrhizas/ plant pathogenic bacteria/ plant pathogens/ plant pathology/ power stations/ properties/ pyrites/ rain/ soil/ soil pollution/ stress/ stress factors/ symbiosis/ vesicular arbuscular mycorrhizas/ acid precipitation/ corn/ isolates/ phytopathogens/ phytopathology/ plant growth/ rainfall

Abstract: Culturing in soils from degraded ecosystems significantly influenced the effectiveness of indigenous arbuscular mycorrhizal fungi (AMF) isolated from disturbed and undisturbed soils. The AMF isolates from degraded or artificially created habitats (acid rain polluted site, power station fly ash deposits, spoil banks, pyrite deposit), were not, in most cases, more effective than those from undisturbed soils, when grown in symbiosis with maize in the disturbed soils. Significant effects of soil or substrate on plant growth were found, while the influence of the AMF inoculant was much less pronounced. The development of AMF isolates was reduced in soils with more adverse chemical properties irrespective of the isolate origin. The length of extraradical mycelium of AMF and NADH-diaphorase activity of the mycelium were good indicators of negative effects of stress factors in the soil.

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194. The effectiveness of industrial by-products to stop phosphorous loss from a Pallic soil.

McDowell, R. W.

Australian Journal of Soil Research 42(7): 755-761. (2004)

NAL Call #: 56.8 Au7; ISSN: 0004-9573

Descriptors: boron/ eutrophication/ fly ash/ industrial effluents/ industrial wastes/ pastures/ phosphorus/ slags/ soil pH/ grazing lands

Abstract: A study was conducted of the effectiveness of applying various rates (0-50 g/kg) of fly and bottom ash (<2 mm and 2-4 mm) from a coal-fired power plant, and melter (AP10B and PAP5) and basic (KOBM) slags from a steel-manufacturing plant on mitigating phosphorus (P) loss from a Pallic soil sown to pasture. Measurements were made of soil pH, Olsen P, and H₂O-P (as a measure of P loss in overland flow), and soluble P and contaminants (B, As, Cd, Pb, Se) from a weekly leaching regime for 9 weeks. Results shows that H₂O-P had decreased up to 40% in soils treated at the greatest rate of melter slag (50 g/kg), and increased in KOBM and fly ash treated soils. The effect on Olsen P relative to H₂O-P was much less in melter slag

and bottom ash treated soils than soils treated with fly ash or KOBM slag. The fly ash was considered unsuitable for the mitigation of P loss from soils due to B toxicity to plants, while KOBM is also unsuitable due to a liming effect and the increase in soluble P loss. At the rates applied, no treated soil leached toxic metals (As, Cd, Hg, or Se) above current guidelines. In contrast, the incorporation of melter slag and bottom ash is considered an effective P loss mitigation strategy.

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195. Effects of *Alternaria triticina* and foliar fly ash deposition on growth, yield, photosynthetic pigments, protein and lysine contents of three cultivars of wheat.

Singh, L. P. and Siddiqui, Z. A.

Bioresource Technology 86(2): 189-192. (2003)

NAL Call #: TD930.A32 ; ISSN: 0960-8524

Descriptors: chemical composition/ crop yield/ deposition/ dusting/ fly ash/ foliar application/ fungal diseases/ growth/ leaf area/ leaves/ lysine/ photosynthesis/ plant composition/ plant diseases/ plant pathogenic fungi/ plant pathogens/ protein content/ wheat/ carbon assimilation/ carbon dioxide fixation/ chemical constituents of plants/ foliar methods/ Hyphomycetes/ phytopathogens

Abstract: A greenhouse experiment was conducted to study the effects of *Alternaria triticina* with and without foliar dusting of fly ash (0.0, 2.5, 5.0, 7.5 g plant⁻¹/day⁻¹) on the growth, yield, photosynthetic pigments, protein and lysine contents of three cultivars of wheat, *Triticum aestivum*.

Dusting of 2.5 and 5.0 g fly ash caused a significant increase in growth, yield, photosynthetic pigments, protein and lysine contents of all the three cultivars. Dusting of 5.0 g fly ash caused a higher increase in the parameters than the 2.5 g dusting. However, dusting of 7.5 g fly ash had an adverse effect on growth, yield, photosynthetic pigments, protein and lysine contents. Cultivar HD-2009 suffered highest reductions in growth and yield and showed greater infected leaf area and disease symptoms from *A. triticina* followed by HD-2329 and Lok-1. Inoculation of *A. triticina* to plants dusted with 2.5/5.0 g fly ash gave higher reduction in growth and yield than did plants inoculated with *A. triticina* without fly ash. Cultivar Lok-1 showed highest growth, yield, photosynthetic pigments, protein and lysine contents followed by HD-2329 and HD-2009.

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196. Effects of clinker ash on the properties of jagaru soil, and growth and mineral composition of lettuce.

Kubotera, H.

Japanese Journal of Soil Science and Plant Nutrition 77(5): 541-548. (2006); ISSN: 0029-0610

Descriptors: ash/ bulk density/ chemical composition/ coal/ crop yield/ growth/ lettuces/ particle size distribution/ Regosols/ soil amendments/ soil chemical properties/ soil density/ soil physical properties/ soil salinity/ soil strength/ soil types/ soil water content/ water availability/ chemical properties of soil/ physical properties of soil/ rhesosols

Abstract: A gray Terrestrial Regosol called "Jagaru" that corresponds to Udorthent in the Soil Taxonomy is widely distributed in the southwestern islands of Japan. Jagaru is a heavy-textured smectitic soil and shows problematic

physical properties such as severe hardening by air-drying. In order to improve the physical properties, the effects of clinker ash, which is the coarse fraction of coal ash, on the properties of Jagaru, and growth and mineral composition of lettuce were investigated. Physical and chemical analysis of clinker ash revealed that it is a mixture of grains of various particle sizes and chemical composition. Total elemental composition of bulk clinker ash was similar to Jagaru. Application of clinker ash increased the available water content and reduced solid ratio, bulk density and the strength of air-dried soil blocks of Jagaru, and clinker ash was more effective for the improvement of these physical soil properties than river sand of the same quantity. On the other hand, pot cultivation experiments showed that the application of clinker ash does not increase the yield of lettuce, and heavy application of the ash caused a slight reduction of yield. The yield was remarkably small in the plot that was not watered before planting in order to reduce the salinity caused by ash. The effect of clinker ash on the improvement of the soil physical properties was greater than sand and an inverse effect was observed for lettuce growth and cost for the transportation of ash. A suitable application rate was assumed to be around 10% of topsoil which corresponds to 240 t ha⁻¹. No problematic effect such as heavy metal accumulation in the plant was caused by ash application.

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197. Effects of coal fly ash amended soils on trace element uptake in plants.

Brake, S. S.; Jensen, R. R.; and Mattox, J. M.

Environmental Geology 45(5): 680-689. (2004)

NAL Call #: QE1.E5; ISSN: 0943-0105

Descriptors: antimony / arsenic/ barium/ bioavailability/ bismuth/ cadmium/ coal/ cobalt/ copper/ crop growth stage/ fly ash/ growth/ lead/ manganese/ marrows/ mercury/ molybdenum/ nickel/ phytotoxicity/ selenium/ soil amendments/ sunflowers/ temporal variation/ thallium/ thorium/ tin/ tomatoes/ trace elements/ tungsten/ uptake/ uranium/ zinc/ courgettes/ microelements/ Mn/ Mo/ United States of America/ zucchini

Abstract: Variations in As, Ba, Bi, Cd, Co, Cu, Hg, Mn, Mo, Ni, Pb, Sb, Se, Sn, Th, Tl, U, W, and Zn uptake were evaluated in young, middle-aged, and mature basil, tomato, zucchini, and sunflower plants grown in soils amended with 5, 10, and 20% by weight fly ash. Elements susceptible to uptake with increasing fly ash were As and Tl, with As exceeding potentially toxic levels in basil and zucchini. Temporal variations in element uptake included (1) increasing Ba and Cd concentrations in tomato and As, Ba, Cd, and Tl in zucchini, (2) decreasing Co concentrations in tomato, zucchini, and sunflower, Ni in zucchini, and Tl in basil, and (3) increasing As and Ni concentrations in basil and Pb in zucchini and sunflower during early growth followed by decreasing concentrations at maturity. Although most of the trace elements were below reported toxic levels, the elevated concentrations of As in plant tissue suggests that fly ash treatment programs can lead to potentially toxic accumulations of As, and thus, should be carefully monitored.

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198. Effects of compost, coal ash, and straw amendments on restoring the quality of eroded Palouse soil.

Cox, D.; Bezdicek, D.; and Fauci, M.

Biology and Fertility of Soils 33(5): 365-372. (May 2001)

NAL Call #: QH84.8.B46; ISSN: 0178-2762

Descriptors: *Hordeum vulgare/ Pisum sativum/ Triticum aestivum/ eroded soils/ composts/ ash/ straw/ soil amendments/ soil fertility/ soil chemistry/ nitrogen fertilizers/ soil biology/ crop yield/ carbon nitrogen ratio/ phosphorus/ potassium/ nitrogen/ nutrient availability/ cation exchange capacity/ bulk density / soil texture/ enzyme activity/ microbial activity/ application rate/ soil aggregates/ Washington/ infiltration*

Abstract: Ridgetops in the dryland farming region of eastern Washington suffer from low productivity and poor soil quality from years of erosion. Two studies investigated the effectiveness of soil amendments in restoring soil quality. Study 1 treatments were two rates of compost and a control. Study 2 treatments were compost, coal ash, wheat straw, three rates of inorganic N, and a control. A wide array of soil biological, chemical and physical parameters were measured from 1995 to 1997 and yield of spring barley, spring pea, and winter wheat were measured in different years from 1995 through 1998. In study 1, compost plus N increased barley yield and soil pH. Compost without N in study 2 increased total soil C and continued to immobilize soil N 2 years after incorporation because of the high C:N ratio of the compost. Total soil N, available P and K, some micronutrients, and cation exchange capacity were increased by the compost. Compost reduced soil bulk density and soil impedance, while increasing water-stable aggregates and improving infiltration. Coal ash slightly suppressed phosphatase activity, while tending to increase pH and soil B, and improving infiltration. Straw decreased soil bulk density and microbial activity in 1996 only. Barley grain trace element uptake, barley yield, and pea yield were uninfluenced by amendments. In 1998, 3 years after application of the amendments, winter wheat yield was significantly higher from the compost application than from any other treatments. Compost had the greatest benefit to improving soil quality and crop yield.

This citation is from AGRICOLA.

199. Effects of cow manure on release regulation of microelements in coal bottom ash.

Li Fahu and Keren, R.

Transactions of the Chinese Society of Agricultural Engineering 20(6): 260-265. (2004)

NAL Call #: S671.N8; ISSN: 1002-6819

Descriptors: *arsenic/ ash/ barium/ boron/ cadmium/ cattle manure/ chromium/ cobalt/ copper/ cows/ leachates/ leaching/ lime/ lithium/ manganese/ molybdenum/ nickel/ selenium/ strontium/ tin/ titanium/ trace elements/ vanadium/ zinc/ microelements/ Mn/ Mo*

Abstract: The release regulation of microelements from bottom ash under rainfall condition was studied in laboratory. The treatments include: bottom ash, bottom ash + lime, bottom ash + lime + cow manure and incubation of bottom ash + lime + cow manure. Results indicated that the maximum concentrations of B, Sr, Ba and Li in leachate were higher than 1 mg/litre, while the concentrations of the other microelements were lower than this value. The application of lime increased the concentrations of B and

Ba but decreased those of Li, Mo and Cr in the leachate. The application of cow manure and the incubation of bottom ash and cow manure mixture increased concentrations of B, Mo, Zn, V, Cu, Ni, Cd, As, Mn, Ti, Co, Sn and Se, but decreased those of Sr, Ba, Li and Cr. Except V, the concentrations of all microelements in leachate decreased with the increase of leachate volume. Cr, Zn, Cd, Cu and As are the main microelements from bottom ash that may impose potential adverse impact on the environment.

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200. Effects of different rates of fly ash and sewage sludge mixture amendments on cation availability and their leachability.

Sajwan, K. S.; Paramasivam, S.; and Alva, A. K.

Journal of Environmental Science and Health Part A, Toxic/Hazardous Substances and Environmental Engineering 42(8): 1155-1160. (2007)

NAL Call #: TD172.J6; ISSN: 1093-4529

Descriptors: *application rates/ cations/ fly ash/ leaching/ sandy soils/ sewage sludge/ soil amendments/ soil pH/ soil types/ United States of America*

Abstract: A leaching column study was conducted to evaluate the leaching of cations from soils amended with a mixture of (1:1) fly ash (FA) from Port Wentworth power plant, Savannah, GA: sewage sludge (SS) from President Street water pollution control plant, Savannah, GA. Two sets of soil-leaching columns (30-cm high and 7.5-cm diameter; 15 columns per soil) were prepared with a fine sandy soil from Florida (Candler fine sand; pH 6.8) and Georgia (Ogeechee loamy sand; pH 5.6). The top one inch of soil from each of these columns was amended (3 columns per treatment) with 1:1 mixture of SS and FA at either 0, 24.7, 49.4, 98.8 or 148.3 Mg ha⁻¹ rate. After saturating the columns with deionized water, 18 cycles of intermittent leaching and drying was performed on weekly basis. Leaching of major cations and changes in ionic strength and pH were evaluated on half pore volume (220 mL) of leachate collected at each event. Results of this study indicated that leaching of cations increased rapidly up to the 3rd leaching event, and then rapidly decreased and the concentration of cations reached somewhat similar to that of unamended soil columns. Effects of soil type and rates of amendments on leaching of major cations along with changes of pH and ionic strength are discussed in this paper.

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201. Effects of different sources of sulphur on growth and yield performance of blackgram.

Poonkodi, P. and Deepa, B.

Journal of Ecobiology 15(6): 437-440. (2003)

NAL Call #: QH540.J56 ; ISSN: 0970-9037

Descriptors: *black gram/ crop quality/ crop yield/ filter cake/ fly ash/ growth/ gypsum/ lignite/ protein content/ pyrites/ sulfur fertilizers/ clarification mud/ sulphur fertilizers*

Abstract: A pot culture experiment was conducted on a clay loam soil to study the effect of different sources of S (applied in equivalent amounts to supply 40 kg S/ha), i.e. gypsum (250 kg/ha), pyrite (228 kg/ha), lignite flyash (LFA, 4 tonnes/ha), pressmud (PM, 6 tonnes/ha) and LFA+PM (2+3 tonnes/ha), on the growth and yield performance of

black gram cv. ADT3. Gypsum recorded the maximum seed yield of 4.22 g pot⁻¹ over control, recording 2.48 g pot⁻¹. The treatment next in order was LFA+PM combination, followed by LFA alone, pyrite and pressmud. Quality attribute, i.e. protein content, also followed the same trend. Each treatment was significantly different from each other. Reproduced with permission from the CAB Abstracts database.

202. Effects of farming soil treated with fly-ash on soil structure and erosion through artificial rainfall simulation.

Duan XiMing; Wu Pute; Wang ChunHong; and Feng Hao
Transactions of the Chinese Society of Agricultural Engineering 22(8): 50-53. (2006)

NAL Call #: S671.N8; ISSN: 1002-6819

Descriptors: agricultural soils/ bulk density/ erosion/ fly ash/ infiltration/ porosity/ runoff/ sediment/ sediment yield/ soil conservation/ soil density/ soil structure

Abstract: Through artificial rainfall simulation, the farming soil structure and infiltration, water and sediment yields were studied under different slopes from 0 degrees to 20 degrees and different contents of fly ash from 0 to 10%. Results show that with the increase of fly ash content in the soil, soil infiltration rate obviously increased. Infiltration rate after treatment with 10% fly ash improved by 55.34% compared with the soil without fly ash. Soil bulk density decreased and soil porosity increased after adding fly ash. Compared with the contrast soil, the bulk density of the soil with 10% fly ash reduced by 17.42%, and porosity improved by 9.84% at the 10 degrees -slope. Runoff yield and soil losses decreased under the same conditions. Runoff yield of the soil with 10% fly ash accounted for 26.87% of that of the comparison at the 20 degrees -slope. Therefore, after addition of 10% fly ash in the cultivated soil layers, soil structure could be improved effectively. Furthermore, runoff and sediment are intercepted resulting to higher practical value.

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203. Effects of field application of fly ash on the growth and yield of chilli, eggplant and tomato in the presence and absence of root knot nematode.

Khan, M. R. and Ghadirpour, M. H.

Zeitschrift fur Pflanzenkrankheiten und Pflanzenschutz 106(6): 624-632. (1999)

NAL Call #: 464.8 Z3; ISSN: 0340-8159

Descriptors: aubergines/ carotenoids/ chemical control/ chlorophyll/ control/ fly ash/ fruit vegetables/ growth/ nematicides/ nematology/ organic amendments/ plant parasitic nematodes/ tomatoes/ vegetables/ yields/ brinjal/ eelworms/ eggplants/ plant/ Secernentea/ tetraterpenoids/ Tylenchida/ vegetable crops

Abstract: Fly ash @ 0.6 kg/m² was applied to soil in field plots as spot, row or broadcast treatments. The plots were planted with chilli, egg plant and tomato, and half of each treatment was inoculated with *Meloidogyne incognita*. Row or broadcast treatment significantly increased plant growth and yield of the vegetables, but spot application did not. Carotenoids and chlorophylls content of leaves were also increased due to fly ash application. The three treatments of fly ash decreased the number of galls and egg masses caused by *M. incognita* and soil population

of the nematode. The egg masses excised from the fly ash-grown plants contained fewer eggs. Row application of fly ash greatly enhanced the yield (weight of fruits/plant) of inoculated and uninoculated chilli, egg plant and tomato plants by 28.7 and 30.3%, 33.2 and 51.45%, and 95 and 67.7%, respectively, compared with plants grown in the plot not treated with fly ash.

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204. Effects of fly ash and *Alternaria triticina* on the yield, protein and lysine contents of three cultivars of wheat.

Singh, L. P. and Siddiqui, Z. A.

Thai Journal of Agricultural Science 35(4): 397-405. (2002); ISSN: 0049-3589

Descriptors: chemical composition/ crop yield/ cultivars/ fly ash/ fungal diseases/ liming materials/ loam soils/ lysine/ plant composition/ plant diseases/ plant pathogenic fungi/ plant pathogens/ protein content/ soil amendments/ soil types/ susceptibility/ varietal reactions/ wheat/ chemical constituents of plants/ cultivated varieties/ Hyphomycetes/ phytopathogens

Abstract: A greenhouse experiment was conducted to study the effects of fly ash (0, 20, 40, 60, 80 and 100% v/v) combined with loam soil (71, 18 and 11% sand, silt, and clay, respectively) and *Alternaria triticina* on the yield and protein and lysine contents of wheat cultivars Lok-1, HD-2329, and HD-2009. The application of 20 and 40% fly ash with soil significantly increased the yield and protein and lysine contents of all the cultivars, where 40% fly ash level resulted in the greatest increase in these three components. Fly ash amendments of 60, 80 and 100% had an adverse effect on the three components in all the cultivars, with 100% fly ash level having the most significant adverse effect. Inoculation of *A. triticina* had an adverse effect on the yield and protein and lysine contents in all the cultivars. HD-2009 exhibited the greatest infected leaf area and showed the highest number of disease symptoms caused by *A. triticina* followed by HD-2329 and Lok-1. Plants grown in 100% fly ash suffered higher reduction in yield when inoculated with *A. triticina* than plants grown in soil without fly ash. In general, high yield and protein and lysine contents were observed in Lok-1 followed by HD-2329 and HD-2009.

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205. Effects of fly ash and *Helminthosporium oryzae* on growth and yield of three cultivars of rice.

Singh, L. P. and Siddiqui, Z. A.

Bioresource Technology 86(1): 73-78. (2003)

NAL Call #: TD930.A32 ; ISSN: 0960-8524

Descriptors: application rates/ crop yield/ fly ash/ growth/ rice/ paddy/ Pleosporaceae

Abstract: A 120-day greenhouse experiment was conducted to study the effects of various fly ash concentrations (0, 20, 40, 60, 80 and 100% vol/vol) with normal field soil and *Helminthosporium oryzae* [*Cochliobolus miyabeanus*] on the growth and yield of three cultivars (Pusa Basmati, Pant-4 and Pant-10) of rice, *Oryza sativa*. Application of 20 and 40% fly ash with soil caused a significant increase in plant growth and yield of all the three cultivars. Forty percent fly ash caused a higher increase in growth and yield than did 20%. Sixty percent, 80 and 100%

fly ash had an adverse effect on growth and yield of all the three cultivars, the maximum being with 100% fly ash. Inoculation of *H. oryzae* had an adverse effect on the growth and yield, Pant-10 suffered higher damage by *H. oryzae* than Pusa Basmati and Pant-4. Pant-10 also exhibited higher infected leaf area and greater disease symptoms of *H. oryzae* than did Pusa Basmati and Pant-4. Plants grown in 100% fly ash suffered higher reductions in growth and yield with *H. oryzae* than plants grown in pure soil or in 20 or 40% fly ash. In general, plant growth was best in Pusa Basmati followed by Pant-4 and Pant-10, while yield was higher in Pant-4 followed by Pant-10 and Pusa Basmati.

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206. Effects of fly ash and sewage sludge amendments on transport of metals in different soils.

Alva, Ashok K.; Paramasivam, S.; Prakash, O.; Sajwan, Kenneth S.; Ornes, W. H.; and van Clief, D.

In: Fourth international conference on the biogeochemistry of trace elements. Berkeley, CA, United States.) Sajwan, Kenneth S.; Alva, Ashok K; and Keefer, Robert F. (eds.); 1999.

Descriptors: alkalinity/ ash/ biochemistry/ chemical properties/ clastic sediments/ concentration/ effects/ geochemistry/ leachate/ loam/ mixing/ nitrogen/ nutrients/ pH/ phosphorus/ sand/ sediments/ sewage sludge/ soils/ transport/ utilization/ geochemistry of rocks, soils, and sediments

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207. Effects of fly ash and soil micro-organisms on plant growth, photosynthetic pigments and leaf blight of wheat.

Siddiqui, Z. A. and Singh, L. P.

Zeitschrift fur Pflanzenkrankheiten und Pflanzenschutz 112(2): 146-155. (2005)

NAL Call #: 464.8 Z3; ISSN: 0340-8159

Descriptors: application rates/ biological control/ biological control agents/ cation exchange capacity/ conductivity/ cultural control/ fly ash/ fungal antagonists/ fungal diseases/ growth/ inoculation/ mineral content/ plant disease control/ plant diseases/ plant pathogenic fungi/ plant pathogens/ plant pigments/ porosity/ soil amendments/ soil bacteria/ soil fertility/ soil fungi/ soil ph/ water holding capacity/ wheat/ biocontrol agents/ biological control organisms/ Glomaceae/ Hyphomycetes/ phytopathogens

Abstract: Effects of different fly ash concentrations (0, 20, 40%) and soil microorganisms (*Pseudomonas fluorescens*, *Azotobacter chroococcum*, *Glomus mosseae* and *Aspergillus awamori*) on the plant growth, photosynthetic pigments and leaf blight of wheat (*Triticum aestivum*) caused by *Alternaria triticina* were studied in a glasshouse experiment. Amendments of soil with fly ash increased contents of minerals except nitrogen. Moreover, conductivity, pH, porosity, water-holding capacity and cation exchange capacity were also found to be increased with the addition of fly ash to soil. Addition of 20 and 40% fly ash to soil increased growth and photosynthetic pigments of wheat, maximum being with 40% fly ash. However, addition of fly ash had no visible effect on *Alternaria triticina*-infected leaf area. Inoculation of

beneficial soil microorganisms increased plant growth and photosynthetic pigments and reduced the percentage of infected leaf area. *Glomus mosseae* caused the greatest increase in plant growth and photosynthetic pigments and greater reduction in percent infected leaf area followed by *P. fluorescens*, *Aspergillus awamori* and *Azotobacter chroococcum*.

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208. Effects of fly ash applications on soil properties, nutrient status and environment in Northern Thailand.

Inthasan, J.; Hirunburana, N.; Herrmann, L.; and Stahr, K. Bangkok, Thailand.); pp. 249; 2002.

Descriptors: application rates/ arsenic/ boron/ calcium/ cobalt/ fly ash/ heavy metals/ iron/ lead/ magnesium/ manganese/ nickel/ nutrients/ soil amendments/ soil parent materials/ soil types/ Mn

Reproduced with permission from the CAB Abstracts database.

209. The effects of fly ash-containing sludge amendment on nitrogen content and urease activity of soils.

Topac, F. O.; Baskaya, H. S.; and Alkan, U.

Fresenius Environmental Bulletin 16(5): 532-536. (2007); ISSN: 1018-4619

Descriptors: adverse effects/ ammonium nitrate/ chemical composition/ clay soils/ fly ash/ monitoring/ nitrate/ nitrogen/ sludges/ soil/ soil types textural/ urease/ waste water/ adverse reactions/ surveillance systems

Abstract: The present study was undertaken to demonstrate the effects of fly-ash addition to sludges on nitrogen content and urease activity of soils. Wastewater sludges added with varying doses of fly-ash (40, 80 and 120%, on dry weight basis) were amended to a clay soil, and the variations in ammonium, nitrate and total nitrogen contents and urease activities were monitored during incubation at 28 degrees C for 360 days. Co-application of fly-ash and wastewater sludge, especially at the dose of 120% fly-ash, caused an initial decrease in inorganic nitrogen and urease activity levels in contradiction to sludge-only application. However, after the first 3 months of incubation, this adverse effect almost disappeared. Application of fly-ash/sludge mixture to soil with appropriate dosages (<120%) may not affect the microbiological processes occurring in soil system.

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210. Effects of fly ash from coal-burning electrical utilities on ecosystem and utilization of fly ash.

Baba, Alper and Usmen, Mumtaz A. Canakkale, Turkey.) Baba, Alper; Howard, Ken W. F.; and Gunduz, Orhan (eds.); Vol. 70.

Netherlands (NLD); pp. 15-31; 2006.

Notes: Conference: NATO Advanced Research Workshop on Groundwater and Ecosystems; ISSN: 1568-1238.

Descriptors: actinides/ aquatic environment/ ash/ chemical properties/ coal/ combustion/ concentration/ degradation/ discharge/ dissolved materials/ ecosystems/ energy sources/ environmental management/ hazardous waste/ heavy metals/ isotopes/ leaching/ metals/ pH/ pollution/

power plants/ radioactive isotopes / recycling/ sedimentary rocks/ sludge/ soils/ Th-232/ thorium/ toxicity/ trace elements / U-238/ uranium/ waste management/ water quality/ Environmental geology
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211. Effects of fly ash, gypsum, and shell on the chemical properties of soil and growth of Chinese cabbage in acidic soils.

Ha, H. S.; Lee, H.; Lee, Y. B.; and Kang, Y. G.
Korean Journal of Environmental Agriculture 17(2): 164-169. (1998); ISSN: 1225-3537.
Notes: 1 illu.; 7 tables; 32 ref. Summaries (En, Ko).
Descriptors: fly ash/ gypsum/ shell/ soils: chemical properties, growth/ Chinese cabbage/ acidic soils
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212. Effects of fly ash incorporation on heavy metal accumulation, growth and yield responses of Beta vulgaris plants.

Singh, A.; Sharma, R. K.; and Agrawal, S. B.
Bioresource Technology 99(15): 7200-7. (Oct. 2008)
NAL Call #: TD930.A32 ; ISSN: 0960-8524 . 18280142
Descriptors: Beta vulgaris: growth & development: metabolism/ Carbon: metabolism/ Crops, Agricultural: growth & development: metabolism/ Metals, Heavy: metabolism/ Particulate Matter: metabolism
Abstract: Use of fly ash (FA) to agriculture is not always beneficial, however, utilization of lower concentration of FA as soil amendment is suitable for better management of few crops. The present study was conducted to study the effects of various concentrations of FA (0%, 5%, 10%, 15% and 20%) on heavy metal accumulation, growth, and yield responses of palak (*Beta vulgaris* L. var All Green H1). The results showed that application of FA caused significant reductions in growth, biomass and yield responses of *B. vulgaris* plants at different ages of observations. The concentrations of all the heavy metals increased significantly with increasing concentrations of FA. Metal pollution index (MPI) of both roots and shoots showed significant and negative relationships with the yield of *B. vulgaris* plants. The study concludes that *B. vulgaris* plant is sensitive to FA concentrations used in this study. It is further recommended that leafy vegetable like *B. vulgaris* is not a suitable crop to be grown in a region where FA is used for amendment of agricultural soils.
This citation is from PubMed.

213. Effects of fly ash on rice-groundnut cropping system in lateritic soil.

Pradhan, K. C.; Sahu, S. K.; and Samanta, P. K.
International Arachis Newsletter 24: 49-50. (2004); ISSN: 1010-5824
Descriptors: application rates/ crop yield/ cropping systems/ farmyard manure/ fly ash/ groundnuts/ nitrogen fertilizers/ NPK fertilizers/ phosphorus fertilizers/ potassium fertilizers/ residual effects/ rice/ sequential cropping/ trace element fertilizers/ FYM/ micronutrient fertilizers/ paddy/ peanuts/ phosphate fertilizers/ potash fertilizers
Abstract: An experiment was conducted to study the direct and residual effects of fly ash on rice-groundnut (cv. AK 12-24) system in Orissa, India, during the 1999/2000 rabi

season. The treatments comprised: 20 and 40 t fly ash/ha; 10 t farmyard manure (FYM)/ha; and recommended NPK (80:17:33 kg/ha) alone and in combination with NPK and FYM. The highest yields of rice (3.8 t/ha) and groundnut (1.4 t/ha) with high shelling outturn (70%) and oil content were obtained with 40 t fly ash/ha, 5 t FYM/ha and 50% recommended dose of NPK.
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214. Effects of fly ash on soil characteristics, plant growth and soil microbial populations.

Siddiqui, Z. A. and Singh, L. P.
Heavy Metal Contamination of Soil: Problems and Remedies: 171-193. (2005)
Descriptors: application rates/ application to land/ aromatic hydrocarbons/ crop yield/ cycling/ dioxins/ electrical conductivity/ fly ash/ growth/ heavy metals/ inorganic compounds/ microbial activities/ microorganisms/ nutrient content/ organic compounds/ phenols/ physicochemical properties/ phytotoxicity/ polycyclic hydrocarbons/ seed germination/ seedlings/ soil amendments/ soil chemical properties/ soil pH/ soil physical properties/ soil properties/ toxicity/ waste management/ waste utilization/ chemical properties of soil/ land application/ micro organisms/ microbial communities/ organic chemicals/ physical properties of soil/ polycyclic aromatic hydrocarbons
Abstract: Utilization of fly ash is a practical and important waste management issue, and agronomic uses of fly ash are being explored as a means of disposal. Fly ash changes the physico-chemical properties of soil. Ash applications increase soil pH and electrical conductivity. Fly ash contains numerous plant nutrients and improves the nutritional status of soil. The effects of fly ash amendment on plants include improvements in seed germination and seedling growth, plant growth and yield. However, it also contains heavy metals and other compounds (e.g., inorganic compounds, organic compounds, polycyclic aromatic hydrocarbons, phenols, dioxins, and leachable compounds within fly ash) which are toxic to plants and microbes. Fly ash changes microbial populations and negatively affects cycling of nutrients. Over-application of fly ash can cause toxicity to animals grazing on recipient soils. Various plant pathogens show variable response to their host plants in fly ash-amended soil. Extensive field trials are required for making proper recommendations of doses of fly ash amendments to soil.
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215. Effects of fly ash pH on the uptake of heavy metals by chicory.

Scotti, I. A.; Silva, S.; and Baffi, C.
Water, Air and Soil Pollution 109(1/4): 397-406. (1999)
NAL Call #: TD172 .W36; ISSN: 0049-6979
Descriptors: availability/ biochemistry/ cadmium/ chicory/ copper/ fly ash/ heavy metals/ nickel/ NPK fertilizers/ pH/ plant composition/ plant nutrition/ pollution/ potassium/ soil/ soil pH/ uptake/ vegetables/ zinc/ chemical constituents of plants/ environmental pollution/ hydrogen ion concentration/ potential of hydrogen/ vegetable crops
Abstract: Chicory was cultivated in a pot experiment in 2 soils of different pH amended with NPK, fly ash (pH 8) +

NP, or fly ash (pH 12) + NP. Another series of pots received heavy metals in soluble form additionally to the described treatments. Fly ash generally decreased Zn, Cd, Ni and Cu concentrations of chicory. The reduction occurred both for the metals naturally present in the soil and, to a greater extent, for those added as salts. This effect was more evident when fly ash at pH 12, rather than at pH 8, was used. The increase of soil-pH through fly ash addition was the major factor decreasing heavy metal availability. K originating from fly ash was not available for crop uptake. Reproduced with permission from the CAB Abstracts database.

216. Effects of fly ash, *Pseudomonas striata* and *Rhizobium* on the reproduction of nematode *Meloidogyne incognita* and on the growth and transpiration of pea.

Siddiqui, Z. A. and Singh, L. P.

Journal of Environmental Biology 26(1): 117-122. (2005)

NAL Call #: QH540.J65 ; ISSN: 0254-8704

Descriptors: colonization/ fly ash/ galls/ growth/ nitrogen fixing bacteria/ nodulation/ peas/ phosphate solubilizing bacteria/ plant nematology/ plant parasitic nematodes/ plant pests/ reproduction/ soil amendments/ transpiration/ eelworms/ pea/ *Secernentea*/ *Tylenchida*

Abstract: Glasshouse experiments were conducted twice to assess the effect of ash amendments (0, 20, and 40% with soil), phosphate solubilizing microorganism *Pseudomonas striata* (Ps), and root nodule bacterium *Rhizobium* sp. (Rh) on the reproduction of root-knot nematode *Meloidogyne incognita*, and on the growth and transpiration of pea both in the presence and in the absence of the root-knot nematode. The effect of fly ash on nodulation and root colonization by Ps was also assessed. Amendments of fly ash with soil had no effect on transpiration. However, *M. incognita* reduced the rate of transpiration from the first week onwards after the inoculation, while inoculation of *Rhizobium* sp. and *P. striata* increased the transpiration from the first week onwards after the inoculation, both in the nematode-inoculated and uninoculated plants. Increase in transpiration was greater when Rh and Ps were inoculated together. The addition of 20 and 40% fly ash with soil was beneficial for plant growth both in nematode-inoculated and uninoculated plants. The inoculation of the organisms also increased the growth of nematode-inoculated and uninoculated plants in different fly ash soil mixture, but growth increase was greater when Rh and Ps were inoculated together. The use of 20% fly ash increased galling and nematode multiplication compared to plants grown without fly ash, while 40% fly ash had an adverse effect on galling and nematode multiplication. Rh had greater adverse effect on galling and nematode multiplication than Ps. The use of Rh and Ps together had greater adverse effect on galling and nematode multiplication than either of them alone. The highest reduction in galling and nematode multiplication was observed when Rh and Ps were used in 40% fly ash amended soil. However, the highest transpiration was observed in plants without nematodes, and inoculated with Rh and Ps in fly ash amended and unamended soil. Reproduced with permission from the CAB Abstracts database.

217. Effects of high rates of coal fly ash on soil, turfgrass, and groundwater quality.

Adriano, D. C.; Weber, J.; Bolan, N. S.; Paramasivam, S.; Koo, B. J.; and Sajwan, K. S.

Water, Air and Soil Pollution 139(1/4): 365-385. (2002)

NAL Call #: TD172 .W36; ISSN: 0049-6979

Descriptors: aluminium/ antimony/ arsenic/ barium/ beryllium/ boron/ cadmium/ calcium/ chromium/ copper/ fly ash/ groundwater pollution/ iron/ lawns and turf/ lead/ magnesium/ manganese/ mercury/ mineral content/ molybdenum/ nickel/ nitrogen/ nutrient content/ plant nutrition/ plant tissues/ polluted soils/ polluted water/ potassium/ selenium/ silver/ soil amendments/ soil chemical properties/ soil pH/ soil pollution/ soil salinity/ soil types/ thallium/ water quality/ zinc/ aluminum/ chemical properties of soil/ lawns and sports turf/ Mn/ Mo/ soil quality/ United States of America/ water composition and quality

Abstract: A field study (1993-96) in the USA assessed the effects of applying unusually high rates of coal fly ash as a soil additive for the turf culture of centipedegrass (*Eremochloa ophiuroides*). In addition, the quality of the soil and the underlying groundwater was evaluated. A latin square plot design was employed to include 0 (control, no ash applied), 280, 560, and 1120 t ha⁻¹ application rates of unweathered precipitator fly ash. The once applied fly ash was rototilled and allowed to weather for 8 months before sowing. Ash application significantly increased the concentrations in plant tissue of B, Mo, As, Be, Se, and Ba while also significantly reducing the concentrations of Mg, Mn, and Zn. The other elements measured (i.e., N, K, Ca, Cu, Fe, Ag, Cd, Cr, Hg, Ni, Pb, Sb, Tl, Na, and Al) were not affected. Of these elements Mg, Cu, and Mo concentrations in plant tissue increased with time while B and Se decreased temporally. The diminution of B and Na appears to be related to the leaching of soluble salts from ash-treated soils. Of all the elements measured, only Mn produced significant correlation (P=0.0001) between the tissue and soil extractable concentrations. Ash treatment elevated the soil pH to as high as 6.45 with the enhanced effect occurring primarily in the 0-15 cm depth. Soil salinity increased with the application rate with the largest increases occurring in the initial year of application. However, by the second year, most of the soluble salts had already leached from the treatment zone into deeper depths, and by the fourth year, these salts had completely disappeared from the profile. The chemical composition of the underlying groundwater was not adversely impacted by the ash application. Plant tissue and groundwater data however, indicate that much higher rates of fly ash can be used on this type of land use where the plant species is tolerant of soil salinity and does not appear to bioaccumulate potentially toxic trace elements. Reproduced with permission from the CAB Abstracts database.

218. Effects of lignite fly ash, pressmud and inorganic fertilizers on the growth performance of blackgram.

Deepa, B. and Poonkodi, P.

Journal of Ecobiology 16(2): 147-150. (2004)

NAL Call #: QH540.J56 ; ISSN: 0970-9037

Descriptors: application rates/ black gram/ clay loam soils/ fertilizers/ filter cake/ fly ash/ growth/ lignite/ soil types/ clarification mud/ Madras

Abstract: A field experiment was conducted in a clay loam soil in Tamil Nadu, India, to investigate the effects of

inorganic fertilizers, lignite fly ash (LFA) and pressmud (PM) on the growth performance of black gram. The results revealed that application of 100% recommended dose of fertilizer (RDF) along with LFA at 5 t ha⁻¹ and pressmud at 6 t ha⁻¹ significantly enhanced the growth of black gram followed by 75% RDF. However, 100 and 75% RDF were not significantly different from each other when applied along with LFA and pressmud.

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219. Effects of nitrogenous and phosphoric fertilizers, coal fly ash and CaCO₃ on bioeffect of wheat seedling and As(III) content of grain in mature with As stress.

Li ChunXi; Shao Yun; Hou XiaoLi; Jiang LiNa; and Feng ShuLi

Research of Environmental Sciences 20(6): 49-55. (2007); ISSN: 1001-6929

Descriptors: arsenic/ biomass/ calcium carbonate/ chemical composition/ chlorophyll/ fly ash/ nitrogen fertilizers/ phosphorus fertilizers/ phytotoxicity/ plant composition/ plant height/ proline/ seed germination/ seedling emergence/ seedling growth/ seedlings/ seeds/ wheat/ chemical constituents of plants/ phosphate fertilizers

Abstract: The effects of N and P fertilizers, coal fly ash (CFA) and CaCO₃ on wheat germination, seedling growth and seed As content were studied in a greenhouse pot experiment on As-polluted soil. The N fertilizer, P fertilizer, CFA and CaCO₃ enhanced seed germination and seedling growth, alleviated the toxicity of As on wheat, and reduced the As content of seeds at the maturity stage, resulting in increases in the rate of emergence, seedling height, fresh weight and content of chlorophyll a, and reduction in the concentrations of MDA [malondialdehyde], free proline and As in grains.

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220. Effects of soil acidity and cropping on solubility of by-product immobilized phosphorus and extractable aluminum, calcium, and iron from two high-phosphorus soils.

Codling, Eton Elsworth

Soil Science 173(8): 552-559. (Aug. 2008)

NAL Call #: 56.8 So3; ISSN: 0038-075X

Descriptors: sandy soils/ silt loam soils/ acid soils/ soil pH / acidification/ water solubility/ phosphorus/ aluminum/ calcium/ iron/ soil amendments/ industrial wastes/ coal fly ash/ immobilization in soil/ drinking water treatment residue/ coal combustion bed ash/ Internet resource

Abstract: Large quantities of by-products and increased costs for landfill have heightened interest in using by-products as soil amendments on agricultural lands. There are concerns of potential negative environmental impacts of by-product-amended soils when fields are taken out of agricultural production or polluted area. The objective of this study was to determine the effects of lowering soil pH and cropping on the solubility of phosphorus (P) immobilized by drinking water treatment residue (WTR) and coal combustion bed ash (BA). Two high-P soils (Evesboro sand and Matapeake silt loam) were mixed with two WTR and a BA and incubated for 15 weeks using several wetting and drying cycles. From 15 to 33 weeks, elemental sulfur

and 1N H₂SO₄ were used to adjust soil pH to levels found in the wooded areas adjacent to agricultural fields. Acidified soils were planted with Bermudagrass. By-products reduced extractable P in both soils. Mehlich-3-extractable P that was immobilized in the by-product-amended Matapeake soil did not become soluble after acidification and cropping. Water-extractable P was significantly higher for the control and BA treatments after acidification and cropping. The water-extractable P that was immobilized by WTR before acidification did not become soluble under acidic and cropping conditions in either soil. Although soil aluminum and iron concentrations were higher under acidification and cropping, it was concluded that they were not at levels that would negatively impact the environment. This citation is from AGRICOLA.

221. Effects of soil additives on spring barley yield and some soil parameters.

Kovacik, P.

Acta Fytotechnica et Zootechnica 9(1): 5-10. (2006); ISSN: 1335-258X.

Notes: Original title: Vplyv nepriamych hnojiv na urodu jacmena jarneho a niektore parametre pody.

Descriptors: arsenic/ barley/ barley straw/ basalt/ cobalt/ crop yield/ fly ash/ heavy metals/ mercury/ nickel/ sodium humates/ soil amendments/ soil pH/ straw

Abstract: The effects of soil additives (Nobasyp, Agrodrap, sodium humate and fly ash mixture) on spring barley yield and some agrochemical and pedological parameters of the soil were investigated in a pot experiment on brown soil (Haplic Luvisol). The experiment was conducted in the vegetative cage placed on the territory of the Slovak Agricultural University, Nitra (48 degrees 18'N, 18 degrees 5'E). Results showed that all tested potential soil additives increased grain and straw yields and decreased the content of starch, a rate of their significance being different. The application of Nobasyp significantly increased both grain and straw yields but at the same time it caused a minimal decrease in starch content and N-substances level. Agrodrap significantly increased straw yield and insignificantly grain one as well as the level of N-substances, the N-substances content increase of 8.76 to 9.25% was considered to be favourable. The content of starch decreased insignificantly. Sodium humate caused a significant increase in grain and straw yields and an insignificant reduction in the contents of starch and N-substances. A decrease in N-substances concentration to 8.54% was not convenient. Of all tested materials the fly ash ash mixture caused the lowest increase in grain yield and the highest decrease in starch and N-substances. The level of 9.32% in the latter was considered to be favourable.

The use of Nobasyp significantly increased the contents of Hg, Co and Ni out of 11 tested metals in grain. Agrodrap increased the contents of As and Co, while sodium humate caused the As concentration increase, and a significant decrease in Hg and Ni levels. The fly ash ash mixture significantly increased Co, Mn and Hg. The hygienic limit of investigated heavy metals in grain has not been exceeded. The application of these materials determined the level of 11 heavy metals in the soil in a nearly immeasurable way. Basalt wools, fly ash, ash mixture and sodium humate slightly increased soil pH and inhibited carbon oxidation in the soil. Unlike fly ash, ash mixture and sodium humate,

wools increased the sorption capacity and porosity of the soil and subsequently they reduced volume weight. The tested materials have shown that they can be used as soil additives.

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222. Effects of soil amendments at a heavy loading rate associated with cover crops as green manures on the leaching of nutrients and heavy metals from a calcareous soil.

Wang, Q. R.; Li, Y. C.; and Klassen, W.

Journal of Environmental Science and Health Part B 38(6): 865-81. (Nov. 2003)

NAL Call #: TD172.J61 ; ISSN: 0360-1234 . 14649715

Descriptors: Abelmoschus/ Crotalaria/ Fertilizers/ Humans/ Industrial Waste/ Metals, Heavy: chemistry/ Nitrogen: chemistry/ Phosphorus: chemistry/ Refuse Disposal/ Soil/ Soil Pollutants/ Sorghum

Abstract: The potential risk of groundwater contamination by the excessive leaching of N, P and heavy metals from soils amended at heavy loading rates of biosolids, coal ash, N-viro soil (1:1 mixture of coal ash and biosolids), yard waste compost and co-compost (3:7 mixture of biosolids to yard wastes), and by soil incorporation of green manures of sunn hemp (*Crotalaria juncea*) and sorghum sudangrass (*Sorghum bicolor* x *S. bicolor* var. *sudanense*) was studied by collecting and analyzing leachates from pots of Krome very gravelly loam soil subjected to these treatments. The control consisted of Krome soil without any amendment. The loading rate was 205 g pot⁻¹ for each amendment (equivalent to 50 t ha⁻¹) of the dry weight), and the amounts of the cover crops incorporated into the soil in the pot were those that had been grown in it. A subtropical vegetable crop, okra (*Abelmoschus esculentus* L.), was grown after the soil amendments or cover crops had been incorporated into the soil. The results showed that the concentration of NO₃-N in leachate from biosolids was significantly higher than in leachate from other treatments. The levels of heavy metals found in the leachates from all amended soils were so low, as to suggest these amendments may be used without risk of leaching dangerous amounts of these toxic elements. Nevertheless the level of heavy metals in leachate from coal ash amended soil was substantially greater than in leachates from the other treatments. The leguminous cover crop, sunn hemp, returned into the soil, increased the leachate NO₃-N and inorganic P concentration significantly compared with the non-legume, sorghum sudangrass. The results suggest that at heavy loading rates of soil amendments, leaching of NO₃- could be a significant concern by application of biosolids. Leaching of inorganic P can be increased significantly by both co-compost and biosolids, but decreased by coal ash and N-viro soil by virtue of improved adsorption. The leguminous cover crop, sunn hemp, when incorporated into the soil, can cause the concentration of NO₃-N to increase by about 7 fold, and that of inorganic P by about 23% over the non-legume. Regarding the metals, biosolids, N-viro soil and coal ash significantly increased Ca and Mg concentrations in leachates. Copper concentration in leachate was increased

by application of biosolids, while Fe concentration in leachates was increased by biosolids, coal ash and co-compost. The concentrations of Zn, Mo and Co in leachate were increased by application of coal ash. The concentrations of heavy metals in leachates were very low and unlikely to be harmful, although they were increased significantly by coal ash application.

This citation is from PubMed.

223. Effects of soil application of fly ash on the fusarial wilt on tomato cultivars.

Khan, M. R. and Singh, W. N.

International Journal of Pest Management 47(4): 293-297. (2001); ISSN: 0967-0874

Descriptors: bicarbonates/ boron/ calcium/ carbohydrates/ crop yield/ cultivars/ cultural control/ fly ash/ fungal diseases/ growth/ magnesium/ manganese/ phosphorus/ plant disease control/ plant diseases/ plant pathogenic fungi/ plant pathogens/ potassium/ soil fertility/ sulfates/ tomatoes/ zinc/ cultivated varieties/ Hyphomycetes/ Mn/ phytopathogens/ saccharides/ sulphates

Abstract: A study was carried out in microplots to evaluate the effect of fly ash on the plant growth and yield of tomato cultivars, Pusa Ruby, Pusa Early Dwarf and New Uday, and on wilt disease caused by *Fusarium oxysporum* f.sp. *lycopersici*. Fly ash was applied to soil by broadcast or in rows at the rate of 1, 2, 3 and 4 kg ash/m in place of inorganic fertilizers. In control plots, NPK (about 40:20:20 kg/acre) and compost were added in place of fly ash. Ash application greatly increased the soil P, K, B, Ca, Mg, Mn, Zn, carbonate, bicarbonate and sulfate content. Plants grown in the ash-treated plots, especially at 3 or 4 kg dose, showed luxuriant growth and greener foliage, and plant growth and yield of the three cultivars were significantly increased in comparison with the plants grown in plots without fly ash. The wilt fungus, *F. oxysporum* f.sp. *lycopersici* at the inoculum level of 2 g/plant caused significant suppression of growth and yield in all three cultivars. Application of fly ash, however, checked the suppressive effect of the fungus, leading to a significant increase in the considered variables compared with the inoculated control. Soil population of the fungus (colony-forming units g/soil) gradually decreased with an increase in ash dose. Row application was found to be relatively more effective in enhancing the yield of tomato cultivars and suppressing the wilt disease. The greatest increase in the yield of fungus inoculated and uninoculated plants due to broadcast or row application at 3 or 4 kg ash/m was recorded in tomato cv. Pusa Ruby (39-61 and 9-24%), followed by Pusa Early Dwarf (31-61 and 17-34%) and New Uday (21-35 and 4-22%).

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224. Effects of the mixture with different proportion of fly ash and filtered mud on red soil properties and barley yield.

Xing Shihe and Zhou Biqin

Journal of Fujian Agriculture and Forestry University (Natural Science Edition) 32(2): 240-244. (June 2003); ISSN: 1671-5470.

Notes: 6 tables, 11 ref.. Summaries (En, Zh). Citation Notes: CN (China).

Descriptors: fly ash/ mud/ soil properties/ barley/ yield
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225. Effects of various modifiers on soil fertility properties and tobacco yields and qualities.

Xing ShiHe; Xiong DeZhong; Zhou BiQing; Xu Qian; and Liu ChunYing

Journal of Fujian Agriculture and Forestry University Natural Science Edition 33(3): 384-389. (2004); ISSN: 1671-5470

Descriptors: calcium/ cellulase/ cellulose/ crop yield/ dolomite/ enzyme activity/ enzymes/ fertilizers/ fly ash/ lime/ magnesium/ nitrogen/ peroxidases/ phosphate/ phosphoric monoester hydrolases/ phosphorus/ potassium/ soil bacteria/ soil fertility/ soil pH/ tobacco/ urease/ phosphatases

Abstract: The effects of various modifiers such as lime, fly ash, dolomite, culture waste of edible fungi and chemical fertilizers on soil major fertility properties and tobacco yields and qualities in China were studied. Results showed that the effects of applying modifier composed of lime, culture waste of edible fungi and chemical fertilizer were the best among the modifiers studied. After applying these modifiers, soil pH, contents of rapidly available N, P and K, contents of exchangeable Ca and Mg were 21.33, 44.81, 63.97, 123.2, 56.70 and 88.64%, respectively, higher than those of the other modifiers. The quantities of soil bacteria, actinomyces, phosphate-degrading bacteria, potassium silicate-degrading bacteria and cellulose-degrading bacteria increased to approximately 252.54, 125.00, 466.67, 129.59, and 3114.29%, respectively. The activities of soil peroxidase, urease, phosphatase and cellulase increased to approximately 130.77, 100.00, 110.00 and 515.38%, respectively. The biomass, economic yields and quantities of the highest class tobacco were 50.89, 49.18 and 38.33%, respectively.

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226. Effects on plant height and flowering of winter ornamental plants when grown in mediums of soil and fly ash.

Khan, M. R. and Abdussalam

Tests of Agrochemicals and Cultivars 22: 44-45. (2001)
NAL Call #: S587.T47; ISSN: 0951-4309

Descriptors: crop yield/ flax/ flowering/ fly ash/ growing media/ linseed/ ornamental plants/ plant height/ sage/ yield components/ Acroclinium/ Acroclinium roseum/ anthesis/ Brachycome/ Bracteantha/ Bracteantha bracteata/ ornamentals/ potting composts/ Rhodanthe/ Rhodanthe chlorocephala/ Rhodanthe chlorocephala subsp rosea/ rooting media

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227. Efficacy of alum and coal combustion by-products in stabilizing manure phosphorus.

Dou, Z.; Zhang, G. Y.; Stout, W. L.; Toth, J. D.; and Ferguson, J. D.

Journal of Environmental Quality 32(4): 1490-1497. (2003)
NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: byproducts/ cattle manure/ coal/ combustion/ dry matter/ fly ash/ losses from soil/ phosphorus/ pig

manure/ poultry manure/ runoff/ stabilization/ waste management/ waste utilization/ losses from soil systems/ poultry litter

Abstract: Animal manures contain large amounts of soluble phosphorus (P), which is prone to runoff losses when manure is surface-applied. Here we report the efficacy of alum and three coal combustion by-products in reducing P solubility when added to dairy, swine, or broiler litter manures in a laboratory incubation study. Compared with unamended controls, alum effectively reduced readily soluble P, determined in water extracts of moist manure samples with 1 h of shaking, for all three manures. The reduction ranged from 80 to 99% at treatment rates of 100 to 250 g alum kg⁻¹ manure dry matter. The fluidized bed combustion fly ash (FBC) reduced readily soluble P by 50 to 60% at a rate of 400 g kg⁻¹ for all three manures. Flue gas desulfurization by-product (FGD) reduced readily soluble P by nearly 80% when added to swine manure and broiler litter at 150 and 250 g kg⁻¹. Another by-product, anthracite refuse fly ash (ANT), was ineffective for all three manures. In all cases, reduction in readily soluble P is primarily associated with inorganic phosphorus (P_i) with little change in organic phosphorus (P_o). Sequential extraction results indicate that the by-product treatments shifted manure P from H₂O-P into a less vulnerable fraction, NaHCO₃-P, while the alum treatment shifted the P into even more stable forms, mostly NaOH-P. Such shifts in P fractions would have little influence on P availability for crops over the long term but would retard and reduce potential losses of P following manure applications. Reproduced with permission from the CAB Abstracts database.

228. Efficacy of fly-ash based Rhizobium on growth and incidence of powdery mildew in pea.

Vipin Kumar and Pramila Gupta

Annals of Plant Protection Sciences 16(1): 248-249. (2008)
NAL Call #: SB950.A1A46; ISSN: 0971-3573

Descriptors: fly ash/ formulations/ fungal diseases/ lignite/ nodulation/ nodules/ peas/ plant diseases/ plant height/ plant pathogenic fungi/ plant pathogens/ priming/ seed germination/ Erysiphaceae/ pea/ phytopathogens

Abstract: Pea seeds were primed with Rhizobium mixed with fly ash, fly ash + lignite (1:1) or lignite at a concentration of 2x10⁹/g. Seed germination and root nodulation were markedly enhanced by the Rhizobium formulations. Rhizobium mixed with fly ash resulted in the greatest seed germination (85.4%), plant height (22.3 cm) and number of nodules per plant (54.6), and lowest powdery mildew [Erysiphe sp.] incidence at 45 days after sowing (0.0%). The results showed the potential of fly ash as a carrier in commercial Rhizobium populations. Reproduced with permission from the CAB Abstracts database.

229. Efficacy of various amendments for amelioration of fly-ash toxicity: growth performance and metal composition of Cassia siamea Lamk.

Tripathi, R. D.; Vajpayee, P.; Singh, N.; Rai, U. N.; Kumar, A.; Ali, M. B.; Kumar, B.; and Yunus, M.

Chemosphere 54(11): 1581-1588. (2004)
NAL Call #: TD172.C54; ISSN: 0045-6535

Descriptors: amendments/ bioavailability/ biomass/ cattle manure/ chlorophyll/ copper/ detoxification/ fly ash/ gardens/ growth/ iron/ landfills/ leaves/ nickel/

photosynthesis/ phytotoxicity/ polluted soils/ protein/ revegetation/ roots/ soil pollution/ soil types/ toxicity/ uptake/ zinc/ carbon assimilation/ carbon dioxide fixation/ *Cassia siamea*

Abstract: Plants of *Cassia siamea* Lamk were grown in garden soil (control), fly-ash (100%) and fly-ash amended by various ameliorants (cowdung manure, press-mud, garden soil; 1:1, w/w). The plants survived in fly-ash (100%) though their growth was less in comparison to the treatments. Fly-ash+press-mud (1:1, w/w) proved to be the best combination as growth (total biomass, leaf number, photosynthetic area, total chlorophyll and protein) was significantly high in this treatment followed by cowdung manure and garden soil. Leaves and roots accumulated significant amount of Cu, Zn, Ni and Fe. However, the concentration of all the metals was more in roots than leaves except Ni. Although, fly-ash contains high amount of metals but the metal uptake was more in the plants grown in fly-ash+press-mud mixture. In spite of high metal availability in fly-ash and press-mud mixture, plant growth was good. This might be attributed to the some metal detoxification mechanism active in this treatment. The present study concluded that *C. siamea* seems to be a suitable plant for developing a vegetation cover on fly-ash dumps.

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230. The efficiency of *Candiotia's* mineral coal ashes in the correction of soil pH.

Martins, J. L.; Vahl, L. C.; Jablonski, A.; Nunes, H. C.; and Soares, E. R.

Revista Brasileira de Agrociencia 6(3): 248-250. (2000); ISSN: 0104-8996.

Notes: Original title: Eficiencia da cinza do carvão mineral resultante da dessulfuração na correção da acidez do solo.

Descriptors: desulfurization/ fly ash/ lime/ limestone/ liming/ liming materials/ red yellow podzolic soils / soil acidity/ soil pH/ soil types/ Ultisols/ desulphurization

Abstract: A red-yellow podzolic soil (Paleodult) was incubated for 90 days with the purpose of evaluating the efficiency of fly ashes resulting from the burning of coal in the correction of soil acidity. Two kinds of ash have been used in the incubation: one from the Usina Termelétrica Presidente Medici (UTPM), without desulfurization process; the other from the Universidade da Região da Campanha (URCAMP), with desulfurization. The experiment consisted of a 5x5x2 factorial (five levels of ash 0, 5, 10, 20 and 30 t ha⁻¹, five limestone levels and two types of ash) in a totally randomized design, with two replications, in a split-plot experiment. The pH was measured four times in water after 21, 42, 63 and 90 days of incubation. The ash produced at UTPM, even though it had an alkaline pH, did not increase the pH of the soil, which happened only with limestone. The ash produced at URCAMP increased soil pH from 4.5 to 5.1, indicating that it can partially substitute limestone in soil amendment.

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231. Enhancement of hardpan formation by amending sulphidic tailings with limestone or fly ash.

Xenidis, A.; Mylona, E.; and Harokopou, A. D.

Land Contamination and Reclamation 15(3): 359-373. (2007); ISSN: 0967-0513

Descriptors: drainage / fly ash/ heavy metals/ hydraulic conductivity/ leachates/ leaching/ lignite/ limestone/ mine tailings/ oxidation/ pH/ polluted soils/ resistance to penetration/ soil amendments/ soil depth/ soil pollution/ soil types/ sulfides/ hydrogen ion concentration/ potential of hydrogen/ remediation/ sulphides

Abstract: The potential formation of low-permeability hardpan layers by mixing limestone or lignite fly ash with oxidized sulfidic tailings was investigated under actual field conditions. Field tests covering an area of 900 m² were implemented in Lavrion, Greece. The field testing area was divided into four equal testpads, which were filled with: (a) Lavrion sulfidic tailings without any amendment (control test); (b) sulfidic tailings covered by a 60-cm-thick layer of tailings homogeneously mixed with 75 kg/t limestone; (c) sulfidic tailings - 75 kg/t limestone mixture having a thickness of 150 cm; and (d) sulfidic tailings covered by a 30-cm-thick layer of tailings homogeneously mixed with 180 kg/t lignite fly ash. After four years of field test operations, cemented layers or hardpan, exhibiting increased resistance to penetration, were formed in the testpads. The hardpan layer in the control test was observed at a depth of 65 cm and had a thickness of 30 cm. Limestone and fly ash addition to the oxidized tailings resulted in the formation of hardpan layers at depths of 35 and 15 cm, respectively. The samples collected from the hardpan layers had paste pH higher than 4.5, as compared to pH 2.0 of the oxidized tailings. Limestone was proved to be more effective than fly ash in neutralizing the acidity and maintaining near-neutral pH conditions within the hardpan. On the other hand, the hardpan samples collected from limestone and fly-ash-amended testpads exhibited similar hydraulic conductivity values in the order of 10⁻⁶ m/second.

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232. Enrichment of pressmud through different amendments during composting.

Babitha, J. S.; Devi, L. S.; and Datta Amlan

Current Research University of Agricultural Sciences Bangalore 30(5/6): 86-87. (2001); ISSN: 0253-7133

Descriptors: calcium/ cattle dung/ coir/ composting/ composts/ electrical conductivity/ filter cake/ fly ash/ magnesium/ nitrogen/ nutrient content/ organic amendments/ organic carbon/ pH/ phosphorus/ rock phosphate/ trace elements/ waste utilization/ clarification mud/ coconut fibre/ hydrogen ion concentration/ microelements/ Mysore/ phosphate rock/ potential of hydrogen

Abstract: A composting experiment was conducted in Bangalore, Karnataka, India during 1999. The treatment combinations used in the study include: (C1) pressmud + cow dung; (C2) pressmud + cow dung + coir dust; (C3) pressmud + cow dung + gliricidia; (C4) pressmud + cow dung + gliricidia + rock phosphate; (C5) pressmud + cow dung + gliricidia + rock phosphate + micronutrients; and (C6) pressmud + fly ash + urea + rock phosphate. Maximum pH and Mg content was recorded with C6 while the minimum values was recorded with C2 and C1 treatments, respectively. C5 treatment resulted to maximum values of electrical conductivity, and contents of N, P and Ca. Minimum values of electrical conductivity, and P and Ca content were recorded under C1. C2 treatment gave maximum organic C content but had minimum N content. Minimum organic C was recorded under C6. Results on the

biochemical composition of pressmud compost showed that C2 allowed for maximum lignin, lignin:cellulose ratio and C:N ratio while C5 gave minimum values for these parameters. On the other hand, cellulose content was maximum under C3 and minimum under C6. The protocol emerged from this study involves the use of rock phosphate at 5%, gliricidia at 5%, cow dung at 10%, and micronutrients at 400 ppm (Zn), 200 ppm (Fe and Mn) and 20 ppm (Cu).

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233. Environmental impact of fly ash and its management.

Banerjee, S. K. and Kashyap, M. K.

Advances in Forestry Research in India 18: 31-53. (1998); ISSN: 0971-2704

Descriptors: composts / fly ash/ growing media/ growth/ increment/ mixtures/ mortality/ multipurpose trees/ nutrients/ plant succession/ planting/ reclamation/ soil chemistry/ soil fertility/ soil properties/ species trials/ survival/ trees/ vegetation/ woody plants/ death rate/ potting composts/ rooting media/ soil development

Abstract: The introductory part of the paper discusses the hazardous effects of fly ash, a byproduct formed in increasing amounts from thermal power plants using coal in India. Studies by the authors are then reported on fly ash management through forestry. Data are provided on the physicochemical characteristics, nutrient status and vegetation development of different aged fly ash dykes (6, 12, 24, 36 and 60 yr old, with comparative natural forest data) in [Madhya Pradesh]. Trials are reported from Chachai, on fly ash dykes from the Amarkantak Thermal Power Station (Madhya Pradesh). In the first experiment, seedlings of 10 multipurpose tree species were established at 2x2 m spacing in pits ([45 cm]^{superscript 3}) filled with various media (soil, fly ash, soil + sand + fly ash and soil + sand + fly ash + compost); only Eucalyptus hybrid [E. tereticornis] and Acacia auriculiformis survived. Growth measurements and details of the ground vegetation which developed after 6 yr are given; growth was best in the soil + sand + fly ash + compost medium, and poor in the fly ash only medium. In the second experiment a 2.54 cm layer of soil was spread over the fly ash, and seedlings of 4 species were planted in pits of the same size. All the species survived and growth was satisfactory, although less than that in the best treatment in the first experiment; the soil spreading operation is also expensive. E. tereticornis grew best, followed by A. auriculiformis, Peltophorum ferrugineum [P.

pterocarpum] and Pongamia pinnata (also tested in the first experiment).

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234. Environmental risks of farmed and barren alkaline coal ash landfills in Tuzla, Bosnia and Herzegovina.

Dellantonio, A.; Fitz, W. J.; Custovic, H.; Repmann, F.; Schneider, B. U.; Grunewald, H.; Gruber, V.; Zgorelec, Z.; Zerem, N.; Carter, C.; Markovic, M.; Puschenreiter, M.; and Wenzel, W. W.

Environmental Pollution 153(3): 677-86. (June 2008)

NAL Call #: QH545.A1E52; ISSN: 0269-7491 . 17949870

Descriptors: Adsorption/ Agriculture/ Arsenic: analysis/ Bosnia-Herzegovina/ Chromium: analysis/ Coal/ Copper: analysis/ Environmental Monitoring: methods/ Environmental Pollution/ Environmental Remediation: methods/ Humans/ Hydrogen-Ion Concentration/ Incineration/ Industrial Waste/ Molybdenum: analysis/ Power Plants/ Refuse Disposal/ Risk/ Soil Pollutants: analysis/ Time

Abstract: The disposal of coal combustion residues (CCR) has led to a significant consumption of land in the West Balkan region. In Tuzla (Bosnia and Herzegovina) we studied previously soil-covered (farmed) and barren CCR landfills including management practises, field ageing of CCR and the transfer of trace elements into crops, wild plants and wastewaters. Soil tillage resulted in mixing of cover soil with CCR. Medicago sativa showed very low Cu:Mo ratios (1.25) which may cause hypocuprosis in ruminants. Total loads of inorganic pollutants in the CCR transport water, but not pH (approximately 12), were below regulatory limits of most EU countries. Arsenic concentrations in CCR transport water were <2microgl(-1) whereas reductive conditions in an abandoned landfill significantly enhanced concentrations in leachates (44microgl(-1)). The opposite pattern was found for Cr likely due to large initial leaching of CrVI. Public use of landfills, including farming, should be based on a prior risk assessment due to the heterogeneity of CCR. This citation is from PubMed.

235. Enzyme activities in a sandy soil amended with sewage sludge and coal fly ash.

Lai, K. M.; Ye, D. Y.; and Wong, J. W. C.

Water, Air and Soil Pollution 113(1/4): 261-272. (1999) NAL Call #: TD172 .W36; ISSN: 0049-6979

Descriptors: biological activity in soil/ copper/ enzyme activity/ fly ash/ heavy metals/ manganese/ phosphoric monoester hydrolases/ sandy soils/ sewage sludge/ sludges/ soil amendments/ soil types/ urease/ zinc/ Mn/ phosphatases

Abstract: Previous studies showed that coal fly ash could stabilize sewage sludge by reducing metal availability, but fly ash may cause an adverse effect on soil microbial activities. Therefore, an experiment was performed to evaluate the effects of amendment of soil with anaerobically digested dewatered sewage sludge, stabilised with alkaline coal fly ash, on soil enzyme activity and the implications for soil nutrient cycling. Sewage sludge was amended with 0, 5, 10, 35 and 50% w/w of fly ash, and then the ash-sludge mixtures were incubated with a sandy soil at 1:1 (v/v). Dehydrogenase activity decreased with an increase in fly ash amendment level and the time of incubation. Soil receiving 5% ash-sludge amendment had a higher dehydrogenase activity than other treatments. Soil receiving 10% ash-sludge mixture had the highest urease activity and in general, urease activity decreased with increasing incubation time. Phosphatase activity was the highest at 5% ash-sludge mixture amended soil and no general trend was observed with time. Water-soluble Zn, Mn and Cu contents were suppressed by the addition of fly ash. The present experiment indicated that addition of 10% ash-sludge mixture should have a positive benefit on the activity of soil microorganisms, N and P nutrient cycling, and reduce the availability of heavy metals. Reproduced with permission from the CAB Abstracts database.

236. Enzyme activity of an acid sulphate soil:

Dehydrogenase, phosphatase, arylsulphatase.

Ramesh, V. and Chhonkar, P. K.

Journal of the Indian Society of Soil Science 49(1): 207-210. (2001)

NAL Call #: 56.9 IN2; ISSN: 0019-638X

Descriptors: acid sulfate soils/ application rates/ arylsulfatase/ enzyme activity/ fly ash/ lettuces/ lime/ liming/ oxidoreductases/ phosphoric monoester hydrolases/ residual effects/ rice/ soil enzymes/ acid sulphate soils/ arylsulphatase/ paddy/ phosphatases/ redox enzymes/ thionic soils

Abstract: A greenhouse study was conducted to determine the effects of fly ash (0, 72 and 144 g kg⁻¹ soil) and lime (0, 3.0, and 6.0 kg-1 soil), used as ameliorants, on dehydrogenases [oxidoreductases], phosphatases [phosphoric monoester hydrolases] and arylsulfatase in an acid sulfate soil under rice-lettuce system. The direct effect of fly ash and lime was studied using rice as the test crop. The residual effects were determined using lettuce. Fly ash application at 0.5 calcium equivalent basis (CEB) increased the dehydrogenase activity during the first two stages. Lime application at the highest level (1.0 lime requirement) decreased dehydrogenase activity (DHA) throughout the experiment. The residual effects of fly ash on DHA was not positive indicating a short term beneficial effect following its application. Soil phosphatase and arylsulfatase activity decreased with increased ash and lime treatments. The residual effects of fly ash and lime at the highest level failed to influence phosphatase activity under lettuce, while the effect of fly ash application (72 g kg⁻¹) and lime increased arylsulfatase activity. The residual effect corresponding to the interaction between 3.0 kg-1 soil and 72 g kg-1 soil was beneficial with respect to the enzymes' activity. Reproduced with permission from the CAB Abstracts database.

237. Erodibility of fly ash used as a topsoil substitute in mineland reclamation.

Gorman, J. M.; Sencindiver, J. C.; Horvath, D. J.; Singh, R. N.; and Keefer, R. F.

Journal of Environmental Quality 29(3): 805-811. (May 2000-June 2000)

NAL Call #: QH540.J6; ISSN: 0047-2425 [JEVQAA]

Descriptors: fly ash/ mined soils/ erosion control/ waste utilization/ land restoration

Abstract: Fly ash, a by-product of coal-fired power plants, has been used successfully in reclaiming abandoned mine lands by improving minesoil chemical and physical properties. However, the fine sand-silt particle size of fly ash may make it more susceptible than natural soils to detachment and transport by erosive processes. Furthermore, the high content of silt-size particles in fly ash may make it more susceptible to surface crust formation, resulting in reduced infiltration and increased surface runoff and erosion. In the summer of 1989, fly ash-wood waste mixtures, used as a topsoil substitute, were surface applied on two separate mine sites in Preston County, WV, one with 10% slope and the other 20% slope. Erosion rates were measured directly using the Linear Erosion/Elevation Measuring Instrument (LEMI). Erosion measurements were taken during the first two growing seasons on both sites. Erosion values were up to five times greater on the fly ash-treated minesoil than on the untreated minesoil. Mulching with wood chips reduced fly ash erosion to about one-half

the loss of the unmulched plots. Erosion was related to both the amount and type of ground cover. Increased vegetative ground cover resulted in reduced erosion. Mosses and fungi appeared to provide better erosion protection than grass-legume cover.

This citation is from AGRICOLA.

238. Evaluating possibility of heavy metal accumulation by fly ash application in rice paddy soils.

Hong, C. O.; Lee, C. H.; Lee, H.; Lee, Y. B.; and Kim, P. J. *Korean Journal of Environmental Agriculture* 25(4): 331-338. (2006); ISSN: 1225-3537

Descriptors: heavy metals/ fly ash/ rice paddy/ soils

Abstract: Coal combustion fly ash, which has a high available Si content and alkaline pH, was selected as a potential source of soil amendment in this study. Two field experiments were carried out to evaluate the possibility of heavy metal accumulation in silt loam (Pyeongtaeg series) and loamy sand (Nagdong series) of rice (*Oryza sativa*) paddy soils to which 0, 40, 80, and 120 Mg ha⁻¹ of fly ash were added. Rice yields increased significantly with fly ash application and the highest rice yields were achieved following the addition of around 90 Mg ha⁻¹ fly ash. © AGRIS 2008 - FAO of the United Nations

239. Evaluation of bottom ash and composted dairy manure as a fill material.

Mukhtar, S.; Sadaka, S.; Kenimer, A.; and Mathis, J. In: 2000 ASAE Annual International Meeting. Milwaukee, Wisconsin, USA.; pp. 1-14; 2000.

Descriptors: ash/ cattle manure/ composts/ conferences/ leaching/ nutrients

Abstract: In a column study, blends of bottom ash (BA) and composted dairy manure (CM) were evaluated for use as a soil fill material. Four blends (BA: CM, v/v) namely, B1 (100%:0%), B2 (70%:30%), B3 (50%:50%) and B4 (0%:100%) were subjected to flow-through and constant-head water table regimes (B2 and B3 only) using de-ionized water. Leachate and standing water samples were collected and analysed for total solids, volatile solids, COD, pH, N, NO₃-N, P and K. Blend effects on chemical properties of leachate and standing water are discussed. Reproduced with permission from the CAB Abstracts database.

240. Evaluation of bottom ash and composted manure blends as a soil amendment material.

Mukhtar, S.; Kenimer, A. L.; Sadaka, S. S.; and Mathis, J. G.

Bioresource Technology 89(3): 217-228. (2003)

NAL Call #: TD930.A32 ; ISSN: 0960-8524

Descriptors: agricultural byproducts/ ash/ cattle manure/ chemical oxygen demand/ composts/ heavy metals/ leachates/ nitrogen/ phosphorus/ polluted water/ potassium/ soil amendments/ standing water/ total solids/ waste management/ water pollution/ water quality/ water table/ United States of America/ water composition and quality

Abstract: The long-term goal of this project was to find alternative uses for bottom ash (BA) and composted dairy manure (CM), by-products of coal combustion and livestock production, respectively. The study discussed in this paper focused on potential water quality impacts associated with using blended BA and CM as a soil amendment. The constituents of BA and CM include heavy metals and other chemicals that, while essential nutrients for plant growth,

also pose a potential threat to water quality. Four blends (BA:CM, v/v) namely, B1 (100%:0%), B2 (70%:30%), B3 (50%:50%) and B4 (0%:100%), were subjected to flow-through water table management and two blends, B2 (70%:30%) and B3 (50%:50%), were subjected to constant head water table management using de-ionized water. Leachate and standing water from saturated and flooded blends of BA and CM were examined for total solids (TS), volatile solids (VS), COD, pH, total Kjeldahl nitrogen (TKN), NO₃-N, total P, total K as well as selected metals over a 5 and 7 week period for flow-through and constant head watertables, respectively. The results showed that higher CM content resulted in higher TS, VS, TKN, P and K concentrations in the leachate and standing water. Concentrations of these constituents were higher in leachate than in the standing water. Even though, marked reductions of most chemicals in the leachate and standing water were realized within one to three weeks, initially high concentrations of chemicals in leachate and standing water from these particular blends made them unsuitable as soil amendment material. Based upon these results, it was concluded that additional column studies of BA and CM blends with reduced CM content (5%, 10% and 20%) should be performed to further assess the feasibility of BA and CM blends as an environmentally safe soil amendment material. Reproduced with permission from the CAB Abstracts database.

241. Evaluation of cocomposted coal fly ash on dynamics of microbial populations and heavy metal uptake.

Vallini, G; Vaccari, F; Pera, A; Agnolucci, M; Scatena, S; and Varallo, G
Compost Science and Utilization. 1999; 7(1): 81-90 (1999)
 NAL Call #: TD796.5.C58 ; ISSN: 1065-657X
 Descriptors: alkalinity/ clay soils/ coal/ composts/ faba beans/ fly ash/ heavy metals/ microorganisms/ plant residues/ pot experimentation/ sandy soils/ uptake/ broad beans/ fava beans/ field beans/ horse beans/ micro organisms/ tic beans
 Abstract: *Vicia faba*, in a pot experiment with sandy and clayey soils under greenhouse conditions, was checked for growth response to different amendments with coal alkaline fly ash or co-composted fly ash mixed with lignocellulosic residues. Soil microbial populations, pH and electrical conductivity as well as heavy metal uptake by plants were monitored. At rates of 5 and 10% (on a dry matter basis) in both soils, neither fly ash alone nor co-composted fly ash exerted any negative effect. Plant biomass production was not influenced in either clayey or sandy soil. Alkaline fly ash did not promote microbial growth when applied alone to the soils. However, co-composted fly ash generally increased bacterial and Actinomycetales counts in both soils. Fungi were not affected by ash. Due to the increase of soil pH by alkaline fly ash or co-composted fly ash, plant uptake of heavy metals was depressed in the sandy soil. Heavy metal mobility did not cause change in the clayey soil where a high buffering capacity mitigated the effects of fly ash amendments.

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242. Evaluation of fine brown coal and brown coal ash as organomineral fertilizers for vegetables .

Suchorska Orowska, J.
Rozprawy Akademia Rolnicza w Szczecinie 184: 92. (1998); ISSN: 0239-6467.
 Notes: Original title: Przydatność miazgi węgla brunatnego o popiołu z węgla brunatnego do produkcji nawozów organiczno mineralnych stosowanych w uprawie warzyw.
 Descriptors: amendments/ ammonium nitrate/ application rates/ ash/ brown coal/ cabbages/ carrots/ coal/ dust/ farmyard manure/ lignite/ manures/ nitrogen fertilizers/ onions/ organomineral fertilizers/ plant composition/ root crops/ rotations/ spinach/ sugar/ vegetables/ Araliales/ Capparales/ chemical constituents of plants/ crop rotation/ FYM/ rotational cropping / vegetable crops
 Abstract: Two separate field experiments conducted in Poland investigated the effects of organomineral fertilizers (obtained from brown coal dust and brown coal ash) on cabbages, onions, *Beta vulgaris*, as compared with farmyard manure, or of organomineral fertilizers together with different forms of N on cabbages, carrots and spinach. The results showed that application of organomineral fertilizers had no significant effect on P, K, Ca, and Mg, but increased the sugar content of plants. The nutrient content of cabbages was significantly increased by organomineral fertilizers applied together with ammonium nitrate. It was concluded that preparations of brown coal ash and brown coal dust are a safe substitute for farmyard manure and improve both the yield and quality of vegetables. Reproduced with permission from the CAB Abstracts database.

243. Evaluation of fly ash and ceramic dust as a soil amendment and its effect on growth and yield performance in tomato.

Raghav, D.; Khan, A. A.; and Chauhan, B.
Tests of Agrochemicals and Cultivars 24: 18-19. (2003)
 NAL Call #: S587.T47; ISSN: 0951-4309
 Descriptors: application rates/ biomass/ dust/ fly ash/ fruits/ growth/ roots/ shoots/ soil amendments/ tomatoes
 Abstract: A study was conducted to investigate the effects of fly ash and ceramic dust (10, 20, 30, 40, 50, 60, 70, 80, 90 and 100%) as soil amendment on the growth and yield of tomato cv. 'Ruby'. The length, fresh weight and dry weight of root and shoot, fruit number and fresh fruit weight of tomato plant were significantly affected by fly ash inclusion rate. The growth and biomass accumulation peaked at 30% fly ash inclusion rate, after which there was a steady decline. The root and shoot length, fresh and dry weight and fruit number and yield, were all significantly affected by the inclusion rate of the ceramic dust. The performance of tomato peaked at 20% inclusion rate. Reproduced with permission from the CAB Abstracts database.

244. Evaluation of fly ash as a carrier for diazotrophs and phosphobacteria.

Sunita Gaiand and Gaur, A. C.
Bioresource Technology 95(2): 187-190. (2004)
 NAL Call #: TD930.A32 ; ISSN: 0960-8524
 Descriptors: fly ash/ nitrogen fixation/ nitrogen fixing bacteria/ phosphate solubilizing bacteria/ soil amendments/ waste management/ biofertilizers

Abstract: Fly ash and its different combinations with soil (w/w) were tested to explore its possible use as a potential carrier for diazotrophs and phosphobacteria. *Azotobacter chroococcum*, *Azospirillum brasilense* and *Bacillus circulans* showed their maximum viability in fly ash alone whereas *Pseudomonas striata* proliferated most in soil:fly ash (1:1) combination.

Reproduced with permission from the CAB Abstracts database.

245. Evaluation of oilseed crops to different concentrations of fly ash.

Era Upadhyay and Khan, A. A.

Tests of Agrochemicals and Cultivars 23: 24-25. (2002)

NAL Call #: S587.T47; ISSN: 0951-4309

Descriptors: carotenoids/ chlorophyll/ flax/ flowers/ fly ash/ growth/ Indian mustard/ leaves/ linseed/ plant pigments/ roots/ seeds/ shoots/ trace element fertilizers/ Capparales/ micronutrient fertilizers/ tetraterpenoids

Abstract: The impact of fly ash incorporation in soil on the growth, productivity and photosynthetic pigments of linseed (*Linum usitatissimum*) and Indian mustard (*Brassica juncea*) was studied under pot conditions. Fly ash was mixed with soil to produce concentrations of 0, 15, 30, 45, 60, 75 and 100%. The fresh weight of the shoots and roots, number of seeds per capsule, and chlorophyll b and carotenoid contents of linseed increased up to 45% fly ash. However, the length and dry weight of the shoots and roots, and chlorophyll a content significantly increased up to 60% fly ash. The numbers of flowers, seeds per siliqua and leaves, and length and dry weight of shoots and roots of Indian mustard significantly increased up to 60% fly ash. However, the number of siliquae, fresh weight of shoots and roots, and contents of photosynthetic pigments significantly increased up to the 45% concentration. All the parameters of both crops were best at 15% fly ash. Reproduced with permission from the CAB Abstracts database.

246. Evaluation of radioactive security for applying coal ash in farmland.

Shi JianJun; Chen Hui; and Xu YinLiang

Journal of Shanghai Agricultural College 18(2): 95-100.

(2000); ISSN: 1000-193X

Descriptors: agricultural land/ fly ash/ maize/ potassium/ radioactivity/ radionuclides/ rice/ thorium/ uranium/ Anhwei/ Chekiang/ corn/ farmland/ paddy/ radioactive isotopes/ radioactive nuclides/ radioisotopes/ Shantung

Abstract: Ten coal ash samples from the electric power plants of Zhejiang, Shandong and Anhui were measured by HPGE gamma spectrometer analyzer respectively. The results showed that the main radioactive nuclides in ash are ²³⁸U, ²³²Th and ⁴⁰K. The specific activities of ²³⁸U, ²³²Th and ⁴⁰K were from 75-284, 96-164 and 120-382Bq/kg respectively. The simulated experiment on the application of coal ash showed that the specific activity of ²³⁸U, ²³²Th and ²²⁶Ra in the treated soil were 2.44, 1.39 and 1.88 times higher than those in control soil, respectively, when the coal ash was applied up to 525 tonnes/hm². The specific activity of three nuclides in paddy and maize seed grown in soil with coal ash were similar to that in control soil. The effect of edible security is not evident. The results of sampling from the farmland used

coal ash showed that the specific activity of the 3 nuclides in paddy grown in soil with silicon fertilizer did not exceed security standard.

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247. Evaluation of use of fly ash-gypsum mixture for rice production at different nitrogen rates.

Lee YongBok; Ha HoSung; Lee KyungDong; Park KiDo;

Cho YoungSon; and Kim PilJoo

Soil Science and Plant Nutrition 49(1): 69-76. (2003)

NAL Call #: 56.8 SO38 ; ISSN: 0038-0768

Descriptors: application rates/ boron/ clay loam soils/ crop yield/ fly ash/ gypsum/ Inceptisols/ nitrogen fertilizers/ nonclay minerals/ nutrient availability/ nutrient balance/ nutrient uptake/ paddy soils/ plant nutrition/ rice/ silicates/ soil amendments/ soil types/ paddy/ South Korea

Abstract: Although a silicate fertilizer had been recommended for application at 4-year intervals by the Korean government to enhance rice production, since the quantity was not sufficient, it became necessary to identify an alternative source of cheaper silicate fertilizer. Fly ash, which has a high silicate content, was selected as an alternative. To improve fly ash, that is highly alkaline and has a high boron content, it was mixed with a by-product of gypsum (hereafter, referred to as gypsum) at the 75:25 ratio on a weight basis. A field experiment was carried out to evaluate the productivity of rice (*Oryza sativa*) on a silty clay loam to which 0 and 25 Mg ha⁻¹ of the fly ash-gypsum mixture had been applied. Under these two conditions, five levels of nitrogen (0, 40, 80, 120, and 160 kg ha⁻¹) were set up to compare the rice response. The mixture increased the maximum grain yield by 8%. With increasing N uptake of rice, the mixture could decrease nitrogen application level to about 50 kg N ha⁻¹ to produce the target yield i.e., the maximum yield in the non-amendment treatment. The use of the mixture increased the uptake of silicate by rice, but did not result in an excessive uptake of heavy metals. The level of available B increased with the mixture application up to 1.5 mg kg⁻¹ in the surface soil at the initial stage, but did not reach toxicity levels. In conclusion, the mixture was considered to be a good alternative as a soil amendment to restore the nutrient balance in paddy soils and to reduce the nitrogen application rate of rice.

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248. An experiment with lignite ash from power plants for soil restoration: A case study in the Arnsberg forest.

Asche, N.

In: *Proceedings of the International Conference. Forest Ecosystem Restoration: Ecological and Economical Impacts of Restoration Processes in Secondary Coniferous Forests*. Vienna, Austria.; pp. 35-43; 2000.

Descriptors: acidification/ aluminium/ case studies/ fly ash/ forest soils/ leaching/ lime/ liming/ liming materials/ mineral soils/ nitrate/ plant nutrition / polluted soils/ soil conservation/ soil invertebrates/ soil pollution/ soil solution/ soil types/ sulfate/ aluminum/ Nordrhein Westfalen

Abstract: High acid loads lead to the acidification of forest soils. In order to compensate soil acidification, ~38% of the forests in North Rhine-Westphalia, Germany have been

limed since the early eighties. Approximately 90% of the used lime originated from quarries of different geological formations. Because some lignite ashes from power plants have a high acid neutralization capacity, their use could help reduce the use of natural lime and the negative impacts caused by quarries to the landscape. Results of this study showed positive effects on mineral soil, soil solution, beech (*Fagus sylvatica*) nutrition and earthworm abundance and fresh weight compared to an untreated control five years after the application of 6 t lignite ash per hectare. Undesired effects as high nitrate, sulfate and aluminium leaching were limited to the intensively rooted layers and therefore led not to significant loads of seepage water in 90 cm depth. Sulfate retention of the soil was high and until 1998 approximately 80% of sulfate input was adsorbed in the soil. Lignite ash, which fulfils not only the demands of substances used for forest soil restoration but also preconditions of different fertilizer laws, could be a practical example for a Kreislaufwirtschaft in an ecological sensitive society. It could help to reduce the use of natural lime and the negative effects of lime exploitation to landscape and environment.

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249. Experimental research on improvement of reclaimed soil properties and plant production based on different ratios of coal-based mixed materials.

Hu ZhenQi; Kang JingTao; Wei XiuJu; Ji JingJing; and Wang WanJie

Transactions of the Chinese Society of Agricultural Engineering 23(11): 120-124. (2007)

NAL Call #: S671.N8; ISSN: 1002-6819

Descriptors: coal/ crop production/ crude protein/ fly ash/ lucerne/ mined land/ nutrients/ reclaimed soils/ soil amendments/ soil compaction/ soil fertility/ soil types/ waste management/ waste utilization/ alfalfa/ mined sites

Abstract: On the goal of comprehensive utilization of coal-based mixed materials, weathered coal, coal waste and fly ash are being used, by mixing those materials according to a certain formula which is weathered coal:coal waste: fly ash=5:1:4, as well as adding the exact quantitative fertilizer, which improve reclaimed soil in mined area. This kind of coal-based mixture is full of nutrient for soil improvement. Through pot experiments, coal-based mixture could distinctly improve the fertility of soil, the pot experiments results showed that the output of lucerne (*Medicago sativa*) is two times as much as that of the controlled, and the crude proteins are also distinctly improved. Using coal-based mixture can avoid problems of soil compaction caused by only using of fertilizer, and improved ratio of comprehensive utilization of waste materials in mined area. Reproduced with permission from the CAB Abstracts database.

250. Experimental study on phytoremediation of reclaiming substrate contaminated by heavy metal.

Zheng JiuHua; Feng YongJun; Yu KaiQin; and Liu XiMin

Transactions of the Chinese Society of Agricultural Engineering 24(2): 84-88. (2008)

NAL Call #: S671.N8; ISSN: 1002-6819

Descriptors: absorption/ cabbages/ cadmium/ Chinese cabbages/ copper/ fly ash/ growth/ heavy metals/ phytoremediation/ polluted soils/ rape/ sewage sludge / soil pollution/ soil types/ substrates/ swede rape/ vinasse/ waste

utilization/ zinc/ canola/ Capparales/ oilseed rape

Abstract: The effects on the growth of cabbage, Chinese cabbage and rape planted on fly ash plus vinasse substrate and fly ash plus sewage sludge substrate were studied and the remediation of cabbage, Chinese cabbage and rape on heavy metal Cd, Cu and Zn was investigated by calculating absorption coefficient, transmission coefficient and absorption modulus. The conclusions were that: the absorption coefficient, transmission coefficient and absorption modulus of cabbage, Chinese cabbage and rape increased along with the time lapsed and it indicated the remediation effects of the plants in anaphase were better than that in prophase; the results showed cabbage, had effective functions in phytoremediation on heavy metal Cd, rape had some potential in phytoremediation on Cu and cabbage was better than Chinese cabbage and rape in absorption on Zn; absorption modulus was an ideal index which can estimate the ability of phytoremediation on heavy metal, because it took into account the above-ground biomass of plants and the heavy metal gross in plant root-layer.

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251. Exploiting fly ash as soil ameliorant to improve productivity of sabai grass (*Eulaliopsis binata* (Retz) C.E. Hubb) under acid lateritic soil of India.

Manisha Basu; Mahapatra, S. C.; and Bhadoria, P. B. S. *Asian Journal of Plant Sciences* 5(6): 1027-1030. (2006); ISSN: 1682-3974

Descriptors: crop yield/ dry matter accumulation/ farmyard manure/ fertilizers/ fly ash/ leaves/ tillers/ FYM/ vermicomposts

Abstract: The effects of fly ash (FA), organic wastes such as farmyard manure (FYM), vermicompost (VC) and green manure (*Sesbania rostrata*) (GM) and chemical fertilizers on the growth and yield of sabai grass (*Eulaliopsis binata*) were determined in a field experiment conducted in West Bengal, India in 2002-04. Integrated application of FA, organic wastes and CF resulted in significantly higher tiller number, dry matter accumulation and green leaf yield to sole application of CF in all experimental years. Application of AF in combination with organic wastes and chemical fertilizers resulted in the highest yield advantage (up to 22.8 and 27.6% in the wet season of first and second year, respectively), while the yield increase was 3.6 and 9% in the first and second year, respectively when it was used in combination with chemical fertilizers only. GM application resulted in higher yield compared to FYM or VC application during the wet season, however, the performance of sabai grass was superior under residual fertility of VC-based treatments compared to FYM or GM application during the dry season.

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252. A feasibility research on improving desert soil by combined solid wastes: A case study of the yulin city, shaanxi province.

Huang, G.; Chi, Z.-W.; and Yang, X.-M.

Bulletin of Mineralogy Petrology and Geochemistry 27(1): 63-68. (2008); ISSN: 10072802 .

Notes: Language of Original Document: Chinese.

Descriptors: coal ash / improving desert soil/ sewage sludge/ yulin city, shaanxi province/ ash/ desert soil/

feasibility study/ sludge/ soil improvement/ soil quality/ solid waste/ asia/ china / eurasia/ far east/ shaanxi/ yulin/ zea mays

Abstract: In this study, combined urban solid wastes including coal ash and sewage sludge have been firstly used to test if they could meliorate the quality of desert soil in the Maowusu Desert, south edge of the Yulin City of Shaanxi Province. The feasibility of this method has been discussed through the experiment of corn growing in pot. The results are given below. (1) With the addition of urban solid wastes into the desert soil, the nutrient contents of the treated desert soil are significantly increased, heavy metal contents of the treated desert soil are lower than the soil environmental quality standards, and the C/N ratios are in accordance with the soil standards. (2) With the addition of urban solid wastes into the desert soil, the physical properties of the treated desert soil has been greatly improved, as its bulk density is decreased, its porosity is increased, its fertilizer and water conservation capability is improved significantly, and its pH value is decreased obviously with the water consumption decreased 44% to 48%. (3) The desert soil (coarse sandy soil) has been changed as a sandy loam and light loam. This is of great significance for cultivating plant and restoring the ecological environment of the arid desert areas and for effectively reutilizing the urban solid wastes simultaneously.
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253. Field disease potential of tomato cultivation in West Bengal.

Kanjilal, S.; Samaddar, K. R.; and Samajpati, N.
Journal of Mycopathological Research 38(2): 121-123. (2000)
NAL Call #: QK600.J68 ; ISSN: 0971-3719
Descriptors: bleaching powder/ crop yield/ cultivars/ fly ash/ hybrids/ plant diseases/ plant pathogenic bacteria/ plant pathogenic fungi/ plant pathogens/ plant viruses/ soil amendments/ tomatoes/ urea/ yield losses/ chlorinated lime/ cultivated varieties/ Hyphomycetes/ Peronosporomycetes/ phytopathogens/ Pythiaceae
Abstract: Survey of disease potential of hybrid and deshi (indigenous) cultivars of tomatoes were conducted in Coochbehar, Jalpaiguri, Nadia and Murshidabad districts of West Bengal, India. Results showed heavy disease incidence on hybrid compared to deshi cultivars. Predominant diseases of hybrid cultivars were bacterial wilt caused by *Ralstonia solanacearum*, leaf curl by virus, blight caused by *Phytophthora infestans* and *Alternaria* sp. The field disease incidence of hybrid cultivars were severe in North Bengal acidic sandy soils than in nearly neutral loam soil of Nadia and Murshidabad districts. The deshi cultivars showed little or no infection due to the above pathogens. Bacterial wilt was the most serious disease in North Bengal districts. Crop loss in fields ranged from 70 to 100%, resulting in a complete loss of economic stability of the local farmers. In the absence of resistant cultivars, disease management by soil amendments was attempted. Significant decrease in wilt occurrence was observed following treatment of soil with urea, fly ash and active bleaching powder singly or in combination.
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254. Flue gas desulfurization by-products additions to acid soil: Alfalfa productivity and environmental quality.

Chen, L.; Dick, W. A.; and Nelson, S.
Environmental Pollution 114(2): 161-8. (2001)
NAL Call #: QH545.A1E52; ISSN: 0269-7491
Descriptors: agriculture/ air pollutants: metabolism/ coal/ environmental monitoring/ gases/ hydrogen-ion concentration/ incineration/ medicago sativa: growth & development/ refuse disposal/ soil/ soil pollutants: analysis
Abstract: Flue gas desulfurization (FGD) by-products are created when coal is burned and SO₂ is removed from the flue gases. These FGD by-products are often alkaline and contain many plant nutrients. Land application of FGD by-products is encouraged but little information is available related to plant responses and environmental impacts concerning such use. Agricultural lime (ag-lime) and several new types of FGD by-products which contain either vermiculite or perlite were applied at 0, 0.5, 1.0, and 2.0 times the soil's lime requirement (LR) rate to an acidic soil (Wooster silt loam). The highest FGD by-products application rate was equivalent to 75.2 Mg ha⁻¹. Growth of alfalfa (*Medicago sativa* L.) was significantly increased compared to the untreated control in the second year after treatment with yields for the 1 x LR rate of FGD approximately 7-8 times greater compared to the untreated control and 30% greater than for the commercial ag-lime. Concentrations of Mo in alfalfa were significantly increased by FGD by-products application, compared to the untreated control, while compared to the ag-lime treatment, concentrations of B increased and Ba decreased. No soil contamination problems were observed, even at the 2xLR rate, indicating these materials can be safely applied to agricultural soils.
This citation is from PubMed.

255. Flue gas desulfurization products as sulfur sources for corn.

Chen, L.; Kost, D.; and Dick, W. A.
Soil Science Society of America Journal 72(5): 1464-1470. (2008)
NAL Call #: 56.9 So3; ISSN: 03615995 [SSSJD].
Notes: doi: 10.2136/sssaj2007.0221.
Descriptors: desulfurization/ corn growth/ interactive effects/ nitrogen deficiency/ sulfur sources/ *Zea mays* L./ sulfur/ concentration (composition)/ cost-benefit analysis/ crop production/ fertilizer application/ gas/ growth response/ hybrid/ maize/ nutrient uptake/ silty loam/ sulfur/ water quality/ yield response/ North America/ Ohio/ United States/ Wooster
Abstract: Nitrogen deficiency in the soil often limits corn (*Zea mays* L.) production. Recently, S deficiency in several crops, including corn, has been observed. Little information is available, however, related to the interactive effects of N and S fertilization on corn growth and yield using modern corn hybrids. Field experiments were conducted from 2002 to 2005 to test corn response to seven rates (0-233 kg ha⁻¹) of N and two rates (0 and 33 kg ha⁻¹) of S applied to a silt loam soil at Wooster, OH. The S was applied as flue gas desulfurization (FGD) products and was primarily in the form of gypsum. Corn grain yields were significantly (P < 0.05) increased by N fertilizer addition from 2003 to 2005. Sulfur addition also significantly increased the average yield

of corn in 2002 and 2003. An N x S interaction for corn yield was observed in 2005. Sulfur application at 33 kg ha⁻¹ significantly ($P < 0.05$) increased corn yield at the intermediate N rate of 133 kg ha⁻¹, and showed a general tendency to increase yield at lower N rates in 2004 and 2005. Nitrogen and S concentrations in corn grain were increased by application of 200 kg N ha⁻¹, and S concentration was increased by S application in 2005. These results suggest that application of S fertilizer, with N, can promote the uptake of N by corn in S-responsive soils. This will decrease the amount of N required for high-yield corn production and reduce production costs and degradation of water quality associated with oversupply of N. © Soil Science Society of America. All rights reserved. © 2009 Elsevier B.V. All rights reserved.

256. Fly ash amendment of sandy soil to improve water and nutrient use efficiency in turf culture.

Pathan, S. M.; Aylmore, L. A. G.; and Colmer, T. D. *International Turfgrass Society Research Journal* 9: 33-39. (2001)

Descriptors: application rates/ biomass production/ fly ash/ growth/ heavy metals/ hydraulic conductivity/ lawns and turf/ nutrients/ phosphorus/ plant water relations/ rhizomes/ roots/ sandy soils/ soil amendments/ soil texture/ use efficiency/ water holding capacity/ water use efficiency/ Bermuda grass/ lawns and sports turf

Abstract: Sandy soils pose a particular challenge for water and nutrient management due to the low water retention and low ionic adsorption capacities of these substrates. Fly ash is comprised primarily of fine sand- and silt-sized particles so, if applied at sufficient rates, can permanently change soil texture. Fly ash from Kwinana Power Station and also Karrakatta sand were evaluated in field experiments conducted in Western Australia, from 1999 to 2000, for a range of physical and chemical properties. Field plots of Karrakatta sand were amended to a depth of 12-15 cm with several rates (0 to 20%, wt/wt) of fly ash and effects on soil water holding capacity, hydraulic conductivity, plant nutrition and turf growth during establishment were assessed. Plant available water increased progressively with increasing rates of fly ash additions, whereas hydraulic conductivity decreased. Fly ash also provided a source of plant available phosphorus. Possible release of heavy metals was evaluated using the toxicity characteristic leaching procedure. Values obtained for heavy metals were all well below the regulatory guideline levels. *Cynodon dactylon* cv. Wintergreen planted as rhizomes had a 1.3- to 1.6-fold larger root biomass after 9 weeks of growth in plots amended with fly ash when compared to non-amended plots. Thus, fly ash amendment may be a useful management option for turf culture on sandy soils.

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257. Fly ash: An exploitable resource for management of Australian agricultural soils.

Yunusa, I. A. M.; Eamus, D.; DeSilva, D. L.; Murray, B. R.; Burchett, M. D.; Skilbeck, G. C.; and Heidrich, C. *Fuel* 85(16 SPEC. ISS.): 2337-2344. (2006)

NAL Call #: S590 .G4 TP315; ISSN: 00162361 [FUELA].
Notes: doi: 10.1016/j.fuel.2006.01.033.

Descriptors: Plant growth/ Soil acidity/ Soil structure/ Agriculture/ Coal/ Combustion/ Costs/ Soils/ Coal

combustion products (CCP)/ Coal-fired power stations/ Plant growth/ Soil acidity/ Soil structure/ Soil treatment/ Fly ash/ Coal/ Costs/ Fly Ash/ Soil

Abstract: Agricultural soils in Australia have inherent limitations of structural and nutritional nature that pose major constraints to crop productivity. These soils are still productive due to intensive management that involves routine treatments with lime and gypsum at significant costs both to the farmer and the environment. Production costs associated with these inputs average about 30% of the total cost of soil treatment. Furthermore, reserves of gypsum are under pressure. There is therefore an opportunity for the more than 13 million tonnes of coal combustion products (CCPs) produced annually by coal-fired power stations to be utilised in the management of agricultural soils. At present, about 70% of the ash is emplaced within landfills. In this paper we briefly describe the main constraints of major agricultural soils that could be ameliorated with fly-ash. We used a model to estimate that application of fine (<20 μ m) fly-ash to the top 0.15 m coarse textured (sandy) soil would reduce hydraulic conductivity by 25% and so improve water-holding capacity. The same treatment of fine textured clayey soil with coarse (>20 μ m) fly-ash would increase conductivity by up to 20%. We cite examples of studies that have shown beneficial use of coal-ash for crop production, including our ongoing glasshouse study in which fly-ash was found to increase early growth vigour and seed yield by 20% for canola (*Brassica napus*). There are several issues, including costs and regulation, and knowledge-gaps that need to be addressed before adoption of CCP for routine soil management. © 2006 Elsevier Ltd. All rights reserved.

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258. Fly ash and sewage sludge as potential source of soil amendment and component of integrated plant nutrient supply system.

Yeledhalli, N. A.; Prakash, S. S.; and Ravi, M. V. *Environment and Ecology* 25S(Special 4): 998-1002. (2007)
NAL Call #: TD172.E5; ISSN: 0970-0420

Descriptors: application rates/ calcium/ copper/ crop yield/ fly ash/ groundnuts/ magnesium/ NPK fertilizers/ phosphorus/ plant nutrition/ potassium/ seed production/ sewage sludge/ soil amendments/ sulfur/ sunflowers/ use efficiency/ zinc/ elemental sulphur/ Mysore/ peanuts/ sulphur

Abstract: To determine the suitability of fly ash (FA) and sewage sludge (SS) in agricultural application, a field investigation was carried out for three years, 1999 to 2001. An attempt was made to develop an integrated plant nutrition supply system (IPNS) utilizing fly ash, sewage sludge and recommended dose of NPK fertilizers (RDF) for sunflower-groundnut cropping system in Karnataka, India. The treatments include: (1) control; (2) RDF (NPK); (3) 30 tonnes FA/ha; (4) 30 tonnes SS/ha; (5) 15 tonnes FA + SS/ha; (6) FA + RDF; (7) SS + RDF; and (8) FA + SS + RDF. The direct and residual effects of fly ash and sewage sludge were assessed based on crop response and changes in soil characterization. The application of FA at 30 tonnes/ha, SS at 30 tonnes/ha and RDF fertilizers increased the seed yield of sunflower, pod yield of groundnut and equivalent yield of both crops by 6.2 and 18.00%, respectively, as compared to RDF alone. There was beneficial effect of application of FA and SS individually or in combination with RDF at same level and

yield advantage derived by groundnut through IPNS was greater than sunflower. Further, there was improvement in nutrient use efficiency and the availability of P, K, Ca, Mg, S, Zn and Cu besides improving soil physico-chemical properties. The results indicated the prospect of safe disposal and utilization of FA and SS in agriculture for retaining production of sandy soils, reduced the use of costly chemical fertilizer, bring greater economy in cultivation and minimize environmental pollution. Reproduced with permission from the CAB Abstracts database.

259. Fly ash and slag mixture from heat and power generating plant as environmentally friendly industrial waste.

Zerbe, J.; Siepak, J.; and Elbanowska, H.
Polish Journal of Environmental Studies 10(2): 113-117. (2001); ISSN: 1230-1485
Descriptors: chemical composition/ environmental impact/ fly ash/ groundwater/ heavy metals/ mixtures/ slags/ soil amendments/ environmental effects
Abstract: Mixtures of fly ash and slags taken from the ash-disposal grounds at the Karolin plant in Poznan, Poland, were subjected to laboratory tests in order to estimate their influence on natural water and soil condition in order to check their possible application towards for recultivation or landfilling. The chemical composition of the mixtures and their extracts obtained with solutions of sulphuric acid (pH 2 or 4) as eluent (simulating acid rain) were determined. Assuming the criteria to be met by drinking water specified by the European Union and WHO documents, it was established that the heavy metals content in the fly ash and slag mixtures is not expected to have a negative effect on groundwater. Reproduced with permission from the CAB Abstracts database.

260. Fly ash application on two acid soils and its effect on soil salinity, pH, B, P and on ryegrass growth and composition.

Matsi, T. and Keramidis, V. Z.
Environmental Pollution 104(1): 107-112. (1999)
 NAL Call #: QH545.A1E52; ISSN: 0269-7491
Descriptors: acid soils/ application rates/ boron/ fly ash/ growth/ phosphorus/ plant composition/ red soils/ soil amendments/ soil ph/ soil salinity/ uptake/ yields/ chemical constituents of plants/ red earths
Abstract: Samples of alkaline fly ash from two different sources were added to two red Mediterranean acid soils at rates equal to 5, 20 and 50 g kg⁻¹ soil, and changes, relative to the untreated soil, of soil pH, salinity, B and P levels were measured. Ryegrass (*Lolium perenne*) was grown in pots containing fly ash-soil mixtures for 300 days, and dry biomass yield and cumulative plant uptake of B and P were calculated. Soil application of fly ash at these rates increased the pH, up to ~8, and the electrical conductivity of the saturation extract, up to ~2.5 dS m⁻¹, in both soils. Available soil P (0.5 M NaHCO₃ extractable) was unaffected by fly ash application. Water soluble B remained <1 mg litre⁻¹ in the saturation extract, and hot-water-extractable B was <1 mg kg⁻¹ soil. Dry biomass yield of ryegrass and cumulative plant uptake of B and P increased significantly with fly ash application. Therefore, fly ash with

low B and salt content can be used as liming agents in acid soils at rates not exceeding 40 t ha⁻¹. Potential environmental impacts must also be considered. Reproduced with permission from the CAB Abstracts database.

261. Fly ash as a liming material for corn production.

Tarkalson, D. D.; Hergert, G. W.; Stevens, W. B. ; McCallister, D. L.; and Kachman, S. D.
Soil Science 170(5): 386-398. (2005)
 NAL Call #: 56.8 So3; ISSN: 0038-075X
Descriptors: acid soils/ acidification/ aluminium/ calcium/ crop yield/ exchangeable aluminium/ exchangeable calcium/ exchangeable magnesium/ exchangeable potassium/ exchangeable sodium/ fly ash/ liming/ magnesium/ maize/ potassium/ sandy loam soils/ sodium/ soil acidity/ soil ph/ soil types/ aluminum/ corn/ exchangeable aluminum/ United States of America
Abstract: Fly ash produced as a by-product of subbituminous coal combustion can potentially serve as an alternative liming material without negatively affecting corn (*Zea mays* L.) production in areas where use of conventional liming materials can be uneconomical due to transportation costs. A study was conducted to determine if fly ash produced from the Nebraska Public Power District Gerald Gentleman Power Station located in Sutherland, NE could be used as an alternative liming material. This study had the following objectives: (1) compare the effects of fly ash on soil pH with other common agricultural lime materials; (2) determine the effects of fly ash on percent Al saturation in selected soils; and (3) determine the effects of fly ash on corn grain yields. Combinations of dry fly ash (DFA), wet fly ash (WFA), beet lime (by-product of sugar beet [*Beta vulgaris* L.] processing) (BL), and agricultural lime (AGL) were applied at rates ranging from 0.43 to 1.62 times the recommended lime rate to plots on four acidic soils (Anselmo fine sandy loam, Hord fine sandy loam, Holdrege sandy loam, and Valentine fine sand). Soil samples were collected to a depth of 0.2 m from plots and analysed for pH before lime applications and twice periodically after lime application. The Hord and Valentine soils were analysed for exchangeable Ca, Mg, K, Na, and Al for determination of percent Al saturation on selected treatments and sampling dates. Corn grain yields were determined annually. Depending on the lime source, soil pH increased in the upper 0.2 m of soil the year after application compared with the pre-application soil pH values for some sites and years, whereas in others there were no significant increases in pH. However, all lime materials at each site failed to raise the soil pH in the upper 0.2 m of all the treatments and soil types to the target pH of 6.5. Fly ash and AGL treatments did not significantly increase corn grain yields compared with the control on the Anselmo, Hord, and Holdrege soils. At the Hord site, AGL and DFA significantly reduced percent Al saturation by 3.1% and 3.7% compared with the control 5 years after application, respectively. Fly ash did not negatively affect corn grain yields compared with AGL. Yields were 12,472, 12,233, and 12,177 kg ha⁻¹ for the Anselmo, Holdrege, and Hord sites averaged over all treatments and years. The lack of yield response to lime additions was potentially a result of lime materials not raising the soil pH to sufficient levels, higher subsoil pH values, or the exchangeable Al not being

high enough prior to lime material application to reduce grain yields in these soils. We conclude that the fly ash utilized in this study and applied at rates in this study, increases soil pH comparable to agricultural lime and is an appropriate alternative liming material. Reproduced with permission from the CAB Abstracts database.

262. Fly ash as a liming material for cotton.

Stevens, G. and Dunn, D.

Journal of Environmental Quality 33(1): 343-348. (Jan. 2004-Feb. 2004)

NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: fly ash/ liming/ soil amendments/ *Gossypium hirsutum*/ lint cotton/ sandy loam soils/ chemical constituents of plants/ magnesium/ boron/ sodium/ soil chemical properties/ soil ph/ crop yield/ field experimentation/ Missouri

Abstract: A field experiment was conducted to determine the effect of fly ash from a coal combustion electric power facility on soil acidity in a cotton (*Gossypium hirsutum* L.) field. Fresh fly ash was applied to a Bosket fine sandy loam (fine-loamy, mixed, thermic Mollic Hapludalf) soil with an initial soil pH(salt) of 4.8. The fly ash was equivalent to 42 g kg⁻¹ calcium carbonate with 97% passing through a 60 mesh (U.S. standard) sieve. Fly ash was applied one day before cotton planting in 1999 at 0, 3.4, 6.7, and 10.1 Mg ha⁻¹. No fly ash was applied in 2000. Within 60 d of fly ash application in 1999, all rates of fly ash significantly increased soil pH above 6.0. Manganese levels in cotton petioles were reduced significantly by 6.7 and 10.1 Mg ha⁻¹ of fly ash. Soil boron (B) and sodium (Na) concentrations were significantly increased with fly ash. In 1999, B in cotton leaves ranged from 72 to 84 mg kg⁻¹ in plots with fly ash applications. However, no visual symptoms of B toxicity in plants were observed. In 1999, cotton lint yield decreased on average 12 kg ha⁻¹ for each Mg of fly ash applied. In 2000, cotton yields were significantly greater for the residual 3.4 and 6.7 Mg fly ash ha⁻¹ plots than the untreated check. Due to the adverse yield effects measured in the first year following application, fly ash would not be a suitable soil amendment for cotton on this soil at this time. This citation is from AGRICOLA.

263. Fly ash as a liming material for cotton: A rate study.

Dunn, D. and Stevens, G.

In: 2000 Proceedings Beltwide Cotton Conferences. San Antonio, USA.; Vol. 2.; pp. 1402-1404; 2000.

Descriptors: application rates/ boron/ chemical composition/ cotton/ fly ash/ liming/ manganese/ plant composition/ potassium/ soil acidity/ soil amendments/ soil ph/ chemical constituents of plants/ Mn/ United States of America

Abstract: Fly ash from a coal burning electric power plant was used to reduce the soil acidity in a Southeast Missouri cotton field. Three rates of fly ash as well as an untreated check were compared. Fly ash treatments raised soil pH levels over a 5-month period. Fly ash rate did not significantly affect cotton lint yields. Boron, potassium, and sodium levels in cotton leaves and petioles collected during full bloom were increased for fly ash treatments. The magnitude of these increases corresponds to the fly ash

application rates. Manganese levels in leaf and petiole were reduced for fly ash treatments. Total soil manganese levels were similar for all treatments. DTPA extractable manganese levels were lower for fly ash treatments. Reproduced with permission from the CAB Abstracts database.

264. Fly ash as a soil ameliorant for improving crop production: A review.

Sudha Jala and Dinesh Goyal

Bioresource Technology 97(9): 1136-1147. (2006)

NAL Call #: TD930.A32; ISSN: 0960-8524

Descriptors: biomass/ biomass production/ crop production/ degraded land/ fly ash/ groundwater pollution/ pollutants/ polluted soils/ polluted water/ reviews/ soil amendments/ soil pollution/ soil types/ solid wastes/ waste disposal/ waste management/ waste utilization/ water quality/ water composition and quality

Abstract: Fly ash, a resultant of combustion of coal at high temperature, has been regarded as a problematic solid waste all over the world. Many possible beneficial applications of fly ash are being evaluated to minimize waste, decrease cost of disposal and provide value-added products. The conventional disposal methods for fly ash lead to degradation of arable land and contamination of the ground water. However fly ash is a useful ameliorant that may improve the physical, chemical and biological properties of problem soils and is a source of readily available plant macro and micronutrients. In conjunction with organic manure and microbial inoculants, fly ash can enhance plant biomass production from degraded soils. Detailed studies on the nature and composition of fly ash, conducted during the latter half of the 20th century have helped in repeatedly confirming the various useful applications of this hitherto neglected industrial waste. The purpose of this paper is to review the available information on various attributes of fly ash and explore the possibility of exploiting them for agronomic advantage.

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265. Fly ash as a source of plant nutrients and soil conditioner.

Anjali Deshmukh; Matte, D. B.; and Bharti Bhaire

Journal of Soils and Crops 9(2): 278-279. (1999); ISSN: 0971-2836

Descriptors: fly ash/ plant nutrition/ soil amendments/ soil conditioners/ trace element fertilizers/ micronutrient fertilizers

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266. Fly ash--can it be used as nursery mix?

Dhevagi, P.; Udayasurian, C.; and Oblisami, G.

Journal of Ecobiology 16(1): 33-36. (2004)

NAL Call #: QH540.J56 ; ISSN: 0970-9037

Descriptors: container grown plants/ fly ash/ growth/ ornamental plants/ seed germination/ seedlings/ soil amendments/ vigour/ microbial communities/ ornamentals/ vigor

Abstract: The effect of fly ash as a nursery mix for raising *Abizzia labbek* [*Albizia lebbeck*] tree seedlings in polybags was studied. Flyash had glass like particles (0.1 mm) with

alkaline pH and had an EC of 1.4 dS m⁻¹. It had low levels of nitrogen and phosphorus and considerable amounts of potassium. As the flyash content decreased, the vigour index and germination percentage of the seedlings increased. The volume index was maximum at 30%. Soil amendment with flyash seemed to result in decreased microbial numbers from 87.0 to 34.7x10⁶/g. Reproduced with permission from the CAB Abstracts database.

267. Fly ash characteristics and its incorporation effects on germination of maize and rice.

Sharma, S. K.; Kalra, N.; and Singh, G. R.
Journal of Scientific and Industrial Research 60(12): 951-952. (2001)

NAL Call #: 475 J82; ISSN: 0022-4456

Descriptors: fly ash/ maize/ rice/ seed germination/ corn/ paddy

Abstract: Pot culture experiments were conducted during the summer season of 1996 to evaluate the effect of fly ash addition in soil on germination and stand establishment of maize (*Zea mays*) and rice (*Oryza sativa*). Fly ash was added to soil at 0, 5, 10, 15 or 20% levels for both the crops. The changes in physical and physico-chemical characteristics of soil, due to fly ash addition were analysed. Data on germination time, i.e. time taken for 75% germination, and delay index, a normalized parameter, was analysed and discussed.

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268. Fly ash effect on improving soil properties and rice productivity in Korean paddy soils.

Lee Hyup; Ha HoSung; Lee ChangHoon; Lee YongBok; and Kim PilJoo

Bioresource Technology 97(13): 1490-1497. (2006)

NAL Call #: TD930.A32 ; ISSN: 0960-8524

Descriptors: application rates/ crop yield/ fly ash/ loam soils / paddy soils/ phosphorus/ productivity/ rice/ sandy soils/ silicates/ silicon/ silt loam soils/ soil pH/ soil properties/ soil types/ paddy/ South Korea

Abstract: Paddy soils in Korea generally require the addition of Si to enhance rice productivity. Coal combustion fly ash, which has a high available Si content and alkaline pH, was selected as a potential source of Si in this study. Two field experiments were carried out to evaluate rice (*Oryza sativa*) productivity in silt loam and loamy sand soils to which 0, 40, 80, and 120 Mg ha⁻¹ of fly ash were added with 2 Mg ha⁻¹ Si as a control. Fly ash increased the soil pH and available Si and P contents of both soils. The amount of available B increased to a maximum of 2.57 mg kg⁻¹, and the B content of the rice plants increased to a maximum of 52-53 mg kg⁻¹ following the addition of 120 Mg ha⁻¹ fly ash. The rice plants did not show toxicity effects. The highest rice yields were achieved following the addition of around 90 Mg ha⁻¹ fly ash. The application of fly ash increased Si, P and K uptake by the rice plants, but did not result in an excessive uptake of heavy metals in the submerged paddy soil. In conclusion, fly ash could be a good supplement to other inorganic soil amendments to improve the nutrient balance in paddy soils.

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269. Fly ash in integrated plant nutrition system and its impact on soil properties yield and nutrient uptake of groundnut.

Selvakumari, G.; Baskar, M.; Jayanthi, D.; and Mathan, K. K.

Madras Agricultural Journal 86(10/12): 556-561. (1999)

NAL Call #: 22 M262; ISSN: 0024-9602

Descriptors: composts / crop yield/ fly ash/ groundnuts/ lateritic soils/ NPK fertilizers/ nutrient availability/ nutrient uptake/ plant nutrition/ soil amendments/ soil fertility/ soil properties/ soil types/ peanuts

Abstract: A pot experiment was conducted in 1997 using groundnut (VR 12) as a test crop in a laterite soil to study the effect of fly ash (FA) alone and in combination with compost and fertilizers on nutrient uptake, yield of groundnut and available NPK status of the postharvest soil. The increase in the alkaline KMnO₄-N status of the postharvest soil was marked by the addition of FA alone as well as FA integrated with fertilizers and compost. The application of FA also significantly increased the nutrient uptake and yield of groundnut. The presence of essential plant nutrients, and the physical properties of FA could be attributed for its favourable effects on yield of groundnuts as well as for the maintenance of soil fertility. It was also inferred that integration of FA with other components of the nutrient supply system, on account of the synergistic effects, resulted in better nutrient uptake, higher yield and maintenance of soil fertility.

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270. Fly ash incorporation effect on soil health and yield of maize and rice.

Sharma, S. K.; Naveen Kalra; and Singh, G. R.

Journal of Scientific and Industrial Research 60(7): 580-585. (2001)

NAL Call #: 475 J82; ISSN: 0022-4456

Descriptors: bulk density/ cadmium/ copper/ crop yield/ fly ash/ growth/ hydraulic conductivity/ iron/ maize / manganese/ moisture/ rice/ soil fertility/ wilting point/ zinc/ corn/ Mn/ paddy

Abstract: Field experiments were conducted in villages around National Capital Power Project, Dadri, Uttar Pradesh, India during 1995 to evaluate fly ash incorporation effects on soil health, and growth and yield of maize (*Zea mays*) and rice (*Oryza sativa*). Fly ash application levels (up to 10t/ha) were decided on the basis of an ash/dust fall range from 5 to 12 t/ha/y in the villages adjoining the thermal power station. The grain yield of maize increased in fly ash-treated plots, whereas rice yield was similar to fly ash treated plots. Fly ash-treated plots had marginally higher uptake of Zn, Cu, Fe, Mn and Cd, but values were insignificant. Fly ash application in soil resulted in lower bulk density. Fly ash addition also reduced hydraulic conductivity and improved moisture retention at field capacity and permanent wilting point. These changes in the soil characteristics might have been due to modifications in the macro- and micro-pore size distribution which also contributed to increased yield of maize in light and medium textured soils.

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271. Fly-ash-induced oxidative stress and tolerance in *Prosopis juliflora* L grown on different amended substrates.

Sinha, S.; Rai, U. N.; Bhatt, K.; Pandey, K.; and Gupta, A. K.

Environmental Monitoring and Assessment 102(1/3): 447-457. (2005)

NAL Call #: TD194 .E5 ; ISSN: 0167-6369

Descriptors: chemical composition/ cysteine/ farmyard manure/ fly ash/ soil amendments/ thiols/ tolerance/ biofertilizers/ FYM/ malondialdehyde/ mercaptans/ oxidative stress

Abstract: Field experiments were conducted to study the impact of metal accumulation on malondialdehyde (MDA), cysteine and non-protein thiol (NPSH) contents in the plants of *Prosopis juliflora* grown on the fly ash (FA) amended with soil, blue green algae (BGA) biofertilizer, farm yard manure, press mud and *Rhizobium* inoculation. The analysis of data revealed that the level of MDA, cysteine and NPSH was higher in the roots of the plant than leaves, which was found positively correlated with metal accumulation. An increase of 361.14, 64.25 and 305.62% in MDA, cysteine and NPSH contents, respectively was observed after 45 days in the roots of the plants grown in 100% FA as compared to 100% garden soil (GS). The level of MDA, cysteine and NPSH was found less in the plants grown on various amendments of FA showing ameliorating effect on the toxicity induced due to the accumulation of metals. The decrease in MDA, cysteine and NPSH contents was higher in *Rhizobium*-inoculated plants as compared to uninoculated plants grown on 100% FA. The results showed a high tolerance potential of the plant, which is further increased by inoculating the plant with FA-tolerant *Rhizobium* showing feasibility of using *P. juliflora* in environmental monitoring of FA landfills.

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272. Fly-ash induced synthesis of phytochelatin in chickpea (*Cicer arietinum* L.) plants.

Gupta, D. K.; Rai, U. N.; Tripathi, R. D.; Sinha, S.; Rai, P.; and Inouhe, M.

Journal of Environmental Biology 26(3): 539-46. (July 2005)

NAL Call #: QH540.J65 ; ISSN: 0254-8704 .

16334294

Descriptors: Carbon: chemistry: metabolism/ Chromatography, High Pressure Liquid/ *Cicer*: metabolism/ Cysteine: analysis/ Electric Conductivity/ Glutathione: analysis: biosynthesis/ Hydrogen / Ion Concentration/ India/ Metals, Heavy: analysis: metabolism/ Particulate Matter/ Phytochelatin/ Soil: analysis/ Species Specificity

Abstract: Phytochelatin and related metabolites (cysteine and GSH) were found to be induced in the shoots of two varieties of *Cicer arietinum* viz., CSG-8962 and C-235 grown under different amendments of fly-ash with garden soil and press mud. Cysteine, GSH, PCs and its speciation were found in higher concentrations in amended fly-ash than in the control 100% soil. Two species of metal binding peptides i.e., PC2 and PC4 were found in both varieties and in amendments, however, their concentration varied depending upon the fly-ash concentrations in both amendments. Further, var. CSG-8962 was found more tolerant than var. C-235 because of higher concentrations of PCs and related metabolites.

This citation is from PubMed.

273. Fly ash influence on near-surface temperature of a clay loam soil.

Hammermeister, A. M.; Chanasyk, D. S.; and Naeth, M. A. *Canadian Journal of Soil Science* 78(2): 345-350. (1998)

NAL Call #: 56.8 C162 ; ISSN: 0008-4271

Descriptors: application rates/ bulk density/ capacity/ clay fraction/ clay loam soils/ coal mined land/ density/ fly ash/ particle size/ particle size distribution/ soil/ soil amendments/ soil temperature/ soil water/ soil water content/ specific heat/ summer/ temperature/ treatment/ water content/ soil moisture

Abstract: Four fly ash treatments (0, 100, 200, and 400 t ha⁻¹) were applied to clay loam soil in a randomized block design at a coal mine site in Alberta, Canada. Bi-hourly soil temperatures were measured on 3 summer days over 2 years, and afternoon temperatures were measured on randomly selected spring days at 5-, 10-, and 20-cm depths in the four fly ash treatments. Temperatures were measured in conjunction with surface bulk density, water content, and particle size distribution which were also used to calculate thermal heat capacity. Fly ash decreased percentage clay, soil water content, and soil heat capacity. Fly ash amendment did not significantly increase mean daily soil temperature under dry conditions. Generalizations in the literature regarding the influence of fly ash on soil temperature, bulk density, and water-holding capacity must be considered carefully since they generally relate only to coarse to medium textured soils.

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274. The fly ash influenced the heavy metal status of the soil and the seeds of sunflower: A case study.

Shazia Siddiqui; Ahmad, A.; and Hayat, S.

Journal of Environmental Biology 25(1): 59-63. (2004)

NAL Call #: QH540.J65; ISSN: 0254-8704

Descriptors: bicarbonates/ calcium/ carbonate/ case studies/ cation exchange capacity/ chloride/ crop yield/ electrical conductivity/ fly ash/ heavy metals/ lead/ manganese/ phosphorus/ polluted soils/ porosity/ potassium/ sandy loam soils/ seed production/ seed quality/ seeds/ soil amendments/ soil ph/ soil pollution/ soil types/ sulfate/ sunflowers/ trace elements/ water holding capacity/ zinc/ microelements/ Mn

Abstract: In this case study, four cultivars of sunflower (*Helianthus annuus*) were grown in a sandy loam soil, supplemented with graded (v/v) quantity (0, 20, 40, 60, 80, 100%) of fly ash released by the combustion of coal from a thermal power plant. The presence of fly ash in the soil increased its porosity, water holding capacity, pH, electrical conductivity, cation exchange capacity, and the content of sulfate, carbonate, bicarbonate, chloride, phosphorus, potassium, calcium and various trace elements. However, in the seeds, except for Fe, Pb, Mn and Zn and other heavy metals remained untraced up to 40% of the fly ash, above that their quantity slightly increased but the values were very much under the permissible limits.

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275. Flyash as a carrier for *Rhizobium* inoculant.

Lal, J. K. and Mishra, B.

Journal of Research, Birsa Agricultural University 10(2):

191-192. (1998); ISSN: 0971-1724

Descriptors: charcoal / farmyard manure/ fly ash/ inoculant

carriers / lignite/ longevity/ storage life/ FYM

Abstract: An incubation study was conducted to test the suitability of Bokaro fly ash, alone or in combination with lignite, charcoal and farmyard manure, to act as a carrier for the Rhizobium inoculant. Rhizobium leguminosarum broth containing 108 cells/ml was mixed with the prospective carriers, packed in polythene and maintained at room temperature. Observations were taken on 0, 15, 30, and 60 days after incubation. Charcoal and lignite produced the highest populations of Rhizobium, possibly due to its ability to absorb toxic compounds and aerate the medium. Fly ash in combination with charcoal (1:1 or 1:3) had the highest population. The Rhizobium increased up to 45 days, and then remained constant. It is concluded that 25% fly ash in combination with lignite or charcoal can be used as a carrier for bioinoculants.

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276. Flyash as a post-harvest preservative for five commonly utilized pulses.

Mendki, P. S.; Maheshwari, V. L.; and Kothari, R. M. *Crop Protection* 20(3): 241-245. (Apr. 2001); ISSN: 0261-2194 [CRPTD6]

Descriptors: Callosobruchus chinensis/ storage pests/ fly ash/ insect control/ postharvest treatment/ soybeans/ mung beans/ black gram/ chickpeas/ cowpeas/ waste utilization/ food quality/ seed germination/ nutritive value/ infestation

Abstract: Flyash, one of the major industrial wastes, generated as a result of coal burning in thermal power stations, was evaluated for post-harvest preservation of five commonly used pulses; viz. soybean (*Glycin max*), bengal gram (*Cicer arietinum*), green gram (*Vigna radiata*), black gram (*V. mungo*) and red gram (*V. unguiculata*). All the pulses were deliberately infested with stored grain pest, commonly known as pulse beetle, *Callosobruchus chinensis* and treated with 1 gm flyash per 5 kg of pulses under ambient storage conditions for 18 months. No adult *C. chinensis* were found in pulses treated with flyash even after 12 months of treatment. After 18 months, bengal gram was most infested, both in terms of number of insects observed in gunny bags and percent damaged grains, whereas soybean and black gram were least infested. Percentage insect-damaged grains were directly proportional to the number of insects observed in gunny bags. There was no effect of flyash on the nutritional quality and percent germination of pulses.

This citation is from AGRICOLA.

277. Flyash as a soil conditioner and fertilizer.

Naveen Kalra; Jain, M. C.; Joshi, H. C.; Choudhary, R.; Harit, R. C.; Vatsa, B. K.; Sharma, S. K.; and Vinod Kumar *Bioresource Technology* 64(3): 163-167. (1998)

NAL Call #: TD930.A32 ; ISSN: 0960-8524

Descriptors: amendments/ available water/ bulk density/ canopy/ capacity/ density/ effects/ electrical conductivity/ field capacity/ fly ash/ grain/ health/ hydraulic conductivity/ incorporation/ Indian mustard/ iron/ maize/ manganese/ moisture/ pH/ power stations/ productivity/ properties/ retention/ rice/ soil/ soil conditioners/ soil properties/ trace elements/ uptake/ wheat/ wilting/ wilting point/ yields/ zinc/ Capparales/ corn/ crown cover/ hydrogen ion concentration/ leaf canopy/ microelements/ Mn/ New Delhi/ paddy/ potential of hydrogen

Abstract: Field experiments were conducted in Uttar Pradesh and New Delhi, India, to evaluate the effects of fly ash incorporation (up to 50 t/ha) on soil properties and the growth and yield of wheat, mustard (*Brassica juncea*), rice and maize. The grain yield of maize increased in fly ash-treated plots with the addition of ash up to a maximum addition of 10 t/ha. Dusting crop canopies with ash decreased the yield in proportion to the amount applied. The yield of wheat increased up to an addition of ash of 20 t/ha, and declined thereafter, but was still higher than the yield when no fly ash was added. Rice yield when 10 t/ha of ash was added was similar to that with no fly ash, whereas mustard showed improvements in seed yield with fly ash addition at 10 t/ha. fly ash-treated plots had a marginally higher uptake of Zn, Cu, Fe, Mn and Cd. fly ash addition to soil resulted in lower bulk density, although the differences compared with non-treated plots were not significant. The addition of fly ash also reduced the hydraulic conductivity and improved moisture retention at field capacity and wilting point, but no changes in available water were observed. These changes in soil properties might have been due to modifications in macro- and micro-pore size distribution and which may also have contributed to the increased crop yields in light- and medium-textured soils. Reproduced with permission from the CAB Abstracts database.

278. Flyash for acidic soils.

Sengupta, P. 22(1): 119-120. (2002); ISSN: 02537141 [IJEPTD]

Descriptors: coal/ agriculture/ combustion/ crop improvement/ environmental reclamation/ fly ash/ forestry/ land use/ short survey/ soil acidity/ Fraxinus
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279. Formulation of environmentally sound waste mixtures for land application.

Schumann, A. W. and Sumner, M. E. *Water, Air and Soil Pollution* 152(1/4): 195-217. (2004) NAL Call #: TD172 .W36; ISSN: 0049-6979

Descriptors: ammonia/ application to land/ boron/ calcium carbonate/ fertilizers/ fly ash/ groundwater pollution/ growth/ heavy metals/ manganese/ nitrite/ nitrogen/ nutrient availability/ nutrient deficiencies/ nutrients/ organic wastes/ phosphorus/ phytotoxicity/ plant nutrition/ polluted soils/ polluted water/ potassium/ poultry manure/ sewage sludge/ soil alkalinity/ soil pollution/ soil types/ soybeans/ water quality/ land application/ Mn/ poultry litter/ soybeans/ water composition and quality

Abstract: Major impediments to the land application of coal combustion byproducts (fly ash) for crop fertilization have been the presence of heavy metals and their relatively low and imbalanced essential nutrient concentration. Although nutrient deficiencies, in particular N, P, and K, may be readily augmented by adding organic wastes such as sewage sludge and animal manure, the indiscriminate application of mixtures to crops can cause excessive soil alkalinity, imbalanced nutrition (P, Mg), phytotoxicities (B, Mn, ammonia, nitrite), and unspecified contamination of the food chain by elements such as As. In this study, nutrient availability data and linear programming (LP) were used to solve these problems by formulating fly ash-biosolid triple mixtures which complied with both plant and soil fertilization requirements, and met existing U.S.A. environmental

regulations for total As application in sewage sludge (EPA-503). Thirteen different fly ash samples were LP-formulated with sewage sludge, poultry manure, CaCO₃, and KCl to yield 13 unique mixtures, which were then evaluated in greenhouse pot experiments. Results indicated that normal growth and balanced nutrition of sorghum (*Sorghum bicolor* L.) and soybean (*Glycine max* (L.) Merr.) crops were achieved in all mixtures, comparable to a balanced fertilizer reference treatment, and significantly better than the untreated control. Phytotoxic levels of B, NH₃, NO₂⁻, overliming problems, and excessive As levels which were previously encountered from indiscriminate use of these waste materials, were all well controlled by LP-formulated mixtures. Most fly ash quantities in mixtures were limited by either available B (<4 kg ha⁻¹) or total As (<2 kg ha⁻¹) restrictions during formulation, while the most alkaline fly ash was limited by its high calcium carbonate equivalence (CCE=53.9%). These results confirmed that fly ash land application should not be at arbitrary fixed rates, but should be variable, depending on the soil, crop, and particularly the fly ash chemistry.

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280. Fungal ergosterol as an indicator of heavy metal accumulation in soils amended with coal ash.

Aparna Asokan; Mohini Saxena; and Asokan Pappu
Fresenius Environmental Bulletin 13(1): 16-20. (2004);
ISSN: 1018-4619

Descriptors: agricultural production/ ash/ biological indicators/ clay loam soils/ clay soils/ coal/ ergosterol/ farmyard manure/ heavy metals/ polluted soils/ productivity/ sandy soils/ silty soils/ soil amendments/ soil fungi/ soil pollution/ soil types/ soil water content/ waste land/ waste management/ waste utilization/ FYM/ waste ground

Abstract: Based on the results obtained from the lab scale study, pilot scale experiments were conducted on the use of 15-25% i.e. 300 to 650 MT ha⁻¹ (metric tonnes per hectare of land) of coal ash to increase the agricultural productivity of sandy, silty clay loam and clayey soil of wasteland located at different parts of India. The present work is an attempt to evaluate the contribution of coal ash addition to these soils in terms of heavy metal loading through fungal invasion via ergosterol estimation in sequestering the heavy metals. The ergosterol estimation was done by HPLC. Ergosterol was eluted at 8 min after injecting of 20 micro l of the extract. An increased content of ergosterol with increased concentration of coal ash is noticed, which is influenced by the sample moisture content, thus freeze-dried samples have 25% more ergosterol content. Statistically significant results were obtained with freeze-dried soil samples with 25% coal ash addition on sandy soil (p<0.05), while with silty clay loam or clayey soil and 20% or 15% coal ash application, respectively, significant results at p<0.05 were obtained with Farm Yard Manure (FYM). Soil amended with coal ash addition showed an increase in concentration of heavy metals and trace elements with higher dose of coal ash treatment.

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281. Geotechnical characteristics of fly ash-soil mixtures.

Kaniraj, S. R. and Havanagi, V. G.
Geotechnical Engineering 30(2): 129-147. (Aug. 1999);
ISSN: 0046-5828.

Notes: Features: References: 23; illus. incl. 8 tables.
Descriptors: ash/ Asia/ Atterberg limits/ Baumineral/ Bochum Germany/ California bearing ratio/ Central Europe/ chemical composition/ compaction/ Delhi India/ Europe/ Germany/ granulometry/ India/ Indian Peninsula/ New Delhi India/ North Rhine-Westphalia Germany/ permeability/ physical properties/ power plants/ Rajghat thermal power station/ shear tests/ soil mechanics/ soils/ triaxial tests/ Engineering geology

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282. Germination behaviour of teak (*Tectona grandis* Linn F.) drupes in flyash incorporated medium.

Masilamani, P. and Dharmalingam, C.
Advances in Plant Sciences 12(1): 57-61. (1999)
NAL Call #: QK1.A38; ISSN: 0970-3586

Descriptors: age/ fly ash/ forest nurseries/ growing media/ seed germination/ seedling growth/ seeds/ soil amendments/ Madras/ potting composts/ rooting media
Abstract: The germination of fresh and 1-yr-old teak drupes collected from a 60-yr-old seed production area in Tamil Nadu (India) was tested in nursery growing media incorporating fly ash from the coal fired plant of the Pugalur Paper Industry. Only drupes of >10 mm in diameter were used in the tests, and before sowing they were pretreated by alternate soaking and drying at 12-h intervals over 6 days. The test media were sand, red earth, red earth + sand + farmyard manure (FYM) at 2:1:1, fly ash, fly ash + red earth + FYM (1:1:1), and fly ash + sand + FYM (1:1:1). The older drupes germinated and produced more and better quality seedlings than the fresh drupes in all the media. The best germination, seedling growth and vigour were in the sand only medium, but this was closely followed by the fly ash + red earth + FYM mixture. Fly ash alone gave the poorest germination and seedling performance. Reproduced with permission from the CAB Abstracts database.

283. Growing highbush blueberry in coal ash-compost mixtures.

Zimmerman, Richard H.
In: 96th Annual International conference of the American Society for Horticultural Science. Minneapolis, Minnesota, USA.; Vol. 34(3); pp. 475; 1999.
NAL Call #: SB1.H6

Descriptors: Horticulture: Agriculture/ Ericaceae: Angiosperms, Dicots, Plants, Spermatophytes, Vascular Plants/ coal ash compost mixture culture: cultivation method/ Flowering/ Fruit Set/ Shoot Growth/ Meeting Abstract/ Meeting Poster
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284. Growth analysis of spring wheat growing in the soil substrate at different content of fly ash.

Gregorczyk, A.
Roczniki Nauk Rolniczych Seria A, Produkcja Roslinna 114(1/2): 13-24. (1999)
NAL Call #: 20.5 R59 SER. A; ISSN: 0080-3650.

Notes: Original title: Wskaznikowa analiza wzrostu pszenicy jarej rosnacej na podozu o zroznicowanej zawartosci popioow lotnych.

Descriptors: fly ash/ growth/ growth analysis/ growth rate/ leaf area/ plant development/ sandy soils/ soil amendments/ wheat

Abstract: Spring wheat cv. Eta grown in pots of light soil with or without amendment with fly-ash (1 kg per 9 kg pot) and harvested 12 times during vegetative growth. Relative growth rate (RGR), unit leaf rate (ULR), leaf area ratio (LAR), specific leaf area (SLA) and leaf weight ratio (LWR) were calculated. Fly ash amendment reduced RGR and delayed wheat development. Changes in RGR mainly resulted from the variability of LAR, which was determined by LWR.

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285. Growth and biochemical parameters of *Cicer arietinum* L. grown on amended fly ash.

Gupta, D. K.; Tripathi, R. D.; Rai, U. N.; Mishra, S.; Srivastava, S.; Dwivedi, S.; and Maathuis, F. J. M.

Environmental Monitoring and Assessment 134(1-3): 479-487. (Nov. 2007)

NAL Call #: TD194 .E5 ; ISSN: 0167-6369

Descriptors: ascorbic acid/ *Cicer arietinum*/ cysteine/ fly ash/ nitrate reductase/ Internet resource

Abstract: Growth and metal accumulation were investigated in two *Cicer arietinum* L. varieties (var. CSG-8962 and var. C-235) when grown in various combinations of fly ash (FA) amended with garden soil (GS), press mud (PM) or saw dust (SD). In addition, the levels of photosynthetic pigments, nitrate reductase (NR) activity, cysteine, non-protein thiols (NP-SH), and ascorbic acid were studied. FA amended with GS or PM led to a 5-10 times increase in biomass compared to FA control and was most pronounced in the less metal tolerant variety CSG-8962. Amendment of FA with either GS or PM only moderately increased the contents of some essential metals whereas the non-essential Cd and Cr remained similar or decreased slightly compared to FA control. FA combined with either GS or PM increased the amount of photosynthetic pigments and was largely absent when SD was added to FA. Improved nitrogen availability led to increased nitrate reductase (NR) activity with all amendments but less so with SD. Metal stress indicating parameters were generally reduced (cysteine and non-protein thiols) or unchanged (ascorbic acid). In conclusion, of the tested ameliorants both GS and PM greatly improved growth of *C. arietinum* making FA a suitable component of plant growth substrates.

This citation is from AGRICOLA.

286. Growth and elemental accumulation by canola on soil amended with coal fly ash.

Yunusa, I. A.; Manoharan, V.; DeSilva, D. L.; Eamus, D.; Murray, B. R.; and Nissanka, S. P.

Journal of Environmental Quality 37(3): 1263-70. (May 2008-June 2008)

NAL Call #: QH540.J6; ISSN: 0047-2425.

18453446

Descriptors: plant growth/ elemental accumulation/ canola/ soil amendment/ coal fly ash

Abstract: To explore the agronomic potential of an Australian coal fly ash, we conducted two glasshouse experiments in which we measured chlorophyll fluorescence, CO₂ assimilation (A), transpiration, stomatal conductance, biomass accumulation, seed yield, and elemental uptake for canola (*Brassica napus*) grown on soil amended with an alkaline fly ash. In Experiment 1, application of up to 25 Mg/ha of fly ash increased A and plant weight early in the season before flowering and seed yield by up to 21%. However, at larger rates of ash application A, plant growth, chlorophyll concentration, and yield were all reduced. Increases in early vigor and seed yield were associated with enhanced uptake of phosphorus (P) by the plants treated with fly ash. Fly ash application did not influence accumulation of B, Cu, Mo, or Zn in the stems at any stage of plant growth or in the seed at harvest, except Mo concentration, which was elevated in the seed. Accumulation of these elements was mostly in the leaves, where concentrations of Cu and Mo increased with any amount of ash applied while that of B occurred only with ash applied at 625 Mg/ha. In Experiment 2, fly ash applied at 500 Mg/ha and mixed into the whole 30 cm soil core was detrimental to growth and yield of canola, compared with restricting mixing to 5 or 15 cm depth. In contrast, application of ash at 250 Mg/ha with increasing depth of mixing increased A and seed yield. We concluded that fly ash applied at not more than 25 Mg/ha and mixed into the top 10 to 15 cm of soil is sufficient to obtain yield benefits. This citation is from PubMed.

287. Growth and metal accumulation response of *Vigna radiata* L. var PDM 54 (mung bean) grown on fly ash amended soil: Effect on dietary intake.

Gupta, A. K. and Sinha, S.

Environmental Geochemistry and Health(July 2008)

NAL Call #: TD195.M5 M54; ISSN: 0269-4042

Descriptors: growth/ metal accumulation/ *Vigna radiata*/ mung bean/ fly ash/ soil amendment/ dietary intake

Abstract: Plants of *Vigna radiata* L. var. PDM 54 (mung bean) were grown in soil amended with different amounts (10 and 25%) of fly ash (FA). Although total metal content increased with increasing FA amendment, DTPA-extractable metals were higher for 10% FA. Accumulation of metals by the plants increased with increasing FA amendment and was greater in shoots than in roots (except for Mn and Cu) and seeds (except Mn). The total daily intake (TDI) of all the tested metals in seeds was within the recommended dietary allowance (RDA)/provisional tolerable daily intake (PTDI) for adults, except for Cd, which was higher than recommended values. Principal-components analysis (PCA) based on studies of physicochemical properties, DTPA-extractable metals, and metal accumulation in the different parts of *V. radiata* showed that physicochemical properties such as cation-exchange capacity, organic carbon, and organic matter had significant positive effects on accumulation of Cd, Co, Ni, and Pb by the plant, whereas EC had a significant negative effect. Although addition of fly ash (10%) initially increased the rate of growth, toxic symptoms were observed for 25% FA. Results from analysis of antioxidants (carotenoids, ascorbic acid, non-protein thiol, and free proline) revealed that these increased more in plants grown in 10% FA than in those grown in garden soil. Cysteine and

malondialdehyde (MDA) content increased with increasing FA amendment. PCA also showed that all the antioxidants studied behaved similarly except cysteine, for which there was a close relationship with MDA content. Thus, the results obtained during this study revealed that *V. radiata* L. var. PDM 54 may be grown in 10% FA and/or contaminated agricultural soil.

This citation is from PubMed.

288. Growth and nutrient uptake of arbuscular mycorrhizal maize in different depths of soil overlying coal fly ash.

Bi, Y. L.; Li, X. L.; Christie, P.; Hu, Z. Q.; and Wong, M. H. *Chemosphere* 50(6): 863-869. (2003)

NAL Call #: TD172 .C54; ISSN: 0045-6535

Descriptors: bioremediation/ crop establishment/ crop yield/ endomycorrhizas/ fly ash/ growth/ maize/ mycorrhizal fungi/ mycorrhizas/ nutrient uptake/ plant development/ arbuscular mycorrhizas/ corn/ Glomaceae

Abstract: Application of topsoil over phytotoxic mine wastes is often practised to establish perennial plant communities on minespoil areas. In China, population pressure encourages attempts to remediate such areas by growing arable crop plants, but efforts to establish agricultural crops often fail. We report an outdoor pot experiment that compared the effects of two arbuscular mycorrhizal (AM) fungi, *Glomus mosseae* (Nicol. and Gerd.) Gerdemann and Trappe and *G. versiforme* (Karsten) Berch, on the growth and nutrient uptake of maize (*Zea mays* L.) grown in different depths of soil layer overlying coal fly ash. Colonization by both AM fungi increased plant growth compared with non-mycorrhizal controls, with *G. mosseae* giving higher yields of maize than *G. versiforme* at the same depths of soil. Increasing soil depth led to increased plant yields. Mycorrhizal plants absorbed more nutrients than non-mycorrhizal controls, and translocated less Na to the shoots, perhaps protecting the plants from excessive Na accumulation. These preliminary results indicate that arbuscular mycorrhizas may make a substantial contribution to successful crop establishment in soils overlying areas of coal fly ash.

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289. Growth and uptake of nutrients by rice and lettuce grown on an acid sulphate soil amended with flyash and lime.

Ramesh, V. and Chhonkar, P. K.

Journal of the Indian Society of Soil Science 49(1): 222-225. (2001)

NAL Call #: 56.9 IN2; ISSN: 0019-638X

Descriptors: acid sulfate soils/ application rates/ crop yield/ fly ash/ growth/ lettuces/ lime/ liming/ mineral content/ nutrient content/ nutrient uptake/ phosphorus/ plant nutrition/ potassium/ residual effects/ rice/ soil amendments/ soil types/ acid sulphate soils/ paddy/ thionic soils

Abstract: A greenhouse experiment assessed the direct and residual effect of fly ash (0, 72 and 144 gm kg⁻¹ soil on calcium equivalent basis, CEB) and lime (0, 3 and 6 gm kg⁻¹ soil bases on lime requirement) on growth and uptake of nutrient by rice cv. Pusa 834 and lettuce cv. Great Lakes grown in a sequence on acid sulfate soil. Various fly ash, lime levels and their interaction significantly influenced the available P content of soil under rice. However, at

postharvest stage, the lowest level of available P was noted irrespective of treatments. The residual effect of application of different amounts of fly ash failed to influence the available P content of soil, while lime increased available P in the soil under lettuce. Available K content of the soil was increased due to fly ash and lower rate of lime. Fly ash at all levels significantly increased the grain yield while it increased the straw yield only at the highest level. The influence of lime was non-significant with respect to grain and straw yield. The highest level of fly ash and lime significantly increased lettuce yield while the interaction between the two was not significant. The P uptake by rice grain as well as lettuce was significantly influenced by both levels of fly ash and the highest level of lime. The different levels of lime failed to influence K uptake by rice grain and lettuce while it was highly significant for rice straw.

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290. Growth and yield of cymbopogon martinii as influenced by fly ash, am fungi inoculation and farmyard manure application.

Sharma, Mahaveer P.; Kaur, Tanu; and Adholeya, Alok. In: 2001 International Symposium on Soil and Plant Analysis. Edmonton, Alberta, Canada.; Vol. 33(15-18).; pp. 2373-2374; 2002.

NAL Call #: S590.C63

Descriptors: agronomy: agriculture/ soil science/ Gramineae: angiosperms, monocots, plants, spermatophytes, vascular plants/ Phycomycetes: fungi, microorganisms, nonvascular plants, plants/ farmyard manure

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291. The growth of corn seedlings in alkaline coal fly ash stabilized sewage sludge.

Su, D. C. and Wong, J. W. C.

Water, Air and Soil Pollution 133(1/4): 1-13. (2002)

NAL Call #: TD172 .W36; ISSN: 0049-6979

Descriptors: ammonium nitrogen/ application to land/ boron/ cadmium/ calcium/ crop yield/ electrical conductivity/ fertilizers/ fly ash/ loam soils/ magnesium/ maize/ nickel/ nutrient content/ phosphate/ phosphorus/ plant nutrition/ potassium/ seedling growth/ seedlings/ sewage sludge/ soil amendments/ soil fertility/ soil ph/ soil types/ stabilizing/ zinc/ ammonia nitrogen/ corn/ land application

Abstract: The aim of the present study was to determine the amount of coal fly ash required to stabilize sewage sludge, without causing an adverse effect on the growth of *Zea mays* seedlings (maize) in a loamy soil receiving the ash-sludge mixtures amendment. Sludge was stabilized by mixing with fly ash at an amendment rate of 0, 5, 10, 35 and 50% (w/w) before undergoing a short fermentation period to produce a range of ash-sludge fertilizer product. Each mixture was then mixed with a loamy soil at either 1 : 1 or 1 : 5 ash-sludge mixture : soil (v/v). Soil pH, electrical conductivity, and soluble Ca, Mg and B contents increased while soluble NH₄-N, PO₄-P, K, Cd, and Ni contents decreased with an increase in ash amendment rate. Dry weight yields of pots receiving 1 : 5 ash-sludge : soil mixture (v/v) were significantly higher than their counterparts with a soil mixing ratio of 1 : 1 (v/v). The highest yields were obtained at 5 and 10% ash-sludge mixture amended soil at 1 : 5 soil mixing ratio. Nevertheless, the yield at 35% ash-sludge amended loamy

soil at 1 : 1 v/v was still higher than that of the control soil with fertilizer treatment. The nutrient content of maize seedlings was higher at 35 and 10% ash-sludge mixture amended soil at 1 : 1 v/v, and 5 and 10% at 1 : 5 v/v than other treatments. Zinc concentrations of maize seedlings increased while B decreased with the decreasing amounts of fly ash added. Hence, the present experiment demonstrates the beneficial effects of the ash-sludge mixture on soil nutrient status and plant root growth environment. An ash amendment rate of up to 35% in the ash-sludge mixture would not have any adverse effects on plant production even at a high soil mixing volume of 1 : 1 (v/v), but an addition of 5 to 10% ash-sludge mixture at 1 : 5 (v/v) produced the optimum condition for maize seedlings growth. The results support the use of coal fly ash as a stabilizing agent for sewage sludge and the product could be used for land application.

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292. Growth parameters in tomato and spinach as influenced by fly ash, soil and their combinations.

Malewar, G. U.; Adsul, P. B.; and Syed Ismail
Journal of Soils and Crops 9(1): 30-33. (1999); ISSN: 0971-2836

Descriptors: cultural methods/ fruit vegetables/ growing media/ growth stages/ industrial wastes/ leaves/ plant development/ plant height/ spinach/ tomatoes/ vegetables/ potting composts/ rooting media/ vegetable crops

Abstract: The effect of fly ash alone or in combination with soil on growth of tomato and spinach in pots was investigated during rabi [winter] 1996 in India. Tomato growth (height) was reduced by fly ash (alone or in combination with soil), but a fly ash:soil ratio of 1:1 increased the number of leaves and number of branches above control values. Spinach growth (height) was promoted by fly ash. On a dry matter yield basis, a fly ash:soil ratio of 1:3 promoted dry matter accumulation in both crops.

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293. Growth performance and biochemical responses of three rice (*Oryza sativa* L.) cultivars grown in fly-ash amended soil.

Dwivedi, S.; Tripathi, R. D.; Srivastava, S.; Mishra, S.; Shukla, M. K.; Tiwari, K. K.; Singh, R; and Rai, U. N.
Chemosphere 67(1): 140-151. (2007)

NAL Call #: TD172 .C54; ISSN: 0045-6535

Descriptors: application rates/ arsenic/ biochemistry/ biomass/ cadmium/ copper/ crop yield/ fly ash/ growth/ iron/ manganese/ nickel/ phytotoxicity/ plant height/ polluted soils/ power stations/ rice/ silica/ soil amendments/ soil pollution / soil types/ tillers/ zinc/ Mn/ paddy

Abstract: The disposal of fly-ash (FA) from coal-fired power stations causes significant economic and environmental problems. Use of such contaminated sites for crop production and use of contaminated water for irrigation not only decreases crop productivity but also poses health hazards to humans due to accumulation of toxic metals in edible grains. In the present investigation, three rice cultivars viz., Saryu-52, Sabha-5204, and Pant-4 were grown in garden soil (GS, control) and various amendments (10%, 25%, 50%, 75% and 100%) of FA for a period of 90 days and effect on growth and productivity of plant was

evaluated vis-a-vis metal accumulation in the plants. The toxicity of FA at higher concentration (>=50%) was reflected by the reduction in photosynthetic pigments, protein and growth parameters viz., plant height, root biomass, number of tillers, grain and straw weight. However, at lower concentrations (10-25%), FA enhanced growth of the plants as evident by the increase of studied growth parameters. The cysteine and non-protein thiol (NP-SH) content showed increase in their levels up to 100% FA as compared to control, however, maximum content was found at 25% FA in Saryu-52 and Pant-4 and at 50% FA in Sabha-5204. Accumulation of Fe, Si, Cu, Zn, Mn, Ni, Cd and As was investigated in roots, leaves and seeds of the plants. Fe accumulation was maximum in all the parts of plant followed by Si and both showed more translocation to leaves while Mn, Zn, Cu, Ni and Cd showed lower accumulation and most of the metal was confined to roots in all the three cultivars. As was accumulated only in leaves and was not found to be in detectable levels in roots and seeds. The metal accumulation order in three rice cultivars was Fe > Si > Mn > Zn > Ni > Cu > Cd > As in all the plant parts. The results showed that rice varieties Saryu-52 and Sabha-5204 were more tolerant and could show improved growth and yield in lower FA application doses as compared to Pant-4. Thus, Sabha-5204 and Saryu-52 are found suitable for cultivation in FA amended agricultural soils for better crop yields. Reproduced with permission from the CAB Abstracts database.

294. Growth rate of fenugreek plant, *Trigonella foenum-graecum*, as influenced by fly ash.

Srivastava, S.; Ansari, A. A.; Singh, S.; Mohd Naeem; and Hashmi, F.

Bionotes 4(4): 92. (2002); ISSN: 0972-1800

Descriptors: application rates/ fenugreek/ fly ash/ growth/ growth rate/ medicinal plants/ soil amendments/ weight/ drug plants/ medicinal herbs/ officinal plants

Abstract: The effects of fly ash on the growth rate of *T. foenum-graecum* (methi) were studied. Different concentrations of fly ash in the soil were given: 0, 25, 50, 75 and 100%. Sampling was done at three different stages: 60, 70 and 80 days after sowing. The fly ash amendment up to 50% increased the total fresh and dry weights of treated plants compared to the plants grown in fly ash-free soil. However, the highest increase of 11% in the plant fresh and dry weights was recorded upon treatment with 25% fly ash. The maximum reduction in plant fresh and dry weights was recorded upon treatment with 100% fly ash. At both stages (60-70 and 70-80 days), the maximum plant growth was achieved by 50% fly ash compared to the control. Complete (100%) fly ash application reduced the growth parameters drastically. Results show that the soils treated with fly ash in low concentrations are more useful for vegetable plant growth, yield and high nutrient status, particularly for leafy vegetables.

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295. Growth response in crops raised in flyash amended soil.

Nikhil, K. 21(4): 409-416. (2002); ISSN: 02578050 [PORS]

Descriptors: biomass/ crop/ flyash amendment/ plant growth/ soil chemical properties/ yield/ agricultural soil/ crop

yield/ fly ash/ growth response/ soil amendment/ trace element/ Brassica/ Brassica juncea/ Cicer/ Cicer arietinum/ Fraxinus/ Pisum/ Pisum sativum/ Triticum/ Triticum aestivum

Abstract: Flyash disposal is a major problem in and around coal based thermal power plants. Although, the flyash contains several essential minerals, its application in agriculture is common. The present study was undertaken to elucidate the possibility of flyash application to agricultural soils to improve crop yields. Three different amounts of flyash (2,4 and 8% w/w) were mixed with soil in 1m² plots and seeds of Triticum vulgare, Cicer arietinum, Pisum sativum and Brassica juncea were sown in these soil-amended plots. Plants and soils were sampled at the time of harvesting (each had five replicates) and analysed with respect to plant growth and yield with change in the soil for the pH, EC, OC, available phosphorus and potassium and DTPA extractable trace elements Zn, Cu, Fe and Mn. The result revealed that flyash application, particularly in higher amount (8% w/w) increased the pH and conductivity of the soils, however, the application of low amounts (2% and 4% w/w) favoured plant growth and improved yield. Although, the element concentration OC, pH, available phosphorus and potassium, EC and DTPA extractable trace elements Zn, Cu, Fe and Mn were found more in flyash amended soils than the control, their levels remained well below the threshold limit and thus helped in the crop plant growth and yields.

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296. Growth response of mustard of fly ash under irrigated and induced drought conditions.

Singh, S. and Lone, P. M.

Advances in Plant Sciences 17(1): 137-141. (2004)

NAL Call #: QK1.A38; ISSN: 0970-3586

Descriptors: agrichemicals/ horticulture: agriculture/ pollution assessment control and management/ cruciferae: angiosperms, dicots, plants, spermatophytes, vascular plants/ irrigation: applied and field techniques/ drought induced conditions/ thermal power station

Abstract: The effect of fly ash was studied at 60d after sowing on chlorophyll harvest, specific leaf weight, plant fresh weight and plant dry weight of two cultivars of mustard grown under irrigated and induced drought conditions. Of the fly ash concentrations used in the study, 20% fly ash to soil application enhanced the characteristics studied and higher concentrations had inhibitory effect. Therefore, fly ash may be used for mustard growth under irrigated as well as drought conditions.

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297. Growth response of phaseolus aureus I Cv. K 851 and cv. Pusa vaisakhi in fly-ash amended soils.

Kumar, G. Sarat and Dubey, P. S.

Geobios (Jodhpur) 25(2-3): 125-130. (1998); ISSN: 0251-1223

Descriptors: agronomy: agriculture/ Leguminosae: angiosperms, dicots, plants, spermatophytes, vascular plants/ dry matter production/ fly ash amended soil/ growth response/ soil mixtures

Abstract: The amended soil enhanced growth, dry matter production and photosynthetic pigments in low FA-soil mixtures on P. aureus. Plants growing in fly-ash-black cotton soil mixtures exhibited improved qualities as compared to those of fly-ash-Ujjain alluvial soil mixtures.

and cv. K 851 responded better than that of cv. Pusa Vaisakhi.

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298. Growth, yield and elemental status of rice (Oryza sativa) grown in fly ash amended soils.

Mamata Mishra; Sahu, R K; and Padhy, R. N.

Ecotoxicology 16(2): 271-278. (2007); ISSN: 0963-9292

Descriptors: application rates/ cadmium/ catalase/ chromium/ cobalt/ copper/ crop yield/ enzyme activity/ enzymes/ growth/ heavy metals/ lead/ leaf area/ leaves/ manganese/ nickel/ panicles/ peroxidase/ phosphorus/ potassium/ rice/ seed weight/ seeds/ shoots/ soil amendments/ soil physical properties/ yield components/ zinc/ Mn/ paddy/ physical properties of soil

Abstract: Fly ash (FA) from coal in Orissa (India) was used for amending soil at levels equivalent to 0, 1, 2.5, 5, 10 and 15 metric tons per ha in which, rice was grown and elemental residues of amended soil and plant parts were enumerated. FA amendments caused significant improvement in soil quality and germination percentage of rice seeds. Growth (shoot length, leaf area and pigment composition) and yield (panicle length, seeds per panicle, seed weight and yield per plant) of rice increased with an increase in FA amendments. Catalase and peroxidase activities of young leaves increased initially in plants cultivated at lower FA levels but declined sharply at higher FA levels while the protein content of seeds improved at higher FA levels. Sodium content of rice-roots did not change with FA amendments but the contents of K, P, Mn, Ni, Co, Pb, Zn, Cu, Cr, and Cd showed a progressive increase. Seeds of plants grown in FA amended soils accumulated Cu, Pb, Cr and Cd in amounts below allowable limits. Based on the data obtained we found that flooded-rice soil amended at 10 metric tons FA per ha level of FA not only improved the physical properties of the soil but also contributed to better growth and yield of rice. Reproduced with permission from the CAB Abstracts database.

299. Growth, yield, metabolism and elemental status of green gram (Phaseolus aureus) and til (Sesamum indicum) grown in soils amended with fly ash.

Mamata Mishra; Sahu, R. K.; and Padhy, R. N.

Fresenius Environmental Bulletin 14(7): 559-564. (2005); ISSN: 1018-4619

Descriptors: application rates/ atomic absorption spectrophotometry/ biomass/ cadmium/ chemical composition/ chromium/ cobalt/ copper/ crop yield/ fly ash/ green gram/ growth/ heavy metals/ iron/ lead/ manganese/ nickel/ nutrient content/ phosphorus/ potassium/ sesame/ sodium/ soil amendments/ waste utilization/ zinc/ beniseed/ Mn/ mung bean

Abstract: Fly ash (FA) amendments (0, 5, 10, 20, 40, and 80 mega gram/ha, or Mg/ha) in soils for the winter crop, a pulse, green gram (Phaseolus aureus cv. Sujata) without and with supplementations of a commercial Rhizobium stock are described. Growth characteristics and biomass were enhanced in plants grown in higher levels of FA (20, 40 and 80 Mg/ha). Further, Rhizobium supplementation caused invariably increments in each growth parameter. The levels of 40 and 80 Mg FA/ha were ideal for grain yield. Biochemical analysis data of healthy leaves corroborated growth and yield, observing that 20 and 40 Mg FA/ha amendments with Rhizobium supplementation caused

better metabolic rates of the plant. Physico-chemical characteristics of the soil were erratically altered by FA amendments, but Rhizobium supplementation caused improvements of soils characteristics. The elemental composition (Na, K, P, Fe, Mn, Ni, Co, Zn, Cu, Pb, Cr, and Cd) of soil was affected adversely due to FA, as analyzed for the latter eight elements by atomic absorption spectrophotometry. Heavy metals, Mn, Ni, Co, Zn, Pb, Cr, and Cd, continued to occur in objectionable concentrations, unsafe for public health. Fly ash (FA) amendments (0, 5, 10, 20, 40 and 80 Mg/ha) in soils for the winter oil seed, til crop (*Sesamum indicum* cv. Kalika) are also described. Growth was enhanced in plants grown in moderate f FA levels (10, 20 and 40 Mg/ha). Yield of the plant was ideal at 2.5 Mg FA. The biochemical analysis of healthy leaves corroborated growth and yield data as above, and elemental composition (Na, K, P, Fe, Mn, Ni, Co, Zn Cu, Pb, Cr and Cd) of soil was enhanced due to FA. Heavy metals continued to occur in objectionable concentrations in the seeds.

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300. Gypsum additions reduce ammonia nitrogen losses during composting of dairy manure and biosolids.

Tubail, K.; Chen, L.; Michel Jr., F. C.; Keener, H. M.; Rigot, J. F.; Klingman, M.; Kost, D.; and Dick, W. A.

Compost Science and Utilization 16(4): 285-293. (2008)

NAL Call #: TD796.5.C58 ; ISSN: 1065657X [CSUTE]

Descriptors: ammonia/ biological materials/ biosolids/ coal combustion/ coal gas/ composting/ cultivation/ desulfurization/ evaporative cooling systems/ flue gases/ heavy metals/ heavy water/ inorganic acids/ manures/ sewage/ stainless steel/ sulfur/ sulfur dioxide/ surface waters/ waste incineration/ waste treatment/ water pollution/ water quality/ ammonia nitrogens/ ammonia volatilizations/ boric acid solutions/ by-product gypsums/ C:N ratios/ combustion of coals/ composting process / crop productions/ dairy manures/ dry weights / final composts/ flue-gas desulfurizations/ high qualities/ organic materials/ organic wastes/ plant nutrients/ quality products / rate controls/ stainless steel vessels/ surface water qualities/ gypsum/ ammonia/ biosolid/ composting/ gypsum/ manure/ nutrient loss/ volatilization/ North America/ United States

Abstract: Composting of N rich organic materials often leads to N loss via ammonia volatilization. Literature references from as early as 1922 have suggested gypsum can prevent N loss from manure. Millions of tons of high quality by-product gypsum are produced each year in the United States as a result of flue gas desulfurization (FGD) scrubbing of sulfur dioxide during combustion of coal. Our objective was to determine the impact of this gypsum on N release when mixed with dairy manure and biosolids during composting. A preliminary experiment was conducted involving 4-liter vessels containing 1.1 kg of dairy manure mixed with by-product gypsum at dry weight rates (w/w) of 0, 6%, 13% and 23% and composted for 18 days. The ammonia-N released in the off gas was trapped in 0.67 M boric acid solution. Loss of ammonia-N was essentially complete after seven days. When expressed as percent of initial N in the mixes, the amount of N lost ranged from 6.4% for the zero rate control to 2.6-2.8% for the gypsum

treatments. Composting studies were also conducted in insulated 210-liter stainless steel vessels over a 28-day period using dairy manure and biosolids treated with or without 17% gypsum (dry weight, w/w). Results revealed the amount of N lost, as a percentage of that originally present in the compost mix, was 7.27% and 15.6% without gypsum for dairy manure and biosolids, respectively, and 3.62% and 13.6% with gypsum. The difference between the dairy manure and biosolids results is attributed primarily to a lower C:N ratio of the biosolids compared to the dairy manure. The final composts were found to contain significant amounts of plant nutrients while heavy metals were well below values considered to be harmful to surface water quality of for crop production. We conclude that combining organic waste streams, especially N-rich streams, with by-product gypsum produces a quality product while also decreasing the loss of N and reducing odors associated with the volatilization of ammonia during the composting process.

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301. Heavy metal and phosphorus content of fractions from manure treatment and incineration.

Möller, H B; Jensen, H S; Tobiasen, L; and Hansen, M N

Environmental Technology 28(12): 1403-1418. (2007)

NAL Call #: TD1.E59; ISSN: 0959-3330

Descriptors: cadmium/ cattle manure/ coagulants/ copper/ energy sources/ fertilizers/ flocculants/ fly ash/ heavy metals/ nickel/ nitrogen/ phosphorus/ pig manure/ pollutants/ polluted water/ soil amendments/ waste management/ waste treatment/ water pollution/ water quality/ zinc/ water composition and quality

Abstract: Alternative uses of pig manure are being considered, including separation and eventual incineration of the solid fraction to produce energy and ash. The efficiency of a screw press, a decanting centrifuge and chemical treatment in transferring N, P and heavy metals from slurry to a solid fraction were compared. Chemical treatment by coagulants and flocculants removed heavy metals most efficiently; they were transferred to the solid fraction in the order Zn > Cu > Cd by all three types of equipment. With centrifugation the heavy metal load on land where the solid fraction was applied was very low, whereas on land where the liquid fraction was applied it was only slightly less than that from un-separated manure. Conversely, chemical treatment resulted in a heavy metal load similar to that from un-separated manure with the solid fraction, while with the liquid fraction it was reduced to 20% of that from un-separated manure. Incineration of the solid fraction produces bottom ash and fly ash containing high levels of P. Most of the P and less than 10% of Cd is present in the bottom ash, producing an ash low in Cd content and a fly ash high in Cd. However, Cu and Ni tend to accumulate in the bottom ash. Chemical extraction procedures revealed that P-availability was high in all liquid and solid fractions except the bottom ash from incineration where ~80% of the P was transformed into a form of apatite. Since more bottom ash than fly ash is being formed, significant amounts of P may be immobilized by incineration of solid fractions.

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302. Heavy metal leaching from coal fly ash amended container substrates during Syngonium production.

Li, Q. S.; Chen, J. J.; and Li, Y. C.

Journal of Environmental Science and Health. Part B, Pesticides, Food Contaminants, and Agricultural Wastes 43(2): 179-186. (2008)

NAL Call #: TD172.J61 ; ISSN: 0360-1234

Descriptors: arsenic/ ash/ cadmium/ chromium/ coal/ copper/ dry matter/ groundwater/ growth/ heavy metals/ leachates/ leaching/ lead/ manganese/ mercury/ molybdenum/ nickel/ ornamental plants/ selenium/ substrates/ surface water/ zinc/ Mn/ Mo/ ornamentals/ United States of America

Abstract: Coal fly ash has been proposed to be an alternative to lime amendment and a nutrient source of container substrates for ornamental plant production. A great concern over this proposed beneficial use, however, is the potential contamination of surface and ground water by heavy metals. In this study, three fly ashes collected from Florida, Michigan, and North Carolina and a commercial dolomite were amended in a basal substrate. The formulated substrates were used to produce *Syngonium podophyllum* Schott 'Berry Allusion' in 15-cm diameter containers in a shaded greenhouse. Leachates from the containers were collected during the entire six months of plant production and analyzed for heavy metal concentrations. There were no detectable As, Cr, Hg, Pb, and Se in the leachates; Cd and Mo were only detected in few leachate samples. The metals constantly detected were Cu, Mn, Ni, and Zn. The total amounts of Cu, Mn, Ni, and Zn leached during the six-month production period were 95, 210, 44, and 337 micro g per container, indicating that such amounts in leachates may contribute little to contamination of surface and ground water. In addition, plant growth indices and fresh and dry weights of *S. podophyllum* 'Berry Allusion' produced from fly ash and dolomite-amended substrates were comparable except for the plants produced from the substrate amended with fly ash collected from Michigan which had reduced growth indices and fresh and dry weights. Thus, selected fly ashes can be alternatives to commercial dolomites as amendments to container substrates for ornamental plant production. The use of fly ashes as container substrate amendments should represent a new market for the beneficial use of this coal combustion byproduct. Reproduced with permission from the CAB Abstracts database.

303. Heavy metals adsorption and their distribution in three soil types of india: Effect of coal fly ash and sewage sludge amendment.

Tripathy, S.; Veeresh, H.; Chaudhuri, D.; Powell, M. A.; and Hart, B. R.

In: *Coal Combustion Byproducts and Environmental Issues*. Uppsala, Sweden.)

233 Spring Street, New York, NY 10013: Springer; pp. 66-83; 2006 .

Notes: 7th International Conference on Biogeochemistry of Trace Elements.; ISBN: 0387258655

Descriptors: Pollution Assessment Control and Management/ Waste Management: Sanitation/ Sewage Sludge/ Coal Fly Ash

Abstract: Even though both coal fly ash and sewage sludge are rich sources of bio-essential nutrients, one of the

major limiting factors in their use either individually or in mixture proportions as for amendment into agricultural soil is the presence of various metals likely to be potentially toxic at their elevated concentrations. This study evaluated the adsorption and distribution behaviours of selected metals in three different soils from India amended with mixtures of ash and sludge in various proportions at a maximum application rate of 52t ha⁻¹ and incubated up to 90 days at near field capacity moisture level. The properties of amended soils were affected significantly by sludge than the ash and the Freundlich distribution coefficients (K(D)s) of metals were marginally higher compared to their respective controls. The degree of impact of amendment on soil properties, distribution coefficients of metals and their adsorption affinity sequences, based on KDS, within and across soil types were determined. Sequential extraction indicated that, the concentrations of native metals in each soil type tends to be less in highly mobile and moderately mobile fractions than the resistant; and changed marginally following amendment while the distribution patterns remained more or less undisturbed. The sequential extraction of adsorbed metals at various equilibrating concentrations of their addition indicated shifts in the distribution patterns in each soil type. However, the changes in the partitioning of adsorbed metals were wide and clearly noticeable only at higher loadings and the metals showed propensity to accumulate preferentially in more mobile fractions, depending on the type of soil surface and substrate. The results indicated that at low rate of application, ash and sludge, though capable of changing the soil properties and its metal adsorption capacities to certain extent; they had no major influence on metal distribution patterns in the amended soils which mainly depended on the soil properties, type of metal and its concentration.

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304. Hydraulic conductivity and leachate characteristics of stabilized fly ash.

Ghosh, A. and Subbarao, C.

Journal of Environmental Engineering 124(9): 812-820. (Sept. 1998); ISSN: 0733-9372.

Notes: Language: English.

Descriptors: chemical treatment/ fly ash/ fly ash/ groundwater pollution/ hydraulics/ land disposal/ leachates/ leaching/ lime/ permeability coefficient/ recycling/ waste disposal/ waste treatment/ water pollution sources/ gypsum

Abstract: Disposal of fly ash on land amounts to sacrificing precious land space. Recycling of fly ash is one of the methods of solving the disposal problem. Stabilization of a low lime fly ash with lime and gypsum was studied through large scale tests on the stabilized material designed to simulate field recycling conditions as closely as possible, and found to be a very effective means to control hydraulic conductivity and leachate characteristics. The effects of moulding water content, lime content, gypsum content, curing period, and flow period on hydraulic conductivity, and on leachate of metals flowing out of the stabilized fly ash are reported herein. With proper proportioning of the mix, and adequate curing, the values of hydraulic conductivity on the order of 10 super(-7) cm/s were achieved. The concentrations of As, Cd, Cr, Cu, Fe, Hg, Mg, Ni, Pb, and Zn in the effluent emanating from the hydraulic conductivity specimens of mixes with higher

proportions of lime or lime and gypsum were below threshold limits acceptable for contaminants flowing into ground water.

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305. Hydraulic conductivity of the composite materials consisting of fly-ash and organic soils from Zuawy region.

Olchawa, A.

Wiadomosci Instytutu Melioracji i Uzytkow Zielonych 20(4): 175-187. (2000); ISSN: 0509-6677.

Notes: Original title: Przewodnosc hydrauliczna materiaow kompozytowych zozonych z popiou lotnego i gruntow organicznych z obszaru Zuaw. Language: Polish.

Descriptors: fly ash/ hydraulic conductivity/ organic soils/ permeability/ soil compaction/ soil organic matter/ soil types/ soil water content/ organic matter in soil

Abstract: A study was conducted to determine the permeability coefficient of composite material consisting of a fly ash and organic soils from Zulawy region, Poland. The organic matter content of the materials was less than or approximately equal to 2%. Required relative compaction of 0.92 and 0.95 was achieved by process of compaction and corresponding water content. The water content of compacted samples was less or greater than optimum moisture. The permeability coefficients increased with increased relative compaction ranging from 10-8 to 10-10 m/s.

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306. Impact of addition of coal ash from a power plant "Dolna Odra" on chemical properties of medium soil and yield of winter crops.

Stosio, M. and Tomaszewicz, T.

Inzynieria Rolnicza 5(l): 257-262. (1999)

NAL Call #: 381 J8223 S671 .A372.

Notes: Original title: Wpyw dodatku popioow z wegla kamiennego pochodzacych z elektrowni "Dolna Odra" na wasciwosci chemiczne gleby sredniej i plonowanie zboz ozimych.

Descriptors: application rates/ barley/ cations/ chemical properties/ coal/ fly ash/ lead/ magnesium/ properties/ responses/ rye/ saturation/ soil/ soil amendments/ soil chemical properties/ soil ph/ soil properties/ trace elements/ Triticale/ wheat/ winter/ yields/ chemical properties of soil/ microelements

Abstract: Tests carried out at Ostoja, Poland, in 1997 investigated the impact of 4 ash doses (0, 50, 100, 150 t/ha) on soil chemical properties and yields of 4 winter crop varieties (rye, wheat, triticale, barley). The maximum ash dose (150 t/ha) resulted in increases of magnesium and phosphorus content, not increasing the lead content soluble in 1N HCl. Other macro- and microelements tested did not show significance changes in their content. Increasing ash doses caused increases of soil reaction from slightly acid (0 t/ha) to neutral (50, 100 t/ha) and alkaline as well as growth in the saturation ratio of alkaline cations from 90.0% (0 t/ha) to 97.8% (150 t/ha). Crop varieties reacted differently to soil properties, changing as the result of ash doses. For rye and wheat the yield was similar irrespective of the ash dose. For

triticale distinct yield changes were also not found. Higher yields of ~10% were obtained after using a dose of 100 t/ha compared with 150 t/ha. Only barley showed a steady increase in the yield with an increase of ash dose from 0 to 150 t/ha.

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307. Impact of bulk utilization of fly ash/pond ash in irrigated vertisols on long term basis vis-a-vis on grain yield of cropping system and micronutrient content in grain.

Yeledhalli, N. A.; Prakash, S. S.; Ravi, M. V.; and Rao, K. N.

Asian Journal of Soil Science 3(1): 124-129. (2008); ISSN: 0973-4775

Descriptors: copper/ crop yield/ cropping systems/ electrical conductivity/ fly ash/ iron/ maize/ manganese/ nutrient content/ pH/ soil amendments/ soil fertility/ soil physical properties/ soil types/ sunflowers/ Vertisols/ water holding capacity/ zinc/ corn/ hydrogen ion concentration/ Mn/ Mysore/ physical properties of soil/ potential of hydrogen

Abstract: Analysis of fly ash and pond ash collected from Raichur Super Thermal Power Station, Shakhinagar, Karnataka, India, has revealed that both the ashes contained higher proportion of silt sized particles (40.1 to 50.2%). The maximum water holding capacity of ash ranged from 48.1 to 68.1, pH from 7.9 to 10.5 and electrical conductivity (EC) from 0.34 to 1.00 dS/m. Pond ash had higher WHC than fly ash. However, the pH and EC of pond ash were less as compared to fly ash. The available amount of DTPA extractable Fe, Mn, Cu and Zn varied from 8.7 to 12.5, 10.3 to 13.1, 0.3 to 0.6 and 1.0 to 1.5, respectively. Fly ash contained higher amount of available micronutrients than pond ash. The limitation of utilization of fly ash in agriculture was mainly due to presence of reserve alkalinity and high salt content, on the contrary fly ash can be used as an amendment to improve the soil physical conditions and also as a source of trace elements.

Application of fly ash/pond ash at maximum rate significantly increased the concentration of micronutrients in sunflower and maize grains. Further, combined application with farmyard manure at 20 t/ha increased the micronutrient content due to increased solubility of metal ions by forming stable complexes with organic legends. The percent increase in the concentration of micronutrients in sunflower seeds over control due to application of fly ash at 40 t/ha varied from 0.7 to 20.8% in Zn, 1.4 to 14.2% in Mn, 0 to 4.3 in Cu and 0.7 to 63.9% in Fe. Similarly, in the succeeding maize grain, the same varied from 5.1 to 34.0% in Zn, 0 to 3.4% in Mn, 17.6 to 34.7% in Cu and 2.4 to 4.0% in Fe. Reproduced with permission from the CAB Abstracts database.

308. Impact of coal combustion product amendments on soil quality; 1, Mobilization of soil organic nitrogen; comment [modified].

Franklin, Ralph

Soil Science 164(9): 692. (Sept. 1999)

NAL Call #: 56.8 So3; ISSN: 0038-075X.

Notes: For reference to original see Stuczynski, T. I., McCarty, G. W., and Wright, R. J., *Soil Sci.*, Vol. 163, p. 952-959, 1998.

Descriptors: agriculture/ ash/ carbon/ coal/ combustion/ fertilization/ geochemistry/ liming/ nitrogen/ organic nitrogen/ pH/ reclamation/ sedimentary rocks/ soil quality/ environmental geology

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309. Impact of coal combustion product amendments on soil quality: I. Mobilization of soil organic nitrogen.

Stuczynski, T. I.; McCarty, G. W.; and Wright, R. J.

Soil Science 163(12): 952-959. (1998)

NAL Call #: 56.8 So3; ISSN: 0038-075X

Descriptors: acids/ agricultural soils/ amino acids/ ash/ chemical composition/ coal/ combustion/ fly ash/ liming/ losses/ measurement/ mobilization/ nitrogen/ nitrogen content/ organic matter/ organic nitrogen/ reclamation/ requirements/ soil/ soil amendments/ soil organic matter/ soil ph/ sugars/ metrology/ organic matter in soil

Abstract: The effects were studied of fly ash and bed ash applied at rates of 0, 20, 40, and 80 g kg⁻¹ soil on the content of organic N in soils incubated for 10, 25, or 60 days. Studies comparing the influence of these products on the organic N content of the soil showed that although applications of fly ash had little influence on the fate of this N, application of bed ash caused substantial decreases in the total N content of water-extracted soil through the mobilization of organic N. Measurements of the changes in acid hydrolysable N components of organic matter in soils treated with high rates of bed ash showed that within the first 10 days of incubation, losses of N in the forms of amino sugars, amino acids, and hydrolysable NH₄⁺ could largely account for losses of total N in bed ash-amended soils. Decreases in the amino acid content of soil organic matter accounted for most of these losses, and such decreases were directly related to increases in soil pH caused by the bed ash amendment.

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310. Impact of coal combustion product amendments on soil quality: II. Mobilization of soil organic carbon.

Stuczynski, T. I.; McCarty, G. W.; Wright, R. J.; and Reeves, J. B. III

Soil Science 163(12): 960-969. (1998)

NAL Call #: 56.8 So3; ISSN: 0038-075X

Descriptors: acids/ amino acids/ application rates/ ash/ carbohydrates/ carbon/ coal/ combustion/ degradation/ fly ash/ liming/ losses/ mobilization/ organic carbon/ organic matter/ requirements/ soil/ soil amendments/ soil fertility/ soil organic matter/ soil ph/ stabilizing/ treatment/ humic substances/ organic matter in soil/ saccharides

Abstract: The effects were studied of different amounts (0, 20, 40, and 80 g kg⁻¹ soil) of bed ash and fly ash on the mobilization of organic C in soil. Whereas fly ash mobilized little or no organic C when applied at rates as high as 80 g kg⁻¹ soil, bed ash caused substantial mobilization and loss of soil organic C when applied at or above the rate of 20 g kg⁻¹ soil. Chromatographic and spectroscopic methods were used to characterize the different forms of carbon mobilized in soil amended with combustion products. These studies showed that various forms of organic C were mobilized by bed ash treatments such as carbohydrates, phenolic substances, humic substances, and amino acids. The total amounts of soil organic C mobilized by bed ash treatments were related to increased soil pH and with the

losses of C associated with increases of soluble humic substances. The losses of organic C from soils treated with bed ash reached 15.5% of the total soil organic C. These studies also provided evidence for stabilization of some forms of soil organic C by Ca²⁺ from bed ash.

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311. Impact of coal pile leachate and fly ash on soil and groundwater.

Ghuman, G. S.; Sajwan, Kenneth S.; and Denham, M. E. In: Fourth international conference on the Biogeochemistry of trace elements. Berkeley, CA, United States.) Sajwan, Kenneth S.; Alva, Ashok K.; and Keefer, Robert F. (eds.) New York, NY, United States (USA): Kluwer Academic/Plenum Publishers; 1999.

Notes: Features: References: 42; illus. incl. 5 tables.

Descriptors: acetates / attenuation/ boron/ chemical composition/ chlorides/ coal/ coal mines/ concentration/ dissolved materials/ dissolved oxygen/ enrichment/ esters/ ground water/ halides/ leaching/ metals/ mines/ nitrates/ organic compounds/ oxygen/ pH/ phosphorus/ pollutants/ pollution/ remediation/ sampling/ sedimentary rocks/ soils/ storage/ sulfates/ waste disposal/ environmental geology

© American Geological Institute

312. Impact of different levels of fly ash on growth attributes and dry matter yield of various crops.

Malewar, G. U.; Adsul, P. B.; and Syed Ismail

Journal of Maharashtra Agricultural Universities 24(2): 220-221. (1999); ISSN: 0378-2395

Descriptors: fly ash/ soil amendments/ sunflowers/ wheat/ yields

Abstract: Wheat, sorghum and sunflowers were grown in pots in soil or 3:1, 1:1 or 1:3 fly ash:soil mixtures.

Recommended NPK fertilizers were applied. Plant dry weight of wheat and sunflowers was highest in 1:3 fly ash:soil mixtures, while in sorghum the 3:1 fly ash:soil plants gave the greatest weight.

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313. Impact of fly ash amendment and incorporation method on hydraulic properties of a sandy soil.

Gangloff, W. J.; Ghodrati, M.; Sims, J. T.; and Vasilas, B. L.

Water, Air and Soil Pollution 119(1/4): 231-245. (2000)

NAL Call #: TD172 .W36; ISSN: 0049-6979

Descriptors: available water/ crop production/ fly ash/ hydrological factors/ hydrology/ infiltration/ monitoring/ mouldboards/ plant water relations/ ploughs/ sandy soils/ soil amendments/ soil depth/ soil management/ soil physical properties/ soil types/ soil water/ soil water content/ tillage/ water distribution/ water holding capacity/ water relations/ moisture relations/ mouldboards/ physical properties of soil/ plows/ soil cultivation/ soil moisture/ surveillance systems/ United States of America

Abstract: Coal fly ash has physical and chemical characteristics that make it useful as a soil amendment, one of the more important being the potential to permanently improve the soil water relations of sandy, drought-prone soils. Changes in the infiltration rate and water holding capacity of a sandy soil after application of high rates (up to 950 t/ha) of a Class F fly ash. Fly ash was applied to large field plots in the USA by either conventional

tillage (CT, mouldboard plough-disk) or intensive tillage (IT, chisel plough-rotovate-disk), and to microplots using a rototiller. Infiltration rate (i) was measured in both studies with a disk permeameter on three occasions over a 12-month period. Ash effects on gravimetric water content (θ_{g_0}) at the 0-40 cm soil depth were measured during a 168 h period following a 2.5 cm rainfall event and water release curves (33 to 500 kPa) were constructed in the laboratory using soils from the large plots. In both studies i was decreased by ~80% one year after addition of fly ash and θ_{g_0} in ash-amended soil was higher than unamended soil throughout the 168 h monitoring period. Soil water distribution varied with tillage, the IT treatment had the highest θ_{g_0} increases in the 0-20 cm depth while the CT treatment had θ_{g_0} increases throughout the 0-40 cm depth. Soil water content and distribution in ash-amended microplots were similar to IT treatments. Fly ash amendment not only increased water holding capacity but also increased plant available water by 7-13% in the 100-300 kPa range. These results suggest fly ash amendment may have the potential to improve crop production in excessively drained soils by decreasing i and increasing the amount of plant available water in the root zone. Reproduced with permission from the CAB Abstracts database.

314. Impact of fly ash and phosphate solubilising bacteria on soybean productivity.

Sunita Gaiand and Gaur, A. C.

Bioresource Technology 85(3): 313-315. (2002)

NAL Call #: TD930.A32 ; ISSN: 0960-8524

Descriptors: crop yield/ fly ash/ leaching/ nitrogen fertilizers / nutrient uptake/ phosphorus fertilizers/ soil amendments/ soybeans/ trace elements/ microelements/ phosphate fertilizers/ soybeans

Abstract: Fly ash was characterized for the leaching potential of some major and minor constituents and then added to soil at 20, 40, 60 and 80 tonnes/ha with N and P fertilizer to evaluate its effect on nutrient uptake and soybean yield singly as well as in combination with an efficient phosphate solubilizer *Pseudomonas striata*. The application of fly ash at 40 tonnes/ha in conjunction with *P. striata* inoculation improved the bean yield and P uptake by grain. The available phosphorus of soil also showed an upward trend. The fly ash did not exert any detrimental effect on the population of inoculated bacteria. However, the uptake of trace elements did not improve significantly. Reproduced with permission from the CAB Abstracts database.

315. Impact of fly ash application in soil on root colonization by a VAM fungus and root nodulation by Rhizobium.

Madhu Kulshreshtha and Khan, M. W.

Indian Phytopathology 52(2): 185-187. (1999)

NAL Call #: 464.8 IN2 ; ISSN: 0367-973X

Descriptors: air pollution/ fly ash/ mycorrhizal fungi/ mycorrhizas / nitrogen fixing bacteria/ nodulation/ plant pathology/ vesicular arbuscular mycorrhizas/ atmospheric pollution/ Glomaceae/ phytopathology/ root colonization
Abstract: The effect of fly ash from a thermal power plant on *Glomus caledonium* and *Rhizobium* sp. on the roots of *Vigna mungo* was investigated in Aligarh, Uttar Pradesh,

India. It was demonstrated that mycorrhizas and root nodulating bacterium protected the plants from some of the harmful effects caused by fly ash.

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316. Impact of fly ash application on consumptive and water use efficiency in wheat (*Triticum aestivum*) under different soils.

Singh, C. B.; Oswal, M. C.; and Grewal, K. S.

Indian Journal of Agricultural Sciences 72(7): 396-399.

(2002)

NAL Call #: 22 AG831; ISSN: 0019-5022

Descriptors: application rates/ crop yield/ evapotranspiration/ fly ash/ loam soils/ plant water relations/ roots/ sandy loam soils/ sandy soils/ soil types/ soil water balance/ straw/ trace element fertilizers/ water uptake/ water use efficiency/ wheat/ wheat straw/ micronutrient fertilizers

Abstract: A lysimetric study was conducted during 1995-97 in Haryana, India to assess the effect of fly ash application on the performance of wheat on sandy, sandy loam, and loam soils. The treatments were 0.0, 2.5, 5.0, and 10.0% fly ash (w/w) mixed in the top 15-cm layer and 2.5-cm fly ash on the surface of each soil type. The highest grain and straw yields were obtained with the application of 2.5-cm fly ash, irrespective of the soil type. In addition, soil type significantly influenced the grain and straw yields, where the highest were obtained in loam soil. A maximum reduction in evaporation was observed under 2.5-cm fly ash layer (13.3%) treatment and in loam soils. Wheat, on an average, consumed 346-, 330-, and 316-mm water as evapotranspiration to complete its life cycle, respectively, in loam, sandy loam, and sandy soils. Fly ash at 2.5 cm gave the highest water use efficiency compared to the control. The mean water use efficiency improved by 9.9, 20.5, and 27.2 in loam; 7.0, 12.6, and 22.5 in sandy loam; and 7.7, 18.9, and 26.5 in sandy loam soil with incorporation of 2.5, 5.0, and 10.0% fly ash, respectively. Root density improved with an increase in the application rate of fly ash and was highest with 2.5 cm fly ash layer in all soil types. Reproduced with permission from the CAB Abstracts database.

317. Impact of fly ash from coal-fired power stations in Delhi, with particular reference to metal contamination.

Mehra, A.; Farago, M. E.; and Banerjee, D. K. 50(1): 15-35. (1998); ISSN: 01676369 [EMASD].

Notes: Chapter Number: Dordrecht, Netherlands. doi: 10.1023/A:1005860015123.

Descriptors: Brassica juncea/ Eichhornia crassipes/ Electrostatic precipitators (esp)/ Fly ash/ Indraprastha Power Station (IPP Stn)/ Rajghat Power House (RPH)/ River Yamuna/ Coal slurries/ Contamination/ Environmental impact/ Fossil fuel power plants/ Leachate treatment/ Toxicity/ Water pollution/ Ash disposal ponds/ Brassica juncea/ Eichhornia crassipes/ Fly ash leachates/ Fly ash/ coal/ metal/ coal/ developing country/ fly ash/ industrial emissions/ metal contaminants/ pollution/ pollution incidence/ power station/ air monitoring/ air pollution/ electric power plant/ fly ash/ India/ leaching/ nonhuman/ plant growth/ soil/ turbidity/ vegetation/ water pollution/ India, Delhi

Abstract: Indraprastha Power Station (IPP Stn) and Rajghat Power House (RPH), owned by Delhi Electric Supply Undertaking, are both coal-fired power stations located on Ring Road in New Delhi. Ash content of the coal used ranges between 38-47%. The ash is collected in electrostatic precipitators which have an efficiency of 99.3% (IPP station), and 99.7% (RPH). There are instances of major dust pollution around the power stations from fly ash dispersal. The main method of disposal of fly ash from the power stations is by mixing with water, the resultant slurry is pumped through pipes to ash disposal ponds. The supernatant from these ponds is discharged into River Yamuna. Field studies have revealed large quantities of fly ash being deposited into the river. Local populations of *Eichhornia crassipes* have reduced dramatically between 1987-1995, with a marked reduction in the year 1994-1995. Field studies, conducted in January, 1995 have investigated the impact of fly ash dispersal in the Delhi region with particular reference to metal contamination. Elemental concentrations for a range of elements are determined by ICP-AES in fly ash and top soils along four transects from the power stations up to a distance of 8 km. The effects of fly ash leachates from the ash settling ponds on the river are determined by analyzing river overbank soils and vegetation for their elemental contents. It is concluded that fly ash dispersal from the stacks are a source of alkali, alkaline-earth and to some extent heavy metals in soils in the vicinity of the power stations, and enrichment of elements in river overbank soils are a result of discharge of fly ash leachates from ash disposal ponds. However, the impact from both these sources of metal contamination is not large enough to give cause for concern. Marked reduction in populations of *Eichhornia crassipes* downstream of the river where it receives leachates from the ash disposal ponds are attributed to turbidity of the ash pond leachates and metal toxicity. Elemental enrichment in the floodplain soils, as a result of fly ash particle deposition during monsoons, may enhance the horticultural value of these soils as is shown by a healthy cultivated crop of *Brassica juncea*.
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318. Impact of fly ash from the "Dolna Odra" power plant on firmness and physico-chemical properties of light silty loam.

Mynkowiak, W.; Snieg, M.; Tomaszewicz, T.; and Dawidowski, J. B.
Inzynieria Rolnicza 5(2): 237-243. (2001)
NAL Call #: 381 J8223 S671 .A372; ISSN: 1429-7264.
Notes: Original title: Wpyw dawki popioow lotnych z elektrowni "Dolna Odra" na zwiezosc i fizykochemiczne wasciwosci gliny lekkiej pylastej.
Descriptors: barley/ calcium/ exchangeable calcium/ exchangeable magnesium/ firmness/ fly ash/ liming materials/ loam soils/ magnesium/ rye/ silty soils/ soil amendments/ soil chemical properties/ soil mechanics/ soil pH/ soil physical properties/ soil structure/ triticale/ wheat/ chemical properties of soil/ engineering properties of soil/ mechanical properties of soil/ physical properties of soil
Abstract: A study was conducted in a light silty loam soil in Poland to determine the effect on soil firmness and on changes in other soil physical properties of applying fly ash for the production of four winter cereals (wheat, triticale, barley and rye). It was found that introducing ash into the soil resulted in a decrease in firmness. The dose of 100

tonnes/ha appeared to be optimal for majority of experimental plots. An increase in soil reaction [pH] and exchangeable calcium and magnesium contents was observed that may be recognized as being a positive effect on the structure-forming capacity of the soil.
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319. Impact of fly ash on hatching: Penetration and development of root-knot nematode.

Tarannum, A.; Khan, A. A.; Diva, I.; and Khan, B.
Nematologia Mediterranea (Italy) 29(2): 215-218. (2001)
NAL Call #: QL391.N4N42; ISSN: 0391-9749.
Notes: Original title: Meloidogyne javanica [Cicer arietinum L.]: Impatto della cenere di carbone su schiusa-penetrazione e sviluppo del nematode galligeno delle radici. 3 tables. Summary (En). Citation Notes: IT (Italy).
Descriptors: fly ash/ egg hatching/ root-knot nematode
Abstract: Fly ash extract significantly impaired the hatching of *Meloidogyne javanica* juveniles, the inhibition in hatching being proportional to the concentration of the extract. Soil application of fly ash in different doses (0.0%, 25%, 50% and 100%) inhibited root penetration by juveniles, with penetration being inversely related to fly ash ratios. Penetration was completely suppressed at 100% concentration. All the rates suppressed the development of juveniles in chickpea roots. At lower levels (25%, 50%) of mixtures, low numbers of J2 developed to the mature female stage.

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320. Impact of fly-ashes from the "Dolna Odra" power plant on firmness and physicochemical properties of light silty loam.

Mlynkowiak, W.; Snieg, M.; Tomaszewicz, T.; and Dawidowski, J. B.
Inzynieria Rolnicza (Poland) 2: 237-243. (2001)
NAL Call #: 381 J8223 S671 .A372; ISSN: 1429-7264.
Notes: Original title: Wplyw dawki popioow lotnych z elektrowni "Dolna Odra" na zwiezosc i fizykochemiczne wasciwosci gliny lekkiej pylastej. 3 fig., 2 tables; 11 ref. Summaries (En, Pl). Citation Notes: PL (Poland).
Descriptors: fly ash/ power plants/ soils/ silty loam
Abstract: Measurement results of firmness and changes in physicochemical properties of light silty loam supplied with the fly-ashes were presented. Investigations were carried out under four winter cereal crops: wheat, triticale, barley and rye. It was found that introduction of fly-ashes into soil decreased its firmness. The rate of 100 t/ha appeared to be optimal on majority of experimental plots. Moreover, increased soil pH and contents of exchangeable calcium and magnesium forms were observed what may be recognized as a factor positively affecting the structure forming capacity of soil.

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321. Impact of flyash, light and shade environments on growth and chemical response of *Albizia procera* and *Acacia nilotica*.

Sadhna Tripathi and Ashutosh Tripathi
Journal of Environmental Biology 19(1): 33-41. (1998)
NAL Call #: QH540.J65 ; ISSN: 0254-8704
Descriptors: chemical composition/ fly ash/ growth/ light/ multipurpose trees/ pot experimentation/ shade/ soil amendments/ solar radiation/ trees/ woody plants/ sunlight

Abstract: *Albizia procera* and *Acacia nilotica* seeds were sown in pots (5 per pot) containing field soil amended with 10, 20 and 30% fly ash. After establishment of the seedlings, the most healthy seedling in each pot was retained and either set in the shade or kept in the sun. The seedlings were watered regularly and the physical and chemical properties of the plants were measured after 6 months. Results indicated that lower concentrations of flyash favoured the growth of *Albizia procera* and *Acacia nilotica*, however, higher concentrations had adverse effects. On the basis of storage substances, ascorbic acid, proline, phenol and amino acids in both the species, it was concluded that *Acacia nilotica* can survive in shade as well as light. *Albizia procera*, however, exhibited higher values for storage substances only in light-exposed plants; plants in shade areas were under stress. Reproduced with permission from the CAB Abstracts database.

322. Impact of industrial particulate pollutants applied to soil on growth and yield of tomato.

Deepali Raghav and Khan, A. A.

Thai Journal of Agricultural Science 35(2): 187-194. (2002); ISSN: 0049-3589

Descriptors: bricks/ cement dust/ crop yield/ dust/ fly ash/ growth/ kilns/ pollutants/ polluted soils/ soil pollution/ tomatoes

Abstract: The study was conducted to observe the impact of industrial particulate pollutants (fly ash, cement dust, and brick kiln dust) applied to soil on plant growth and yield of tomato (cv. Pusa Ruby). It was observed that all the ratios of fly ash amended soil (5, 10, 15, 20, and 25%) increased the plant growth and yield compared to the control except 50% fly ash, where plant growth and yield were reduced. Growth and yield were maximum at 20% levels. In the cement dust experiments, it was seen that growth and yield of tomato were inversely proportional to the levels of cement dust. Brick kiln dust showed an increment in growth and yield of plants at lower levels and the maximum was observed in 15% concentration. Among three particulates, fly ash and brick kiln dust were found beneficial for plant growth and yield at lower levels. The ideal levels were 15 and 20% for brick kiln and fly ash respectively. However, cement dust was very harmful to plant at all the levels. Reproduced with permission from the CAB Abstracts database.

323. Impact of inorganic fertilizers and organic manures on soil properties and crop yields under soybean-wheat system.

Ravankar, H. N.; Patil, R. T.; and Sarap, P. A.

Research on Crops 4(3): 301-304. (2003); ISSN: 0972-3226

Descriptors: crop yield/ farmyard manure/ fly ash/ gypsum/ lopping/ manures/ NPK fertilizers/ soil fertility/ soil ph/ soil properties/ soyabeans/ straw/ urea fertilizers/ wheat/ wheat straw/ zinc sulfate/ FYM/ soybeans/ zinc sulphate

Abstract: A field study was conducted in Akola, Maharashtra, India, to evaluate the influence of different fertility management practices involving organic and inorganic fertilizers on trends in productivity and fertility status under soyabeans-wheat cropping sequence. The 12 treatment combinations include: T1 - control (no manure or

fertilizer); T2 - recommended dose of NPK (S free), urea, DAP and MOP; T3 - recommended dose of NPK+S (Gypsum) + zinc sulfate; T4 - recommended dose of NPK+zinc sulfate; T5 - recommended dose of NPK+S (Gypsum); T6 - recommended dose of NPK+S+zinc sulfate (50% N through fertilizer and 50% N through *Leucaena* loppings); T7 - recommended dose of NPK+S+zinc sulfate (50% N through fertilizer and 50% through FYM); T8 - recommended dose of NPK+S+zinc sulfate (N is to be added through wheat straw produced in the plot+rest of N through fertilizer); T9 - recommended dose of NPK+S+zinc sulfate (50% N through *Leucaena* loppings + 25% N through wheat straw); T10 - 150% recommended dose of NPK+S (Gypsum) + zinc sulfate; T11 - recommended dose of NPK through urea, SSP and MOP; and T12 - recommended dose of NPK (S free)+fly ash 10 tonnes/ha. Application of fertilizers in inorganic, organic forms and their combinations significantly increased the grain yield of both soyabean and wheat over control. Highest yield was recorded with the application of 150% recommended dose of NPK in combination with S and Zn. Continuous application of FYM for four years reduced the soil pH from initial level of 8.2 in 1997 to 7.9 in 2000-01. The contents of organic carbon, available N, P and K were favourably influenced by increasing rate of fertilizer application. Reproduced with permission from the CAB Abstracts database.

324. Impact of lignite fly ash on the performance of groundnut and residual soil fertility in loamy sand soil (Typic udipsamments).

Poonkodi, P. 22(1): 15-17. (2003); ISSN: 02578050 [PORSO]

Descriptors: Groundnut/ Lignite fly ash/ Soil fertility/ crop yield/ fly ash/ soil amendment/ soil fertility/ *Arachis hypogaea*/ *Fraxinus*

Abstract: The present investigation deals with the impact of lignite fly ash on the yield performance of groundnut cv VRI 2 and the residual soil fertility status. The results revealed that the application of lignite fly ash significantly increased the pod and haulm yield of groundnut. The physico-chemical analysis of soil after harvest reveals that the application of lignite fly ash increased the pH and EC of soil. It also improved the available N, P, K, Ca, Mg and S status of the soil. The optimum dose of lignite fly ash was found to be 4t ha⁻¹.

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325. Impact of soil application of fly ash on growth and yield of wheat.

Yavarzadeh, M. R.; Gavali, R. S.; and Dhumal, K. N.

Journal of Maharashtra Agricultural Universities 33(2): 158-160. (2008); ISSN: 0378-2395

Descriptors: crop yield/ flag leaf/ fly ash/ leaf area/ nitrogen/ phosphorus/ photosynthesis/ plant height/ potassium/ soil fertility/ spikes/ tillers/ trace elements/ wheat/ yield components/ carbon assimilation/ carbon dioxide fixation/ microelements

Abstract: In experiments conducted during rabi 2006, in Maharashtra, India, FA3 (fly ash at 40 t ha⁻¹) was better than other treatments for height of plant, photosynthetic rate, flag leaf area, weight of 1000 grains, and grain yield. The grain yield was higher by 28% over control. Similarly,

the treatment FA4 (20 t ha⁻¹ FA) was the best for number of tillers plant⁻¹, number of grains spike⁻¹ and length of spike over control and other treatments. Fly ash also maintained available N, P, K, and micronutrients in soil. Reproduced with permission from the CAB Abstracts database.

326. Impacts of fly-ash on soil and plant responses.

Gupta, D. K.; Rai, U. N.; Tripathi, R. D.; and Inouhe, M. *Journal of Plant Research* 115(6): 401-409. (2002); ISSN: 0918-9440

Descriptors: bioremediation/ fly ash/ leaves/ metal tolerance/ nitrogen fixation/ nutrient availability/ photosynthesis/ pollution/ soil amendments/ soil chemical properties/ soil fertility/ soil physical properties/ transpiration/ carbon assimilation/ carbon dioxide fixation/ chemical properties of soil/ environmental pollution/ physical properties of soil

Abstract: Coal combustion produces carbon dioxides, SO_x, NO_x and a variety of byproducts, including fly-ash, flue gas and scrubber sludge. Fly-ash consists of minute glass-like particles and its deposition on leaves inhibits the normal transpiration and photosynthesis of plants. Fly-ash also affects the physicochemical characteristics of soil because it is generally very basic, rich in various essential and non-essential elements, but poor in both nitrogen and available phosphorus. The massive fly-ash materials have been a potential resource for the agricultural activities as well as the other industrial purposes. Practical value of fly-ash in agriculture as an 'effective and safe' fertiliser or soil amendment can be established after repeated field experiments. Here remains to be disclosed the biological processes and interactions due to 'lack and excess' of the fly-ash exposures along with abiotic and biotic factors. These may involve the symbiotic fixation of nitrogen and the biological extraction of metals following immobilisation of toxic heavy metal ions, as well as other neutralization and equilibration processes during weathering. Nitrogen-fixing plants with an apparent heavy metal-tolerance can be helpful as the early colonisers of fly-ash dumps and nearby areas.

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327. Implications of fly ash application to soil for plant growth and feed quality.

Hammermeister, A. M.; Naeth, M. A.; and Chanasyk, D. S. *Environmental Technology* 19(2): 143-152. (1998) NAL Call #: TD1.E59; ISSN: 0959-3330

Descriptors: application to land/ barley/ boron/ calcium/ chromium/ crop yield/ fly ash/ growth/ lucerne/ molybdenum/ phosphorus/ potassium/ quality/ selenium/ sodium/ soil/ strontium/ trace elements/ alfalfa/ land application/ microelements/ Mo

Abstract: Fly ash was applied to reclaimed mine soil near Edmonton, Alberta, Canada, at rates of 0, 25, 50, 100, 200, and 400 t/ha. Total and water soluble concentrations of selected elements were determined from soil samples collected at 0 to 15 cm. Growth, development, and elemental uptake of barley (*Hordeum vulgare*), brome (*Bromus inermis*), and lucerne (*Medicago sativa*) were measured at select stages of development. Water soluble concentrations of B, Mo, Ca, Cr, K, Mg, Na, P, Se, and Sr variably increased with increasing fly ash rate. Boron concentration in plant tissue increased significantly to toxic

levels with symptoms evident at early stages of barley development and increasingly severe at later stages. Toxicity symptoms were less severe for brome and lucerne. The Cu:Mo ratio of vegetation decreased with increased fly ash rate to levels which could cause Cu deficiency in livestock. Yield of barley silage was significantly increased at intermediate rates of fly ash application, but significantly reduced at 400 t/ha.

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328. Improvement of calcareous expansive soils in semi-arid environments.

Nalbantoglu, Z. and Gucbilmez, E. *Journal of Arid Environments* 47(4): 453-463. (2001); ISSN: 0140-1963

Descriptors: calcareous soils/ cation exchange capacity/ clay fraction/ fly ash/ hydraulic conductivity/ land improvement/ lime/ mineralogy/ plasticity index/ semiarid zones/ soil conditioners/ soil types/ stabilizing/ swelling
Abstract: The effect was studied of fly ash treatment on volume change, hydraulic conductivity and mineralogy of expansive calcareous soil in Cyprus, using CEC (cation exchange capacity) values to substantiate the formation of new mineral phases, which are produced as a result of pozzolanic reaction. Soil-fly ash mixtures were prepared with 15 and 25% fly ash by dry weight of the soil and one mixture with 15% fly ash plus an additional 3% lime. Results showed that the plasticity index of the treated soils decreased as clay size content decreased with the increase in fly ash content. The lowest plasticity index and clay size fraction were obtained at 3% lime plus 15% fly ash treatment. The specimen treated with 3% lime plus 15% fly ash gave an initial swell potential of 0.9% and with a curing time of 30 days, this value dropped to zero. Results also indicated an increase in the hydraulic conductivity values with the increase in fly ash content and lime-fly ash treatment. The greatest increase in hydraulic conductivity was obtained for the soil treated with 3% lime plus 15% fly ash. The fly ash and lime-fly ash treated soils gave decreasing CEC values which indicated a change in the mineralogy of the treated soils.

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329. Improving rice productivity and soil quality by coal ash-phosphogypsum mixture application.

Lee, Y. B.; Ha, H. S.; Lee, C. H.; Lee, H.; Ha, B. H.; and Kim, P. J.

Korean Journal of Soil Science and Fertilizer 38(1): 45-51. (Feb. 2005); ISSN: 0367-6315.

Notes: Summary(En). Citation notes: KR (Korea-Republic-of).

Descriptors: rice/ productivity/ soil quality/ coal ash/ phosphogypsum

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330. Increase of Available Phosphorus by Fly Ash Application in Paddy Soils.

Lee, C. H.; Lee, H.; Lee, Y. B.; Chang, H. H.; Ali, M. A.; Min, W.; Kim, S.; and Kim, P. J.

Communications in Soil Science and Plant Analysis 38(11-12): 1551-1562. (2007)

NAL Call #: S590.C63; ISSN: 0010-3624

Descriptors: Oryza sativa/ rice/ paddy soils/ fly ash/ soil amendments/ phosphorus/ nutrient availability/ soil fertility/ grain yield/ application rate/ silicon/ pH/ phosphates/ silicates/ soil pH/ acid soils/ buffering capacity/ flooded conditions/ Korea Republic/ ion interactions

Abstract: Fly ash from the coal-burning industry may be a potential inorganic soil amendment to increase rice productivity and to restore the soil nutrient balance in paddy soil. In this study, fly ash was applied at rates of 0, 40, 80, and 120 Mg ha⁻¹ in two paddy soils (silt loam in Yehari and loamy sand in Daegok). During rice cultivation, available phosphorus (P) increased significantly with fly ash application, as there was high content of P (786 mg kg⁻¹) in the applied fly ash. In addition, high content of silicon (Si) and high pH of fly ash contributed to increased available-P content by ion competition between phosphate and silicate and by neutralization of soil acidity, respectively. With fly-ash application, water-soluble P (W-P) content increased significantly together with increasing aluminum-bound P (Al-P) and calcium-bound P (Ca-P) fractions. By contrast, iron-bound P (Fe-P) decreased significantly because of reduction of iron under the flooded paddy soil during rice cultivation. The present experiment indicated that addition of fly ash had a positive benefit on increasing the P availability.

This citation is from AGRICOLA.

331. Increasing bioavailability of phosphorus from fly ash through vermicomposting.

Bhattacharya, S. S. and Chattopadhyay, G. N. *Journal of Environmental Quality* 31(6): 2116-2119. (2002) NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: bioavailability/ cattle dung/ fly ash/ nutrient availability/ organic matter/ phosphate solubilizing bacteria/ phosphorus/ soil amendments/ soil fertility/ soil invertebrates/ vermicomposting/ waste management / waste utilization/ vermicomposts

Abstract: Due to the environmental problems created by large-scale fly ash generation throughout the world, efforts are being made to recycle these materials. An important component of the recycling effort is using fly ash to improve low-fertility soils. Because availability of many nutrients is very low in fly ash, available ranges of such nutrients must be improved to increase the effectiveness of fly ash as a soil amendment. In the present study, we assessed the possibility of increasing P bioavailability in fly ash through vermicomposting in a yard experiment in West Bengal, India. Fly ash was mixed with organic matter in the form of cow (*Bos taurus*) dung at 1:3, 1:1, and 3:1 ratios and incubated with and without epigeic earthworm (*Eisenia fetida*) for 50 days. The concentration of phosphate-solubilizing bacteria was found to increase many fold in the earthworm-treated series of fly ash and organic matter combinations compared with the series without earthworm. This helped to transform considerable amounts of insoluble P from fly ash into more soluble forms and thus resulted in increased bioavailability of the nutrients in the vermicomposted series. Among different combinations of fly ash and organic matter, P availability in fly ash due to vermicomposting was significantly higher in the 1:1 fly ash to cow dung treatment compared with the other treatments. Reproduced with permission from the CAB Abstracts database.

332. Induction of resistance with organic nutrients in rice for the management of brown plant hopper.

Rani, B. U.; Rajendran, R.; and Suresh, K. *Annals of Plant Protection Sciences* 14(2): 374-378. (2006) NAL Call #: SB950.A1A46; ISSN: 0971-3573

Descriptors: behaviour/ biological development/ eclosion/ farmyard manure/ feeding behaviour/ fly ash/ genotypes/ growth/ induced resistance/ insect pests/ lignite/ longevity/ neem seed cake/ pest resistance/ phosphate solubilizing bacteria/ plant pests/ rice/ behavior/ biofertilizers/ brown planthopper/ feeding behavior/ FYM/ Madras/ neem seed oilmeal/ paddy/ rice brown planthopper

Abstract: In field trials conducted during November 2004-February 2005, in Madurai, Tamil Nadu, India, rice genotypes IR 36, IR 64, TKM 6, MDU 3 and ADT 36 were used as resistance sources, while farmyard manure (FYM), biofertilizers (Azospirillum + phosphobacterium + silicate solubilizing bacteria (SSB)), neem cake and lignite fly ash were used as organic nutrient sources. In addition, a laboratory study was conducted to study the mechanism of resistance in terms of population build up, growth and development, and feeding activity of the brown plant hopper (*Nilaparvata lugens*). Results of the field trial indicated that the hopper population was consistently reduced due to combined effect of IR 64 and FYM, Azospirillum, phosphobacterium, SSB, lignite fly ash and neem cake. Significantly prolonged nymphal duration, lower nymphal survival, lower growth index, lower adult emergence and longevity of hoppers were noticed in the treatment with the cultivars IR 64 and IR 36 treated with FYM, Azospirillum, phosphobacterium, SSB, lignite fly ash and neem cake than in the susceptible control T(N)I. The area of honeydew spot and correspondingly the weight of honeydew were significantly less in the cultivars IR 36 and IR 64 treated with organic nutrients. In addition, number of feeding probes were higher in the above said promising treatments. Reproduced with permission from the CAB Abstracts database.

333. Industrial ecology approach to management of fly ash from fluidized bed combustion; production of slow-release fertilizer and soil conditioner.

Castaneda Munoz, Mario
Puerto Rico: University of Puerto Rico, Mayaguez, Puerto Rico, 2006.

Descriptors: agriculture/ Antilles/ applications/ ash/ Caribbean region/ coal/ combustion/ computer programs/ concentration/ deposition/ environmental analysis/ environmental effects/ fertilizers/ Greater Antilles/ HYDRUS-1D/ pollutants/ pollution/ power plants/ Puerto Rico/ sedimentary rocks/ simulation/ soils/ technology/ temperature/ trace elements/ transport/ tropical environment/ United States/ West Indies/ environmental geology

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334. Infectivity and efficacy of *Glomus aggregatum* and growth response of *Cajanus cajan* (L.) Millsp. in flyash amended sterile soil.

Garampalli, R. H.; Sunanda Deene; and Reddy, C. N. *Journal of Environmental Biology* 26(4): 705-708. (2005) NAL Call #: QH540.J65 ; ISSN: 0254-8704

Descriptors: application rates/ endomycorrhizas/ fly ash/ growth/ mycorrhizal fungi/ mycorrhizas/ pigeon peas/ pot culture/ soil amendments/ use efficiency/ vesicular arbuscular mycorrhizas/ arbuscular mycorrhizas/ Glomaceae

Abstract: A pot culture experiment was conducted using sterile, phosphorus deficient soil to study the effect of fly ash at 3 different concentrations (10, 20 and 30 g fly ash/kg soil) on the infectivity and effectiveness of vesicular arbuscular mycorrhiza (VAM) fungus *Glomus aggregatum* in pigeon pea (*Cajanus cajan* cv. Maruti). Fly ash, applied in all 3 different concentrations, was found to significantly affect the intensity of VAM fungal colonization inside the plant roots and also suppressed the formation of VAM fungal structure (vesicles and arbuscules) completely at higher concentration (30 g fly ash/kg soil). The response of the pigeon pea plants, in terms of dry weight, under the influence of fly ash amendment in VAM fungus infested soils was found to be considerably less (though not significant enough) when compared to the control plants (without fly ash) that have otherwise shown significant increase in growth over the plants without *G. aggregatum* inoculation. However, fly ash amendment without VAM inoculation was also found to enhance the growth of plants as compared to control plants (without fly ash and VAM inoculum).

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335. Influence of certain industrial effluents on growth and metabolism of *Abelmoschus esculentus* (L.) Moench seedlings.

Kumari, J. U.; Ramana, V. V.; and Reddy, K. J. Warangal, India.; pp. 181-186; 2001.

Descriptors: amylases / catalase/ catechol oxidase/ coal mine spoil/ effluents/ enzyme activity/ enzymes/ fly ash/ hypocotyls/ okras/ peroxidase/ seed germination/ seedling growth/ water pollution/ colliery spoil/ erythrocyte catalase
Abstract: The effects of different treatments (coal mine effluent from Manuguru, paper board effluent from ITC, Bhadrachalam, and Kinnerasani water with fly ash deposited from KTPS, all in Andhra Pradesh, India) at different concentrations (25, 50, 75 and 100%) on the germination and activity of certain enzymes were studied in okra (*A. esculentus*). The activity of amylase, catalase and polyphenol oxidase [catechol oxidase] increased, while that of peroxidase decreased at 50% level under mine water treatment which correlated with higher germination percentage, fresh weight and dry weight. No significant change occurred with reference to protein. With ITC effluent, no significant change occurred with any of the parameters studied. On the other hand hypocotyl length, fresh weight and dry weight increased at 100% level. Kinnerasani water flooded with fly-ash deposition from KTPS had decreased hypocotyl length, fresh weight and dry weight. Activity of amylase, catalase and peroxidase decreased while the activity of polyphenol oxidase increased with effluent treatment.

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336. Influence of coal ash on microorganisms and applicability of coal ash to remediate desertified soil in the case of desertified land in Inner Mongolia of China.

Mitsuno, M.; Tazaki, K.; Fyfe, W. S.; Powell, M. A.; Hart, B.; Sun Daishng; and Li ShengRong

Clay Science 11(5): 503-515. (2001); ISSN: 0009-8574

Descriptors: afforestation/ ash/ chemical composition/ coal/ desertification/ porosity/ reclamation/ reservoir soils/ sediment/ soil bacteria/ soil degradation/ Inner Mongolia/ Nei Menggu/ reafforestation/ reforestation/ soil quality

Abstract: Natural cultivation experiments using coal ash, reservoir sediments and Yellow River sediments were carried out to determine the applicability of using these wastes to remediate desertified soil in Inner Mongolia, China. In the experiments, the microorganisms multiplied more when coal ash was applied to the desertified soil. Under optical microscope, abundant bacteria were observed in porous surfaces and inside of coal ash particles thereby indicating that the addition of coal ash to desertified soil hastens the breeding of bacteria, improves soil quality and could be used in afforestation practices. The effects of ash on soil can be explained in two ways: first, in terms of its chemical characteristics (the coal ash contains C, N, P and K); and second, in terms of its micromorphology (it is porous). In natural cultivation experiments, the mixing of reservoir sediments and/or Yellow River sediments with the coal ash helped multiply bacteria. These experiments suggest that coal ash and reservoir sediments can be utilized to help solve some of the most serious environmental issues facing China today. Reproduced with permission from the CAB Abstracts database.

337. Influence of coal combustion gases on metal mobility and plant uptake, Centralia, PA.

Hammit, Sarah Ann

Princeton, NJ, United States: Princeton University, 2004.

Notes: References: 37; illus.

Descriptors: aquifers / atmosphere/ carbon dioxide/ sequestration/ coal mines/ Columbia County Pennsylvania/ fires / gases/ ground water/ metals/ mines/ mobility/ Pennsylvania/ pH/ pollutants/ pollution/ reservoir rocks/ soils/ United States/ weathering/ environmental geology
© American Geological Institute

338. Influence of cover crops and soil amendments on okra (*Abelmoschus esculentus* L.) production and soil nematodes.

Wang, Q.; Li, Y.; Klassen, W.; and Handoo, Z. 22(1): 41-53. (2007); ISSN: 17421705

Notes: doi: 10.1017/S1742170507001585.

Descriptors: amendments/ biosolids/ coal ash/ composts/ cover crop/ nematode/ okra/ biosolid/ compost/ cover crop/ crop production/ crop yield/ nematode/ population density/ soil amendment/ taxonomy/ *Abelmoschus*/ *Abelmoschus esculentus*/ *Cannabis*/ *Crotalaria*/ *Crotalaria juncea*/ *Meloidogyne*/ *Meloidogyne incognita*/ *Meloidogyne javanica*/ *Nematoda*/ *Sorghum x drummondii*
Abstract: A pot experiment to determine the effects of

summer cover crops and soil amendments on okra yields and population densities of various soil nematode taxa was conducted in two consecutive growing seasons in a subtropical region. Two cover crops, sunn hemp (*Crotalaria juncea*) and sorghum sudangrass (*Sorghum bicolor* S. bicolor var. sudanense), were grown and returned to the soil with fallow as a control. As soon as these cover crops were harvested, they were soil incorporated together with one of several organic amendments. These organic amendments were biosolids, N-Viro soil (a 1 : 1 mixture of coal ash and biosolids), coal ash, co-compost (a 3 : 7 mixture of biosolids and yard wastes), and yard waste compost compared with a control (no additional amendment). Other treatments were fumigation with MC-33 (a mixture of 33% of methyl bromide and 67% of chloropicrin) and cover crop removal (harvested and removed cover crops and their residues from the soil). A nematode-susceptible vegetable crop, okra (*Abelmoschus esculentus* L.), was grown under these treatments. Among organic amendments, the application of biosolids produced the highest okra yield and biomass, and greatly suppressed root-knot nematodes, *Meloidogyne incognita*, in the soil. Between these two cover crops, sunn hemp was superior to sorghum sudangrass in improving okra production and in suppressing root-knot nematodes. The result indicates that growing sunn hemp as a cover crop and applying certain organic amendments can improve okra production and suppress root-knot nematodes, which are very damaging to okra plants. Such combined practices show a significant potential for application in organic farming and sustainable agriculture systems in a tropical or subtropical region. _ 2007 Cambridge University Press. © 2009 Elsevier B.V. All rights reserved.

339. Influence of crop residue, flyash and varying starter dosages on growth, yield and soil characteristics in rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system under irrigated conditions of Jammu region.

Dileep Kachroo; Dixit, A. K.; and Bali, A. S. *Indian Journal of Agricultural Sciences* 76(1): 3-6. (2006) NAL Call #: 22 AG83I; ISSN: 0019-5022
Descriptors: application rates/ crop residues/ crop yield/ farmyard manure/ fly ash/ growth/ intercropping/ mineral uptake/ nitrogen/ nutrient uptake/ phosphorus/ plant nutrition/ potassium/ rice/ soil chemical properties/ soil fertility/ soil flora/ soil physical properties/ wheat/ yield components/ chemical properties of soil/ FYM/ Hyphomycetes/ Kashmir/ paddy/ physical properties of soil
Abstract: A field experiment was conducted during rainy (kharij) 2001-winter season (rabi) 2002 at research farm of the University at Jammu to evaluate the influence of residue incorporation on the productivity and soil health in rice (*Oryza sativa* L.)-wheat (*Triticum aestivum* L. emend Fiori & Paol.) cropping system under irrigated conditions. Incorporation of rice residues in wheat and wheat residues in rice not only increased the productivity of system (16.2%) and yield components of rice and wheat but also increased the nutrient uptake (18.5 kg nitrogen, 3.6 kg phosphorus and 19.6 kg potassium/ha) compared to without residue incorporation besides improved the physico-chemical and microbiological properties of the soil. Alternatively the incorporation of flyash and left over stubbles of previous crops as residues were equally found effective in increasing the productivity by 13.5 and 8.1%, respectively and soil

environment in rice-wheat cropping system over without residue incorporation. Application of *Trichoderma viride*+20 kg N/ha or farmyard manure (5 tonnes/ha) as starter dose for quick and better decomposition showed to influence the yield, nutrient uptake, available nutrients status, microbial population and physical properties of the soil significantly than no starter dose application. Reproduced with permission from the CAB Abstracts database.

340. Influence of different nitrogenous sources on the growth of *Albizia procera* on fly ash.

Ashish Mishra and Yogeshwar Mishra *Environment and Ecology* 17(4): 886-890. (1999) NAL Call #: TD172.E5; ISSN: 0970-0420
Descriptors: ammonium sulfate/ biomass production/ diameter/ dry matter accumulation/ fly ash/ growth/ height/ nitrogen fertilizers/ seedlings/ trees/ urea/ woody plants/ ammonium sulphate
Abstract: In a study to examine the effects of nitrogen as ammonium sulfate, ammonium chloride and urea on the growth and development of *Albizia procera* seedlings in fly ash, observations were recorded on the influence of different nitrogen sources on extension of growth, diameter, fresh and dry matter accumulation in seedlings of *Albizia procera*. Urea nitrogen was found to result in better growth than other nitrogen sources applied in nutrient solution. Reproduced with permission from the CAB Abstracts database.

341. The influence of fertilization with composted mixtures of waste activated sludges with CaO and brown coal ash on the yield of tested plants and effectiveness of nitrogen .

Kalembasa, S. and Wysokinski, A. *Annales Universitatis Mariae Curie Skodowska Sectio E, Agricultura* 59(4): 1899-1904. (2004) NAL Call #: 512 L96AE; ISSN: 0365-1118.
Notes: Original title: Wpyw nawozenia kompostowana mieszanina osadow sciekowych z CaO lub z popioem z wegla brunatnego na plon roslin i efektywnosc azotu.
Descriptors: activated sludge/ brown coal/ composts/ crop yield/ dry matter/ fertilizers/ maize/ nitrogen fertilizers/ pot experimentation/ sunflowers / waste utilization/ corn
Abstract: The influence of fertilizer application with composted mixtures of waste activated sludge with CaO or ash from brown coal on yield and effectiveness of 1 g of nitrogen was studied. The yield of the tested plants (ryegrass, maize and sunflower) and the effectiveness of 1 g of nitrogen were higher on objects applied with the mixture of waste activated sludge with brown coal ash than with CaO. The composted mixtures were applied in August and therefore the effectiveness of fertilizer application was higher in the 2nd than 1st year of pot experiment. Reproduced with permission from the CAB Abstracts database.

342. The influence of fertilization with composted waste activated sludges with addition of CaO or brown coal ash on the chemical composition of tested plants.

Kalembasa, S. and Wysokinski, A. *Annales Universitatis Mariae Curie Skodowska Sectio E, Agricultura* 59(4): 1891-1897. (2004) NAL Call #: 512 L96AE; ISSN: 0365-1118.

Notes: Original title: Wpyw nawozenia kompostowanymi osadami sciekowymi z dodatkiem CaO lub popiou z wegla brunatnego na skad chemiczny roslin.

Descriptors: activated sludge/ brown coal/ calcium/ calcium fertilizers/ chemical composition/ composts/ fertilizers/ magnesium/ maize/ nutrient content/ potassium/ sodium/ sunflowers/ waste utilization/ corn

Abstract: The influence of fertilizer application with composted mixtures of waste activated sludges with CaO or ash from brown coal on the content of calcium, magnesium, potassium and sodium in the tested plants (ryegrass, maize and sunflower) was studied. The tested plants harvested from objects applied with CaO contained a higher amount of calcium and lower of magnesium than plants applied only with waste activated sludge or with the mixture of waste activated sludge with addition of brown coal ash. The content of potassium and sodium in the tested plants was not directly dependent on the kind of materials added to waste activated sludge.

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343. Influence of fly ash and FYM on the productivity of rice.

Mulla, S. R.; Prakash, S. S.; and Badnur, V. P. *Karnataka Journal of Agricultural Sciences* 13(4): 991-992. (2000)

NAL Call #: S471.I42K37; ISSN: 0972-1061

Descriptors: application rates/ crop yield/ farmyard manure/ fly ash/ nutrient availability/ nutrient uptake/ organic amendments/ rice/ soil properties/ FYM/ Mysore/ paddy

Abstract: Rice was treated with various combination levels of fly ash (0, 10, 20, 30 and 40 t/ha) and farmyard manure (FYM; 0 and 10 t/ha) in a field experiment conducted in Raichur, Karnataka, India during the kharif season of 1997. The highest grain and straw yields resulted from the treatment 40 t fly ash/ha+10 t FYM/ha. Application of increasing rates of fly ash improved soil properties and nutrient availability, as well as the nutrient uptake of the rice.

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344. Influence of fly ash and other amendments on leaching of soil nutrients and metals from a calcareous soil.

Wang, Qingren; Li, Yuncong; and Klassen, Waldemar. In: *Coal Combustion Byproducts and Environmental Issues*. Uppsala, Sweden.) 233 Spring Street, New York, NY 10013: Springer; pp. 171-176; 2006.

Notes: 7th International Conference on Biogeochemistry of Trace Elements.; ISBN: 0387258655

Descriptors: pollution assessment control and management/ soil science/ leaching/ fly ash/ calcareous soil/ soil nutrient

Abstract: The influences on the leaching of soil nutrients and heavy metals by separate application to a calcareous soil of fly ash, biosolids, N-viro soil, co-compost, and yard waste compost in comparison to a control without an amendment were determined in a pot experiment. The results showed that the concentration of NO₃-N in leachate

from biosolids was significantly higher than in leachate from other treatments. The levels of heavy metals found in the leachates from all amended soils were so low as to suggest these amendments may be used without risk of leaching significant amounts of these elements. Nevertheless the level of heavy metals in leachate from fly ash amended soil was substantially greater than in leachates from the other treatments. The results suggest that at heavy loading rates of biosolids, leaching of NO₃⁻ can be an important concern. Leaching of inorganic P can be increased significantly by application of both co-compost and biosolids, but significantly decreased by applying fly ash and N-viro soil. Biosolids, N-viro soil and fly ash applications significantly increased Ca and Mg concentrations in leachates. Copper concentration in leachate was increased by application of biosolids, while Fe concentration in leachates was increased by biosolids, fly ash and co-compost applications. The concentrations of Zn, Mo and Co in leachates were increased by application of fly ash. The concentrations of heavy metals in leachates were very low and unlikely to be harmful, although they were increased significantly by fly ash application.

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345. Influence of fly ash mixtures on early tree growth and physicochemical properties of soil in semi-arid tropical Alfisols.

Ramesh, V.; Korwar, G. R.; Mandal, Uttam Kumar; Prasad, Jasti V. N. S.; Sharma, Kishori Lal; Yezzu, S. Ramakrishna; and Kandula, Venkanna *Agroforestry Systems* 73(1): 13-22. (May 2008); ISSN: 0167-4366

Descriptors: fly ash/ tree growth/ physicochemical properties/ soil / semi-arid/ Alfisols

Abstract: The beneficial effects of planting mixtures comprising of fly ash at the rate of 66%, 33% and 17% by soil volume were assessed for the early growth of two economic tree species, teak (*Tectona grandis*) and leucaena (*Leucaena leucocephala*) in rainfed Semi-Arid Tropical (SAT) Alfisols in India. Measurements of tree growth were made at six monthly intervals over a 3-year period. Fly ash at 66% by soil volume of the planting pit significantly increased the diameter of teak at breast height (dbh). In leucaena, application of fly ash at 17% by soil volume was found to be effective in increasing dbh during most of the study period. Changes in soil physicochemical properties (bulk density, water retention at 0.033 and 1.5 MPa, profile moisture content, pH, soluble salt content and organic carbon) were simultaneously studied. Among these soil properties, plant available water (PAW) and organic carbon (OC) contents explained variations in diameter at breast height (dbh) in teak during most of the sampling period, while none of the soil properties significantly explained dbh in leucaena. The highest dose of fly ash applied (66% by volume) decreased bulk density (BD) and increased PAW in teak and to an extent in leucaena during the first 2 years of tree growth. Higher profile moisture content was noted in pits treated with 66% fly ash during the dry period of November (after the end of seasonal rainfall which occurred from June to October) during the first and second year after application.

This citation is from AGRICOLA.

346. Influence of fly ash on evaporation reduction from bare soils under high evaporativity.

Singh, C. B.; Grewal, K. S.; and Oswal, M. C.
Journal of the Indian Society of Soil Science 48(2): 373-376. (2000)
 NAL Call #: 56.9 IN2; ISSN: 0019-638X
Descriptors: evaporation/ fly ash/ soil/ soil amendments
 Reproduced with permission from the CAB Abstracts database.

347. Influence of fly ash on physico-chemical properties and fertility status of soil.

Singh, K. K. and Gayatri Verma
Research on Crops 4(1): 63-68. (2003); ISSN: 0972-3226
Descriptors: ammonium nitrogen/ electrical conductivity/ fly ash/ loam soils/ nitrogen/ phosphorus/ potassium/ sandy soils/ soil fertility/ soil pH/ soil types/ ammonia nitrogen
Abstract: The effect of different levels of fly ash (FA) on pH, electrical conductivity (EC) and available major plant nutrients such as nitrogen, phosphorus and potassium (NPK) was investigated in an alkaline loamy sand soil of Agra district, Uttar Pradesh, India. A decrease in soil pH and increase in EC was observed with the increasing doses of FA. The effect on the availability of $\text{NH}_4^+ + \text{N}$ and K^+ followed the order $7.5 > 5.0 > 2.5 > 0.0 > 10.05 > 12.5 > 15.0 > 30.0 \text{ g kg}^{-1}$ soil. The available phosphorus increased with the increasing doses upto 7.5 g kg^{-1} and thereafter it decreased with the increasing doses of FA but remained in higher amounts than the control.
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348. Influence of fly ash on productivity rating index of soil under soybean -wheat cropping sequence.

Sanjay Bhojar; Laharia, G. S.; and Rita Thakare
Annals of Plant Physiology 17(1): 102-103. (2003); ISSN: 0970-9924
Descriptors: cropping systems/ fly ash/ indexes of nutrient availability/ NPK fertilizers/ productivity/ soil fertility/ soyabeans/ wheat/ soybeans
Abstract: Field experiments were conducted during 1990-92 with the following treatments: F_0, F_1, F_2, F_3 and F_4 for 0, 25, 50, 75 and 100% of the recommended NPK fertilizer level to both soyabean-wheat crops, respectively; and A_0, A_1, A_2 and A_3 to 0, 5, 10 and 15 tonnes/ha fly ash, respectively, applied to kharif soyabean crop only. The productivity rating index (PRI) is the parameter which indicates the productivity of the soil under specific treatments under the specific management practice. The PRI of the control (F_0A_0) was 65.85, which was low for soyabean. It was observed that fertilizer application to crop increased the productivity of the soil, an evident increase of which was observed upon application of 10-15 tonnes fly ash/ha combined with 75 and 100% fertilizer level. PRI was also lower when fly ash was not applied while increased productivity was enhanced upon increasing rates of fly ash and fertilizer application. Among the various fertilizer rates without fly ash, the highest PRI was observed with full rates of NPK. Results revealed that maximum PRI could be achieved upon application of 100% NPK fertilizer level and 10-15 tonnes fly ash/ha.
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349. Influence of fly ash on soil physical properties and turfgrass establishment.

Adriano, D. C. and Weber, J. T.
Journal of Environmental Quality 30(2): 596-601. (2001)
 NAL Call #: QH540.J6; ISSN: 0047-2425
Descriptors: available water/ boron/ bulk density/ dry matter accumulation/ electrical conductivity/ fly ash/ growth/ infiltration/ lawns and turf/ plant height/ rooting depth/ soil amendments/ soil physical properties/ soil temperature/ soil water retention/ water holding capacity/ lawns and sports turf/ physical properties of soil
Abstract: A field study [place not given] (1993-96) assessed the benefits of applying unusually high rates of coal fly ash as a soil amendment to enhance water retention of soils without adversely affecting growth and marketability of the turf species, centipedegrass (*Eremochloa ophiuroides*). A Latin Square plot design was employed that included 0 (control, no ash applied), 280, 560, and 1120 t ha⁻¹ application rates of unweathered precipitator fly ash. The fly ash was spread evenly over each plot area, rototilled, and allowed to weather under natural conditions for 8 months before seeding. High levels of soluble salts, indicated by the electrical conductivity (EC) of soil extracts, in tandem with an apparent phytotoxic effect from boron (B), apparently inhibited initial plant establishment as shown by substantially lower germination counts in treated soil. However, plant height and rooting depth were not adversely affected, as were the dry matter yields throughout the study period. Ash treatment did not significantly influence water infiltration rate, bulk density, or temperature of the soil, but substantially improved water-holding capacity (WHC) and plant-available water (PAW). Enhanced water retention capacity improved the cohesion and handling property of harvested sod.
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350. Influence of flyash application on micronutrient availability and uptake by Sudan grass and oats grown on coal mine spoils.

Ajaya Srivastava and Chhonkar, P. K.
Journal of the Indian Society of Soil Science 48(4): 859-862. (2000)
 NAL Call #: 56.9 IN2; ISSN: 0019-638X
Descriptors: application rates/ availability/ coal mine spoil/ copper/ fly ash/ iron/ manganese/ nutrient uptake/ oats/ plant composition/ soil/ spoil heap soils/ trace elements/ zinc/ chemical constituents of plants/ colliery spoil / microelements/ Mn
Abstract: The impact of fly ash from Dadri, Ghaziabad, Uttar Pradesh, India on the chemical composition of acidic coal mine spoils and on growth and elemental composition of plants grown on these spoils was evaluated. The crops used were Sudan grass (*Sorghum sudanense*) and oats. Plant analysis showed consistently significant reductions in Fe and Mn uptake by both crops. The concentrations of Fe, Mn, Zn and Cu were particularly low in both crops grown in mine spoils amended with 100 g fly ash kg⁻¹ spoil. Addition of fly ash to spoil significantly increased pH and reduced solubility of Fe, Mn, Zn and Cu. By increasing fly ash application to 100 g kg⁻¹, the available Fe, Mn, Zn and Cu

decreased in the spoils and the amount was approximately 25, 30, 35 and 15%, respectively, lower than that in the untreated spoils.

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351. Influence of flyash with and without FYM and fertilizer on physico-chemical properties of sunflower and cotton growing soils.

Malewar, G. U.; Badole, S. B.; Mali, C. V.; Siddiqui, M. B.; and Syed Ismail

Annals of Agricultural Research 21(2): 187-191. (2000)

NAL Call #: S471.I4A56; ISSN: 0970-3179

Descriptors: boron/ bulk density/ cotton/ farmyard manure/ fly ash/ infiltration/ NPK fertilizers/ nutrient availability/ physicochemical properties/ plant nutrition/ porosity/ soil amendments/ soil chemistry/ soil fertility/ soil physical properties/ soil properties/ sunflowers / FYM/ physical properties of soil

Abstract: The results on the effect of fly ash, with and without FYM [farmyard manure] and fertilizer, on the physicochemical properties and soil fertility showed that application of 10 t FYM/ha + recommended doses of NPK were beneficial for soil improvement and nutrient availability. Further uses of fly ash decreased the bulk density and increased porosity, infiltration rate and available boron in sunflower and cotton growing soils. Fertilizer, FYM and fly ash interactions improved soil physical properties.

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352. Influence of nutrient management on growth and yield of sugarcane (var. Co 86032).

Venkatakrishnan, D. and Ravichandran, M.

Plant Archives 7(1): 99-102. (2007); ISSN: 0972-5210

Descriptors: crop yield/ farmyard manure/ fly ash/ growth/ gypsum/ lignite/ mineral uptake/ nitrogen/ organic amendments/ phosphorus/ plant nutrition/ potassium/ rice husks/ soil fertility/ sugarcane/ vermicompost/ zinc sulfate/ FYM/ Madras/ rice hulls/ zinc sulphate

Abstract: A field experiment was conducted in Tamil Nadu, India, at light textured soil to determine the effects of integrated nutrient management (INM) on NPK uptake, cane yield and soil fertility. The treatments were: (T₁) seasoned pressmud 25 t/ha; (T₂) T₁+rice husk ash 2.5 t/ha; (T₃) T₂+ZnSO₄ 37.5 kg/ha; (T₄) T₁+lignite fly ash 251 t/ha; (T₅) T₁+vermicompost 51 t/ha; (T₆) vermicompost 51 t/ha+lignite fly ash 25 t/ha; (T₇) T₆+ZnSO₄ 37.5 kg/ha; (T₈) vermicompost 5 t/ha+lignite fly ash 25 t/ha; (T₉) biocompost 5 t/ha; (T₁₀) T₉+enriched gypsum 1 t/ha; (T₁₁) T₁₀+ZnSO₄ 37.5 kg/ha; (T₁₂) T₉+lignite fly ash 25 t/ha; (T₁₃) FYM 10 t/ha; (T₁₄) recommended dose of NPK fertilizer. The results revealed that yield, NPK uptake and postharvest soil fertility status improved on the addition of seasoned pressmud 25 t/ha+vermicompost 5 t/ha recorded the highest cane yield (168.65 t/ha). Similarly, NPK uptake of stem and tops and trashes were registered 98.29 and 89.12 kg/ha for N, 57.15 and 46.01 kg/ha for P and 233.17 and 169.54 kg/ha for K, respectively, in this treatment. In soil treated with seasoned pressmud 25 t/ha+vermicompost 5 t/ha recorded the highest postharvest soil N of 254 and P of 22.7 kg/ha. With respect to available K content soil treated with seasoned

pressmud 25 t/ha+lignite fly ash 25 t/ha registered the highest value of 133.1 kg/ha.

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353. Influence of plant growth promoting bacteria and its mutant on heavy metal toxicity in Brassica juncea grown in fly ash amended soil.

Kumar, K. V.; Singh, N.; Behl, H. M.; and Srivastava, S.

Chemosphere 72(4): 678-83. (June 2008)

NAL Call #: TD172 .C54; ISSN: 0045-6535 . 18440582

Descriptors: plant growth/ bacteria/ heavy metals/ toxicity/ Brassica juncea/ fly ash/ amended soil

Abstract: In this study a metal tolerant plant growth promoting bacteria, NBRI K28 *Enterobacter* sp. was isolated from fly ash (FA) contaminated soils. The strain NBRI K28 and its siderophore overproducing mutant NBRI K28 SD1 were found capable of stimulating plant biomass and enhance phytoextraction of metals (Ni, Zn and Cr) from FA by metal accumulating plant i.e. *Brassica juncea* (Indian mustard). Concurrent production of siderophores, Indole acetic acid (IAA) and phosphate solubilization revealed its plant growth promotion potential. The strain also exhibited 1-aminocyclopropane-1-carboxylic acid (ACC) deaminase activity. In most of the cases mutant of NBRI K28, exerted more pronounced effect on metal accumulation and growth performance of *B. juncea* plants than wild type.

This citation is from PubMed.

354. Influence of soil pH and application rate on the oxidation of calcium sulfite derived from flue gas desulfurization.

Lee, Y. B.; Bigham, J. M.; Dick, W. A.; Jones, F. S.; and Ramsier, C.

Journal of Environmental Quality 36(1): 298-304. (Jan. 2007-Feb. 2007)

NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: calcium: chemistry/ gases: chemistry/ hydrogen ion concentration/ oxidation reduction/ soil / sulfites: chemistry/ sulfur: chemistry

Abstract: Calcium sulfite hemihydrate (CaSO₃·0.5H₂O), a common byproduct of coal-fired utilities, is fairly insoluble and can decompose to release toxic SO₂ under highly acidic soil conditions; however, it can also oxidize to form gypsum. The objective of this study was to examine the effects of application rate and soil pH on the oxidation of calcium sulfite under laboratory conditions. Oxidation rates measured by release of SO₄-S to solution decreased with increasing application rate. Leachate SO₄-S from soils amended with 1.0 to 3.0 g kg⁻¹ CaSO₃ increased over a 21 to 28 d period before reaching a plateau. At 4 g kg⁻¹, maximum SO₄-S release was delayed until Week 7. Oxidation and release of SO₄-S from soil amended with 3.0 g kg⁻¹ calcium sulfite increased markedly with decreasing soil pH. After only 3 d incubation, the concentrations of SO₄-S in aqueous leachates were 77, 122, 170, 220, and 229 mg L⁻¹ for initial soil pH values of 7.8, 6.5, 5.5, 5.1, and 4.0, respectively. At an initial soil pH value of 4.0, oxidation/dissolution did not increase much after 3 d. At higher pH values, oxidation was maximized after 21 d.

These results suggest that autumn surface applications of calcium sulfite in no-till systems should permit ample time for oxidation/dissolution reactions to occur without introducing biocidal effects related to oxygen scavenging. Soil and annual crops can thus benefit from additions of soluble Ca and SO₄ if calcium sulfite is applied in advance of spring planting.
This citation is from PubMed.

355. The influence of the addition of ash from brown coal and CaO to waste activated sludges on the losses of nitrogen from waste and fertilization value of mixture.

Kalembasa, S. and Wysokinski, A.

Folia Universitatis Agriculturae Stetinensis, Agricultura 77(145-150)(1999).

Notes: Original title: Wpływ dodatku do osadów ściekowych popiołu z węgla brunatnego i CaO na straty azotu z osadów i wartości nawozowa mieszaniny.

Descriptors: ash/ brown coal/ crop yield/ fertilizers/ lime/ losses/ maize/ nitrogen/ sewage sludge/ sunflowers/ corn

Abstract: The influence of the addition of brown coal ash from Bechatow mine (power station Patnow) and CaO to waste activated sludges from sewage purification plants at Siedlce and ukow on the losses of nitrogen and fertilization value of the mixture was studied. The addition of ash and CaO was 1/6, 1/4, 1/3 and 1/2 in relation to the dry matter of sludges. The losses of nitrogen from waste under the influence of the addition of CaO reached 18.8% for sludge from Siedlce and 16.2% from ukow but after the addition of ash losses were 11.0% and 12.2% respectively. The fertilizer value of the mixtures was tested in pot experiments using loamy sand (low in potassium and with 6.3 g N/kg soil). The addition of ash to the sludges significantly increased maize and sunflower yield, but CaO significantly decreased yield.

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356. Insecticide and phytotoxic effects of hard coal fly ash.

Ulrichs, C.; Dolgowski, D.; Mucha, T.; Reichmuth, C.; and Mewis, I.

Gesunde Pflanzen 57(5): 110-116. (2005); ISSN: 0367-4223.

Notes: Original title: Insektizide und phytotoxische Wirkung von Steinkohlenflugasche.

Descriptors: application rates/ coal/ cress/ fly ash/ growth/ herbicidal properties/ insect pests/ insecticidal properties/ mortality/ phytotoxicity/ soil pH/ stored products pests/ substrates/ Capparales/ death rate/ granary weevil

Abstract: Millions of tonnes of coal fly ash are produced annually and its disposal is a major concern. Fly ash is mainly used in civil construction and as landfill. However, these procedures do not utilize the complete amount of ash produced and thus, thermal power stations have to manage its storage. New ways to dispose of fly ash are needed and research on using fly ash in agricultural settings is conducted worldwide. Recent reports from India indicate the possible use of fly ash as insecticides. A series of laboratory experiments were undertaken to validate the insecticidal effect as well as to discover possible phytotoxicity problems. The growth of *Tropaeolum majus* and *Lepidium sativum* plants in substrate with

different fly ash rates was assessed. Test substrate for *L. sativum* contained 1, 5, 10, 20, 50 or 100% fly ash. Over a period of 12 days, fly ash (5, 25 or 50 mg) was applied every 3 days to *T. majus* potted in pots with 8-cm diameter. All experiments were analysed after four weeks. Surface treatments of fly ash had no effect on growth parameters of *T. majus*. In contrast to this length, growth of *L. sativum* was reduced when planted in substrate with 50% or higher fly ash. This effect is most likely caused by a physical and not chemical effect of the substrate. Soil pH increased with increasing percentages of fly ash. Substrate containing 50% fly ash showed a pH of 7.8 and 100% fly ash a pH of 8.7. Insecticidal effects of fly ash were tested on *Plodia interpunctella*, *Tenebrio molitor*, and *Sitophilus granarius*. Larval stages of *P. interpunctella* have been treated with 3, 8, 18.8, and 37.5 mg fly ash in a plastic box with 29 cm² area and kept for two days at 26 degrees C and 50% RH. The larval mortality did not differ from the untreated control. Fly ash treatment (20, 100 or 200 mg fly ash/50 cm²) had also no lethal effect in *T. molitor* larvae and adults after 12 days. In contrast, *S. granarius* beetle mortality increased slightly about two-fold (up to 14%) when treated with 125 mg fly ash/50 cm² after 12 days. Mortality was significant higher (100%) when insects were treated with the same amount of diatomaceous earths. The results show no potential of coal fly ash as effective insecticide in agricultural settings. Additionally, no phytotoxic effects were observed during a four-week period to *T. majus* and *L. sativum* plants. Results are critically discussed in context with recent publications.

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357. Integrated application of humic acid, fly ash and fertiliser on biochemical parameters and soil fertility.

Bama, K. S.; Sellmuthu, K. M.; and Sivakumar, K.

Journal of Ecobiology 17(6): 561-565. (2005)

NAL Call #: QH540.J56 ; ISSN: 0970-9037

Descriptors: alfisols / enzyme activity/ enzymes/ fly ash/ green gram/ humic acids/ nitrate reductase/ nitrogen/ nitrogen fertilizers/ nutrient availability/ phosphorus/ phosphorus fertilizers/ plant nutrition/ plant proteins/ potassium/ soil fertility/ soil types/ mung bean/ phosphate fertilizers

Abstract: To find out the effects of two organic sources such as humic acid (HA) and fly ash (FA) with inorganic fertilizers on green gram, a pot experiment was conducted in Alfisol. Treatments comprised: control, FA at 20 t ha⁻¹, HA at 10 kg ha⁻¹, nitrogen and phosphorus fertilizers (NP) alone, FA+NP, HA+NP, FA+HA+NP with and without blending. Among the treatments, combined application of HA, FA and fertilizer applied by blending recorded the highest soluble protein (203 mg g⁻¹), and nitrate reductase activity (180 NO₂ g⁻¹ h⁻¹) of green gram. The same treatment also recorded the highest available N (228 kg ha⁻¹), available P (24 kg ha⁻¹) and available K (350 kg ha⁻¹).
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358. An integrated approach to control rice blast through nutrients and biocontrol agent.

Karpagavalli, S.; Marimuthu, T.; Jayaraj, J.; and Ramabadrhan, R.

Research on Crops 2(2): 197-202. (2001); ISSN: 0972-3226

Descriptors: application rates/ biological control/ biological control agents/ carbendazim/ chemical control/ crop yield/ fly ash/ fungicides/ incidence/ lignite/ plant disease control/ plant diseases/ plant pathogenic fungi/ plant pathogens/ potassium fertilizers/ rice/ silica/ biocontrol agents/ biological control organisms/ carbendazol/ Madras/ MBC/ medamine/ paddy/ phytopathogens/ potash fertilizers
Abstract: A field trial was conducted in Aduthurai, Tamil Nadu, India [date not given] to investigate the complementary effect of silica (6 t lignite fly ash (LFA)/ha) and various K fertilizer levels (0, 60 and 45 kg potash/ha), along with a foliar spray of carbendazim and the biological control agent, *Pseudomonas fluorescens*, on the blast [*Magnaporthe grisea*] incidence of rice cultivars IR50 and White Ponni. Foliar spray of carbendazim or *P. fluorescens*, in addition to LFA and 45 kg potash/ha significantly reduced the rice blast incidence and increased crop yield. Reproduced with permission from the CAB Abstracts database.

359. Integrated use of organics and sulphur on the rice yield and sustainable soil health in sulphur deficient soil.

Sriramachandrasekharan, M. V.; Bhuvaneswari, R.; and Ravichandran, M.
Plant Archives 4(2): 281-286. (2004); ISSN: 0972-5210
Descriptors: application rates/ chlorophyll/ clay loam soils/ crop yield/ farmyard manure/ filter cake/ fly ash/ growth/ leaf area index/ nitrogen / nutrient availability/ panicles/ phosphorus/ plant height/ potassium/ residual effects/ rice/ soil fertility/ sulfur/ sulfur fertilizers/ tillers/ use efficiency/ Vertisols/ yield components/ clarification mud/ elemental sulphur/ FYM/ LAI/ Madras/ paddy/ sulphur/ sulphur fertilizers
Abstract: Field experiments were conducted during kharif (June-September) 2001 and rabi (October-January) 2002 on an S-deficient clay loam soil (Typic Haplustert) at Annamalai, Tamil Nadu, India to evaluate the effects S (0, 20, 40 and 60 kg/ha) and organic fertilizers (*Sesbania aculeata* at 12.5 t/ha, sulfitation pressmud at 10 t/ha, lignite fly ash at 20 t/ha and farmyard manure at 12.5 t/ha), applied alone or in combination, on soil fertility and the yields of the main and succeeding rice crops (residual effect). Data were recorded for plant height, number of productive tillers per hill, leaf area index, chlorophyll content, number of panicles/m², number of grains per panicle, thousand-grain weight, grain yield and straw yield. The contents of N, P, K and S in the soil were also determined. The growth and yield of rice increased with increasing level of S fertilizer up to 40 kg/ha. Among the organic fertilizers, *S. aculeata* recorded the highest values for the growth and yield parameters. The percentage of increase in rice yield was 16-20.7% when S was applied alone, and increased to 25-32% when S and organic fertilizers were combined. S use efficiency was highest with 20 kg S/ha and decreased with increasing S level. The residual effect of the fertilizers was well pronounced. S at 40 kg/ha combined with *Sesbania aculeata* or sulfitation pressmud recorded the highest values for growth and yield parameters and soil nutrient availability. Reproduced with permission from the CAB Abstracts database.

360. Interaction of resistant genotypes/varieties with organic nutrients on the management of rice gall midge.

Rani, B. U.; Suresh, K.; Rajendran, R.; and Rajavel, D. S.
Journal of Plant Protection and Environment 4(1): 24-29. (2007); ISSN: 0973-1717
Descriptors: cultivars/ cultural control/ farmyard manure/ fly ash/ genotypes/ insect pests/ neem seed cake / organic amendments/ pest control/ pest resistance/ phosphate solubilizing bacteria/ plant pests/ rice/ biofertilizers/ cultivated varieties/ FYM/ Madras/ neem seed oilmeal/ paddy
Abstract: Field experiments were conducted during November 2003-February 2004, July-October 2004, and October-January 2005 in Madurai, Tamil Nadu, India, to evaluate the interaction effects of different resistant rice genotypes with organic nutrients for the management of rice gall midge (*Orseolia oryzae*). The resistant sources used in the study were TKM6, MDU 3, MDU5, IR 64, IR 36 and ADT 36 with the susceptible control TN1. The organic nutrients such as farmyard manure (FYM), neem cake, biofertilizers and lignite fly ash were applied uniformly in all treatments. The present study indicated that gall midge incidence was significantly less in cv. MDU 3 treated with FYM, *Azospirillum*, phosphobacterium, silicate solubilizing bacteria, lignite fly ash and neem cake. In the present investigation, the consistent reduction of gall midge infestation was due to the combined effect of varietal resistance as well as induced resistance through the application of organic nutrients. Reproduced with permission from the CAB Abstracts database.

361. Interdependence between presence of chemical elements in filtered material from soil fertilised with different doses of coal ash.

Wojcieszczuk, T.; Niedzwiecki, E.; and Sowinska, M.
Journal of Elementology 9(4): 847-855. (2004); ISSN: 1044-2296.
Notes: Original title: Wzspozalezność występowania składników chemicznych w przesączach z gleby nawozonej zroznicowanymi dawkami popiołu z węgla kamiennego.
Descriptors: application rates/ ash/ calcium/ carbon/ chloride/ hydrogen/ losses from soil/ magnesium/ nitrogen/ potassium/ salts in soil/ sodium/ losses from soil systems
Abstract: A laboratory experiment was conducted to determine the quantities of chemical elements (Ca, Mg, K, Na, Cl, H, C, N, total concentration of salt) washed out from soil during 13 sprinkling treatments from 1994 to 2000. The soil was previously fertilized with different doses of ash (0; I=15; II=60; III=120 tonnes ha⁻¹), a by-product of coal burning at the Dolna Odra power plant, Poland. The results of chemical analyses of the soil filtered material served as a basis for computing correlation coefficients for all pairs of chemical elements as well as regression and determination coefficients for the pairs generating significant correlation. Chemical elements added to soil with coal ash modify quantitative and qualitative relationships between elements depending on a dose of ash used, which has been confirmed by the correlation and regression coefficients obtained in the experiment. Reproduced with permission from the CAB Abstracts database.

362. Investigations on pyrite oxidation in mine spoils of the Lusatian lignite mining district.

Meyer, G.; Waschkies, C.; and Huttli, R. F.

Plant and Soil 213(1/2): 137-147. (1999)

NAL Call #: 450 P696; ISSN: 0032-079X

Descriptors: composts / control/ fertilizers/ fly ash/ lignite/ mine spoil/ mining/ organic wastes/ oxidation / pyrites/ reclamation/ sewage/ sewage sludge/ sludges/ treatment/ wastes/ weathering/ mine wastes/ mining spoil/ mining wastes

Abstract: The impact of organic waste material and fly ash on microbial and chemical pyrite oxidation was investigated in a field experiment in Germany, and in column tests under laboratory conditions. For the field experiment, pyritic mine spoil was ameliorated with fly ash and treated either with mineral fertilizer, with sewage sludge or with compost. Independent of treatment, during the 18 months following application, the pyrite-S contents decreased steadily in the top spoil (0-30 cm depth). However, high variations of the pyrite-S content were observed. Compared to other pyrite oxidation studies, the pyrite content of the mine spoil at the experimental site was low. Therefore, a model spoil with a higher pyrite content, derived from Tertiary strata of the overburden sequence in the same open-cast mine, was used for the column experiments. For the first column experiment, the model spoil was mixed with fly ash and mineral fertilizer, reflecting the common reclamation practice in the Lusatian open-cast lignite mining district. Columns with this spoil were either inoculated with different cell numbers of autochthonous acidophilic bacteria, isolated from the model spoil, or with a commercial strain of *Thiobacillus ferrooxidans*. The ratio of sulphate-S to total S was used as a measure for the degree of pyrite oxidation. The sulphate-S:total S ratio increased within 28 days of incubation. The increase was related to the inoculated cell numbers of bacteria, but independent of the origin of the bacteria. It can be stated, that autochthonous bacteria from the model spoil oxidised pyrite at a similar rate as did the commercial *T. ferrooxidans* strain. For the second column test, mineral fertilizer, sewage sludge or compost were applied to the model spoil. The columns were inoculated with autochthonous bacteria, isolated from the model spoil. Application of sewage sludge and compost seemed to promote the weathering of pyrite, as the sulphate-S:total S ratio increased more rapidly in these treatments compared to control or mineral fertilizer application. Both experiments showed an increase of cell numbers of inoculated bacteria, independent of the sulphate-S:total S ratio. Reproduced with permission from the CAB Abstracts database.

363. A kind of mixed media composed of fly ash and acid residue of furfural for land reclamation and its leaching requirement.

Zhang LeiNa; Feng YongJun; and Wang ZhaoFeng

Transactions of the Chinese Society of Agricultural Engineering 20(4): 268-272. (2004)

NAL Call #: S671.N8; ISSN: 1002-6819

Descriptors: fly ash/ furfural/ leaching/ leaching requirement/ nutrient deficiencies/ polluted soils/ reclamation/ salts in soil/ soil amendments/ soil fertility/ soil ph/ soil pollution/ soil salinity/ soil toxicity/ soil types/ subsidence/ water holding capacity/ toxic soils

Abstract: Filling subsided lands with fly ash is currently the dominant land reclamation method in coal mine areas. To avoid some disadvantages of fly ash to soil, such as nutrient deficiency, high pH value, poor water holding capacity and harmful toxic element, a new kind of land media for land reclamation composed of different proportion of fly ash and the acid residue of furfural was developed based on pot tests. Results indicated that the properties of the fly ash was improved after the addition of the acid residue of furfural and this new medium was helpful for the plants growing in the area. The optimum proportion of acid residue of furfural in this new medium was 5-20%. It was also found that salt may be the main factor restraining plants from normal growth. To keep suitable salt content, salt washing for this new medium, in an example case, is needed and the washing amount is suggested to be $\sim 4.39 \times 10^3$ m³/hm². Reproduced with permission from the CAB Abstracts database.

364. Land Uses of Coal Fly Ash: Benefits and Barriers.

Smith, Irene

London: IEA Clean Coal Centre, 2005. 30p.

Notes: ISBN: 92-9029-411-6.

http://www.iea-coal.org.uk/publishor/system/component_view.asp?PhyDocId=5627&LogDocId=81241

Descriptors: fly ash/ land application/ coal

Abstract: This report focuses on three major sectors of fly ash utilisation: soil stabilisation, mine backfill and agriculture. Requirements are generally less rigorous than for use of fly ash in the cement and concrete industries. The benefits of using fly ash are investigated for each sector. These include improvements over use of cement or lime alone at lower cost, more effective land reclamation using less primary materials, and enhanced fertility of soils. Stabilisation of soils and aggregates with fly ash is a successful, high volume use, especially in road construction. Unbound fly ash as structural fill, for example in mines and road subbase, gives high volume, beneficial use of conditioned, stockpiled and lagoon fly ash. In agriculture, studies have shown that crop yields increase and water consumption may be reduced by using fly ash as soil amendment. Fly ash is complemented well by biosolids such as treated sewage sludge and acts synergistically with organic matter in improving plant growth. Barriers to utilisation of coal fly ash on land occur in marketing, transport, and through the potential for leachates containing trace elements from fly ash. These are being overcome by various means in the utilisation sectors. It is essential to follow best engineering practices to ensure there is no environmental risk. Potential long-term effects in agriculture are under investigation.

365. Leachability of trace metals from sandy or rocky soils amended with coal fly ash.

Li, Yuncong and Chen, Jianjun.

In: *Coal Combustion Byproducts and Environmental Issues*. Uppsala, Sweden.)

New York, NY: Springer; pp. 105-113; 2006.

Notes: 7th International Conference on Biogeochemistry of Trace Elements.; ISBN: 0387258655

Descriptors: Pollution Assessment Control and Management/ Soil Science/ soil column: laboratory equipment/ coal fly ash soil amendment: applied and field techniques/ Spodosol/ Entisol/ Alfisol

Abstract: Application of coal fly ash as a soil amendment for Florida sandy or rocky soils is an alternative to disposal of coal fly ash and also will improve soil physical and chemical properties and increase crop production.

However, environmental fate of trace metals in coal fly ash is a major concern. The objective of this experiment was to evaluate movement of trace metals in coal fly ash amended soil columns. Three soils were collected from south Florida to represent Alfisols, Entisols, and Spodosols. Each of three representative soil was packed into separate columns (32.5 cm long and 7.5 cm inner diameter), amended with coal fly ash at rates of 0, 40, 80 Mg ha⁻¹ and leached with 10 pore volumes of water, which is equivalent to 113.8 cm rainfall. Leachates were analyzed for Zn, Cu, Mn, Fe, Cd, Pb, and Ni. There was no detectable Cd in leachate from any of the soil columns. The maximum concentrations of Zn from all three soils with or without coal fly ash amendment were below the Maximum Contamination Level (MCL) for drinking water. High concentrations of Fe, Pb and Mn in leachate were more closely related to the background concentrations of these metals in three soils than to the coal fly ash application. Application of 80 Mg ha⁻¹ coal fly ash to Riviera soil elevated Cu concentration in leachate above MCL. After completion of leaching, soil columns were divided into five sections (5 cm each) and analyzed for total concentrations of selected metals. The results showed that application of coal fly ash increased all of the trace metals measured in soils at top 5 cm or 5-10 cm depth after leaching. Concentrations of Zn, Cu, Mn, and Cd were also elevated in soil depths from 5 to 25 cm of Riviera soils mainly because the soil has very sandy texture and low organic carbon.

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366. Leachate composition and soil quality assessment in coal fly ash amended soils.

Vageesh, T S and Siddaramappa, R
17th World Congress of Soil Science, Bangkok, Thailand, 14-20 August 2002. 2002; 343(2002)

Descriptors: application rates/ boron/ cadmium/ chemical composition/ chromium/ fly ash/ heavy metals/ leachates/ lead/ nickel/ salts/ soil amendments/ soil fertility/ soil pollution/ soil quality

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367. Leachate concentrations from water leach and column leach tests on fly ash-stabilized soils.

Bin Shafique, S.; Benson, C. H.; Edil, T. B.; and Hwang, K. H.

Environmental Engineering Science 23(1): 53-67. (2006)
NAL Call #: TD811.5.H39; ISSN: 1092-8758

Descriptors: cadmium/ cation exchange capacity/ chromium/ fly ash/ heavy metals/ leachates/ leaching/ pH/ polluted soils/ selenium/ silver/ soil pollution/ soil types/ transport processes/ hydrogen ion concentration/ potential of hydrogen/ soil transport processes/ transport processes in soil systems

Abstract: Batch water leaching tests (WLTs) and column leaching tests (CLTs) were conducted on coal-combustion fly ashes, soil, and soil-fly ash mixtures to characterize

leaching of Cd, Cr, Se, and Ag. The concentrations of these metals were also measured in the field at two sites where soft fine-grained soils were mechanically stabilized with fly ash. Concentrations in leachate from the WLTs on soil-fly ash mixtures are different from those on fly ash alone and cannot be accurately estimated based on linear dilution calculations using concentrations from WLTs on fly ash alone. The concentration varies nonlinearly with fly ash content due to the variation in pH with fly ash content.

Leachate concentrations are low when the pH of the leachate or the cation exchange capacity (CEC) of the soil is high. Initial concentrations from CLTs are higher than concentrations from WLTs due to differences in solid-liquid ratio, pH, and solid-liquid contact. However, both exhibit similar trends with fly ash content, leachate pH, and soil properties. Scaling factors can be applied to WLT concentrations (50 for Ag and Cd, 10 for Cr and Se) to estimate initial concentrations for CLTs. Concentrations in leachate collected from the field sites were generally similar or slightly lower than concentrations measured in CLTs on the same materials. Thus, CLTs appear to provide a good indication of conditions that occur in the field provided that the test conditions mimic the field conditions. In addition, initial concentrations in the field can be conservatively estimated from WLT concentrations using the aforementioned scaling factors provided that the pH of the infiltrating water is near neutral.

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368. Leaching of heavy metals from fly ash stabilized soils.

Bin-Shafique, M. Sazzad

Madison, WI, University of Wisconsin at Madison, 2002.

Descriptors: ash/ atmospheric precipitation/ Darcy's law/ experimental studies/ heavy metals/ highways/ laboratory studies/ leachate/ leaching/ lysimeters/ numerical models/ pH/ pollution/ soils/ environmental geology

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369. Leaching of metals from soils amended with fly ash and organic byproducts.

Alva, Ashok K.; Bilski, J. J.; Sajwan, Kenneth S.; and van Clief, D.

In: Fourth international conference on the biogeochemistry of trace elements. Berkeley, CA, United States.) Sajwan, Kenneth S ; Alva, Ashok K; and Keefer, Robert F (eds.); 1999.

Descriptors: ash/ clastic sediments/ Florida/ geochemistry/ granulometry/ hydrology/ leachate/ leaching/ metals/ nutrients/ organic compounds/ porosity/ rainfall/ sand/ sediments/ soil treatment/ soils/ United States/ geochemistry of rocks, soils, and sediments

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370. A life cycle comparison of disposal and beneficial use of coal combustion products in Florida. Part 1: Methodology and inventory of materials, energy, and emissions.

Babbitt, C. W. and Lindner, A. S.

International Journal of Life Cycle Assessment 13(3): 202-211. (2008); ISSN: 0948-3349

Descriptors: case studies/ coal/ combustion/ comparisons/ concrete/ emission/ environmental assessment/ environmental impact/ fly ash/ public health/ raw materials/

recycling/ road construction/ roofs/ soil amendments/ wallboard/ waste disposal/ waste utilization/ environmental effects/ life cycle assessment/ United States of America
Abstract: Background, Goal, and Scope. Currently, only 40%, or 44.5 million metric tons, of coal combustion products (CCPs) generated in the United States each year by electric utilities are diverted from disposal in landfills or surface impoundments and recycled. Despite promising economic and environmental savings, there has been scant attention devoted to assessing life cycle impacts of CCP disposal and beneficial use. The objective of this paper is to present a life cycle inventory considering two cases of CCP management, including the stages of coal mining and preparation, coal combustion, CCP disposal, and CCP beneficial use. Six beneficial uses were considered: concrete production, structural fills, soil amendments, road construction, blasting grit and roofing granules, and wallboard. Methods. Primary data for raw material inputs and emissions of all stages considered were obtained from surveys and site visits of coal-burning utilities in Florida conducted in 2002, and secondary data were obtained from various published sources and from databases available in SimaPro 5.1 (PRe Consultants, Amersfoort, The Netherlands). Results. Results revealed that 50 percent of all CCPs produced, or 108 kg per 1,000 kg of coal combusted, are diverted for application in a beneficial use; however, the relative amounts sold by each utility is dependent on the process operating parameters, air emission control devices, and resulting quality of CCP. Diversion of 50% of all CCPs to beneficial use applications yields a decrease in the total raw materials requirements (with the exception of gravel and iron) and most emissions to air, water, and land, as compared to 100% disposal. Discussion. The greatest reduction of raw materials was attributed to replacing Portland cement with fly ash, using bottom ash as an aggregate in concrete production and road construction in place of natural materials, and substituting FGD gypsum for natural gypsum in wallboard. The use of fly ash as cementitious material in concrete also promised significant reductions in emissions, particularly the carbon dioxide that would be generated from Portland cement production. Beneficial uses of fly ash and gypsum showed reductions of emissions to water (particularly total dissolved solids) and emissions of metals to land, although these reductions were small compared to simply diverting 50% of all CCPs from landfills or surface impoundments. Conclusions. This life cycle inventory (LCI) provides the foundation for assessing the impacts of CCP disposal and beneficial use. Beneficial use of CCPs is shown here to yield reductions in raw material requirements and various emissions to all environmental compartments, with potential tangible savings to human health and the environment. Recommendations and Perspectives. Extension of this life cycle inventory to include impact assessment and sensitivity analysis will enable a determination of whether the savings in emissions reported here actually result in significant improvements in environmental and human health impacts.
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371. Liming acid forest soils with flue gas desulfurization by-product: Growth of northern red oak and leachate water quality.

Crews, J. T. and Dick, W. A.
Environmental Pollution 103(1): 55-61. (1998)
 NAL Call #: QH545.A1E52; ISSN: 0269-7491
Descriptors: acid soils/ aluminium/ boron/ burning/ calcium/ chromium/ copper/ desulfurization/ fly ash/ forest soils/ iron/ lead/ lime/ lime requirement/ liming/ magnesium/ manganese/ metals/ phosphorus/ potassium/ recycling/ soil amendments/ soil types/ sulfur/ titanium/ toxicity/ Ultisols/ water quality/ zinc/ aluminum/ desulphurization/ elemental sulphur/ flaming/ Mn/ northern red oak/ sulphur/ United States of America/ water composition and quality
Abstract: Flue gas desulfurization (FGD) by-product is created when a dolomitic lime [CaMg(CO₃)₂] is used to remove SO₂ during the burning of high sulfur coal in electricity generating power plants. This study evaluated growth of Northern red oak (*Quercus rubra* L.) in an acid forest soil (Rayne silt loam - a fine loamy, mixed, mesic, Typic Hapludult) and water leachate quality when FGD by-product was applied topically or mixed within the A horizon at rates equivalent to 0.25, 0.50, 1.0, 1.5, 2.0 and 2.5 times the soil's lime requirement. Soils were leached with deionized water on a monthly basis and the leachate samples were analysed for pH, conductivity, P, S, B and metals (Al, Ca, Cr, Cu, Fe, Mn, K, Mg, Pb, Ti and Zn). Tree growth significantly increased ($p < 0.05$) when soil was treated with FGD and the greatest growth (75% increase over the untreated control) occurred when FGD was applied at 1.5 times the lime requirement rate. Boron toxicity symptoms were observed in plant tissue when FGD by-product was applied at two times (or higher) the lime requirement rate. Sulfur concentration increased from <10 mg/litre (control soil) to 234 mg/litre (soil treated with FGD at 2.5 times the lime requirement) in the leachate four months after treatment. Boron also approached toxicity concentrations (~1 mg/litre) in the leachate from soil treated at the highest rate during the initial leachings, but concentrations tended to decline with time. Applying FGD by-product onto acid forest soils has the potential to provide growth benefit to a commercially important tree species (red oak) but care will need to be taken to avoid using FGD materials that may release toxic levels of B.
 Reproduced with permission from the CAB Abstracts database.

372. Low -cost way to pave feedlots.

Suszkiw, J.
Agricultural Research 47(1): 22-23. (Jan. 1999); ISSN: 0002-161X [AGREA5].
Notes: Also available via remote access.
Descriptors: feedlots / fly ash/ cattle/ Internet resource
 This citation is from AGRICOLA.

373. Management of lignite fly ash for improving soil fertility and crop productivity.

Ram, L. C.; Srivastava, N. K.; Jha, S. K.; Sinha, A. K.; Masto, R. E.; and Selvi, V. A. 40(3): 438-452. (2007); ISSN: 0364152X [EMNGD].
Notes: doi: 10.1007/s00267-006-0126-9.

Descriptors: Groundnut/ Heavy metals/ Lignite fly ash/ Maize/ Press mud/ Productivity/ Radioactivity/ Sun hemp/ Crops/ Cultivation/ Fertilizers/ Heavy metals/ Lignite/ Nutrients/ Productivity/ Radioactivity/ Soils/ Sugar (sucrose)/ Crop productivity/ Humic acids/ Lignite fly ash/ Soil fertility/ Fly ash/ calcium sulfate/ fertilizer/ heavy metal/ humic acid/ lignite/ trace metal/ crop production/ crop yield/ fly ash/ groundnut/ heavy metal/ humic acid/ lignite/ maize/ radioactivity/ soil amendment/ soil fertility/ soil improvement/ soil quality/ crop production/ environmental management/ fly ash/ gamma radiation/ maize/ organic waste/ peanut/ plant growth/ plant nutrient/ plant yield/ radioactivity/ soil fertility/ soil quality/ sugar industry/ Agriculture/ Carbon/ Crops, Agricultural/ Fertilizers/ Hydrogen-Ion Concentration/ Metals, Heavy/ Particulate Matter/ Soil/ Soil Pollutants/ Zea mays/ Cannabis sativa/ Zea mays

Abstract: Lignite fly ash (LFA), being alkaline and endowed with excellent pozzolanic properties, a silt loam texture, and plant nutrients, has the potential to improve soil quality and productivity. Long-term field trials with groundnut, maize, and sun hemp were carried out to study the effect of LFA on growth and yield. Before crop I was sown, LFA was applied at various doses with and without press mud (an organic waste from the sugar industry, used as an amendment and source of nutrients). LFA with and without press mud was also applied before crops III and V were cultivated. Chemical fertilizer, along with gypsum, humic acid, and biofertilizer, was applied in all treatments, including the control. With one-time and repeat applications of LFA (with and without press mud), yield increased significantly (7.0-89.0%) in relation to the control crop. The press mud enhanced the yield (3.0-15.0%) with different LFA applications. The highest yield LFA dose was 200 t/ha for one-time and repeat applications, the maximum yield being with crop III (combination treatment). One-time and repeat application of LFA (alone and in combination with press mud) improved soil quality and the nutrient content of the produce. The highest dose of LFA (200 t/ha) with and without press mud showed the best residual effects (eco-friendly increases in the yield of succeeding crops). Some increase in trace- and heavy-metal contents and in the level of γ -emitters in soil and crop produce, but well within permissible limits, was observed. Thus, LFA can be used on a large scale to boost soil fertility and productivity with no adverse effects on the soil or crops, which may solve the problem of bulk disposal of fly ash in an eco-friendly manner. © 2007 Springer Science+Business Media, LLC. © 2009 Elsevier B.V. All rights reserved.

374. Management of mine spoil for crop productivity with lignite fly ash and biological amendments.

Ram, L. C.; Srivastava, N. K.; Tripathi, R. C.; Jha, S. K.; Sinha, A. K.; Singh, G.; and Manoharan, V.

Journal of environmental management 79(2): 173-187. (2006)

NAL Call #: HC75.E5J6 ; ISSN: 0301-4797

Descriptors: application to land/ chemical composition/ crop yield/ fertilizers/ filter cake/ fly ash/ green gram/ green manures/ gypsum/ hemp/ humic acids/ lignite/ mine spoil/ nutrient content/ productivity/ rice/ soil amendments/ soil fertility/ soil texture/ biofertilizers/ clarification mud/ land application/ Madras/ mine wastes/ mining spoil/ mining wastes/ mung bean/ paddy

Abstract: Long-term field trials using lignite fly ash (LFA)

were carried out in rice crops during the period 1996-2000 at Mine I, Neyveli Lignite Corporation, Tamil Nadu. LFA, being alkaline and endowed with an excellent pozzolanic nature, silt loam texture, and plant nutrients, has the potential to improve the texture, fertility, and crop productivity of mine spoil. The rice crops were the first, third, fifth, and sixth crops in rotation. The other crops, such as green gram (second) and sun hemp (fourth), were grown as green manure. For experimental trials, LFA was applied at various dosages (0, 5, 10, 20, 50, 100, and 200 t/ha), with and without press mud (10 t/ha), before cultivation of the first crop. Repeat applications of LFA were made at the same dosages in treatments of up to 50 t/ha (with and without press mud) before cultivation of the third and fifth crops. Press mud, a lightweight organic waste product from the sugar industry, was used as an organic amendment and source of plant nutrients. Also, a recommended dosage of chemical fertilizer, along with gypsum, humic acid, and biofertilizer as supplementing agents, was applied in all the treatments, including control. With one-time and repeat applications of LFA, from 5 to 20 t/ha (with and without press mud), the crop yield (grain and straw) increased significantly ($p < 0.05$), in the range from 3.0 to 42.0% over the corresponding control. The maximum yield was obtained with repeat applications of 20 t/ha of LFA with press mud in the third crop. The press mud enhanced the yield in the range of 1.5-10.2% with various dosages of LFA. The optimum dosage of LFA was 20 t/ha for both one-time and repeat applications. Repeat applications of LFA at lower dosages of up to 20 t/ha were more effective in increasing the yield than the corresponding one-time applications of up to 20 t/ha and repeat applications at 50 t/ha. One-time and repeat applications of LFA of up to 20 t/ha (with and without press mud), apart from increasing the yield, evinced improvement in the texture and fertility of mine spoil and the nutrient content of crop produce. Furthermore, some increase in the content of trace and heavy metals and the level of γ -emitters in the mine spoil and crop produce was observed, but well within the permissible limits. The residual effect of LFA on succeeding crops was also encouraging in terms of eco-friendliness. Beyond 20 t/ha of LFA, the crop yield decreased significantly ($p < 0.05$), as a result of the formation of hardpan in the mine spoil and possibly the higher concentration of soluble salts in the LFA. However, the adverse effects of soluble salts were annulled progressively during the cultivation of succeeding crops. A plausible mechanism for the improved fertility of mine spoil and the carryover or uptake of toxic trace and heavy metals and γ -emitters in mine spoil and crop produce is also discussed.

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375. Management of pulse beetle, *Callosobruchus chinensis* L. (Coleoptera: Bruchidae) in stored chickpea using ashes, red soil powder and turpentine oil.

Shaheen, F. A. and Abdul Khaliq

Pakistan Entomologist 27(2): 19-24. (2005); ISSN: 1017-1827

Descriptors: bark/ chickpeas/ essential oils/ farmyard manure/ fecundity/ fly ash/ insect pests/ insecticidal properties/ mortality/ stored products pests/ turpentine/ death rate/ FYM

Abstract: Fly ash, cow dung ash, acacia bark ash, red soil powder and turpentine oil as postharvest grain protectants were tested for their insecticidal potency against pulse beetle (PB) attacking stored chickpea. The results revealed that fly ash at 1.0 g per 50 g of grains showed the minimum days (5.06) to 100% mortality of released adults, minimum fecundity (0.86 eggs per grain), minimum holes (0.41 per grain), lowest number (3.14) of F₁ adults emerged, maximum inhibition (78.62%) of F₁ adults, minimum weight loss (9.63%) and the minimum of 2.86 days to 100% mortality of F₁ adults. Fly ash and turpentine oil were the most effective at all application rates compared to other materials and the control. However, fly ash proved to be the best in managing PB infestation to lower levels followed by turpentine oil and cow dung ash while red soil powder and kikar ash were less effective and were similar to the control at their lower application rates. Reproduced with permission from the CAB Abstracts database.

376. Mass production of VAM fungi using different substrates and hosts.

Seema Sharma; Ashok Aggarwal; Vipin Parkash; and Dipti Sharma

Journal of Mycopathological Research 43(1): 51-56. (2005)
NAL Call #: QK600.J68 ; ISSN: 0971-3719

Descriptors: endomycorrhizas/ farmyard manure/ fly ash/ host plants/ maize/ mycorrhizal fungi/ mycorrhizas/ production/ sand/ vesicular arbuscular mycorrhizas/ Acaulospora lacunosa/ Acaulosporaceae/ arbuscular mycorrhizas/ corn/ FYM/ Gigasporaceae/ Glomaceae/ Glomus reticulatum/ Sclerocystis/ Sclerocystis coremioides
Abstract: The influence of soil: farmyard manure, soil: fly ash and soil: sand on the VAM fungi i.e., Glomus mosseae, Glomus fasciculatum and mixed inoculum (composite spores of Glomus geosporum, G. reticulatum, Gigaspora gigantea, Sclerocystis coremioides, Acaulospora lacunosa and A. laevis) were examined using different hosts maize (Zea mays), bajra (Pennisetum glaucum) and jowar (Sorghum bicolor). Among the substrates, soil: farmyard manure gave best results of VAM mass production. Different hosts showed positive mycorrhizal associations in different substrates but the degree varied. Reproduced with permission from the CAB Abstracts database.

377. Measurement and prediction of resilient modulus of lime fly ash stabilized cohesive subgrade soils.

Lee, Yong-Woong

Columbus, OH: Ohio State University, 2003.

Notes: Features: References: 83; illus. incl. 40 tables

Descriptors: ash/ cohesive materials/ engineering properties/ experimental studies/ laboratory studies/ lime/ numerical models/ prediction/ resilient modulus/ soil mechanics/ soils/ strength/ subgrade materials/ engineering geology
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378. Mechanisms controlling soil carbon turnover and their potential application for enhancing carbon sequestration.

Jastrow, J. D.; Amonette, J. E.; and Bailey, V. L.

Climatic Change 80(1/2): 5-23. (2007); ISSN: 0165-0009

Descriptors: adsorbents/ aggregates/ calcium/ carbon/ carbon sequestration/ charcoal/ exchangeable calcium/ exchangeable cations/ fly ash/ mineral soils/ modification/ organic carbon/ organic soils/ organomineral complexes/ physicochemical properties/ pores/ soil amendments/ soil chemical properties/ soil enzymes/ soil pH/ soil physical properties/ soil structure/ soil types/ sorption/ stabilization/ chemical properties of soil/ physical properties of soil
Abstract: In addition to increasing plant C inputs, strategies for enhancing soil C sequestration include reducing C turnover and increasing its residence time in soils. Two major mechanisms, (bio)chemical alteration and physicochemical protection, stabilize soil organic C (SOC) and thereby control its turnover. With (bio)chemical alteration, SOC is transformed by biotic and abiotic processes to chemical forms that are more resistant to decomposition and, in some cases, more easily retained by sorption to soil solids. With physicochemical protection, biochemical attack of SOC is inhibited by organomineral interactions at molecular to millimeter scales. Stabilization of otherwise decomposable SOC can occur via sorption to mineral and organic soil surfaces, occlusion within aggregates, and deposition in pores or other locations inaccessible to decomposers and extracellular enzymes. Soil structure is a master integrating variable that both controls and indicates the SOC stabilization status of a soil. One potential option for reducing SOC turnover and enhancing sequestration, is to modify the soil physicochemical environment to favor the activities of fungi. Specific practices that could accomplish this include manipulating the quality of plant C inputs, planting perennial species, minimizing tillage and other disturbances, maintaining a near-neutral soil pH and adequate amounts of exchangeable base cations (particularly calcium), ensuring adequate drainage, and minimizing erosion. In some soils, amendment with micro- and mesoporous sorbents that have a high specific surface - such as fly ash or charcoal - can be beneficial. Reproduced with permission from the CAB Abstracts database.

379. Metal accumulation and growth performance of Phaseolus vulgaris grown in fly ash amended soil.

Gupta, A. K.; Dwivedi, S.; Sinha, S.; Tripathi, R. D.; Rai, U. N.; and Singh, S. N.

Bioresource Technology 98(17): 3404-3407. (Dec. 2007)

NAL Call #: TD930.A32 ; ISSN: 0960-8524

Descriptors: agricultural soils/ fly ash/ soil amendments/ soil pollution/ heavy metals/ phytoremediation/ soil properties/ physicochemical properties/ electrical conductivity/ cation exchange capacity/ soil organic carbon/ soil organic matter/ Phaseolus vulgaris/ beans/ plant growth/ biomass/ photosynthesis
Abstract: Phytoextraction of heavy metals from fly ash (FA) contaminated soil was evaluated using Phaseolus vulgaris var. T55. The results showed that electrical conductivity (EC), cation exchange capacity (CEC), organic carbon (OC) and organic matter (OM) of different amendments decreased with the addition of FA in the soil. The level of diethylene triaminepenta acetic acid (DTPA) extractable metals increased with increase in FA amendments up to 25%. However, Cr was found below detection limit in both the amendments. The metal accumulation in the plant

tissues was found in the order of Fe > Zn > Mn > Co > Ni > Pb > Cu > Cd at 25% FA. Accumulation of Fe, Mn, Ni, Cu and Co was found more in the roots while Zn, Pb and Cd were more in the aerial parts.
This citation is from AGRICOLA.

380. Metal content in soil fertilized with brown coal fly ash.

Gibczynska, M.; Meller, E.; Stankowski, S.; and Wooszyk, C.

Agronomy Research 4(2): 509-516. (2006); ISSN: 1406-894X

Descriptors: aluminium/ brown coal/ chemical composition/ cobalt/ copper/ fly ash/ industrial wastes/ iron/ lime/ magnesian limestone/ manganese/ mineral content/ nickel/ soil acidity/ soil amendments/ soil composition/ soil ph/ aluminium/ magnesium limestone/ Mn

Abstract: Studies were conducted evaluate the brown coal ash produced by Power Plant Group Patnow-Adamow-Konin for agricultural purposes, and estimate the influence of fly ash applied to light soil on the metal content of soils (aluminium, iron, manganese, copper, nickel and cobalt). The field experiment was conducted on light soil at the area of the Agricultural Experimental Station in Lipnik, Poland. The study consisted of testing 7 variants (controlburned lime (CaO) dolomite lime CaCO₃ MgCO₃, ash from 1st electrofilter zone, from 2nd electrofilter zone, from 3rd electrofilter zone and mixture of ashes from three electrofilter zones). Lime fertilizers and ashes were applied in a dose corresponding to 1.0 hydrolytic soil acidity expressed in cmol H⁺ kg⁻¹ of soil. Brown coal fly ash produced by Power Plants ZE PAK S.A., used as soil fertilizer, did not contribute to changes of content of the following metals: iron, zinc, copper, nickel, lead and cobalt in the tested soil. Soil-incorporated brown coal fly ash significantly increased the content of manganese. However, the obtained results did not exceed the allowable standard. In the soil of all fertilizer variants, where brown coal ash was applied, the content of mobile aluminium diminished. When brown coal ash produced by Power Plants ZE PAK S.A. was applied in the experiment, soil reaction changed from acid to neutral and its hydrolytic acidity decreased by ca 50%.

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381. Microbial responses to coal fly ash under field conditions.

Schutter, M. E. and Fuhrmann, J. J.

Journal of Environmental Quality 28(2): 648-652. (1999)

NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: alkaline phosphatase/ alkalinity/ arylsulfatase/ biological activity in soil/ coal/ denitrification/ enzyme activity/ enzymes/ fly ash/ liming/ maize/ microorganisms/ mineralization/ nitrification/ nutrients/ phosphoric monoester hydrolases/ responses/ rotations/ soil/ soil amendments/ soil enzymes/ stress/ tillage/ trace elements/ wheat/ alkaline phosphomonoesterase/ arylsulphatase/ corn/ crop rotation/ Festuca elatior/ micro organisms/ microelements/ phosphatases/ rotational cropping/ soil cultivation/ United States of America

Abstract: Field plots in Delaware, USA, received 0 or 505 t fly ash ha⁻¹ (incorporated by conventional tillage to a depth

of 40 cm) and were subsequently cropped to a fallow-maize-wheat rotation or continuous fescue (*Festuca arundinacea*). Twenty months later, during the wheat phase of the rotation, the plots were sampled (0-15 cm) and assayed for activity of soil enzymes (dehydrogenase, alkaline phosphatase, arylsulfatase, and denitrifying enzymes); numbers of aerobic heterotrophs, ammonium oxidizers, denitrifiers, and bradyrhizobia; and N mineralization, nitrification, and denitrification potentials. Nitrification potentials doubled in fly ash-amended soils, and numbers of denitrifiers were 200-fold higher in fescue-cropped, fly ash-amended soils relative to fescue-cropped, non-amended soils. No other large differences in microbial populations or activities were found. The lack of detrimental effects on microorganisms in the field was possibly due to reductions in fly ash soluble salt and trace element concentrations with time, the mild alkalinity of the fly ash used, and the positive responses of crops to fly ash amendment.

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382. Microscopic single particle characterization of zeolites synthesized in a soil polluted by copper or cadmium and treated with coal fly ash.

Terzano, R.; Spagnuolo, M.; Medici, L.; Dorrine, W.; Janssens, K.; and Ruggiero, P.

Applied Clay Science 35(1/2): 128-138. (2007)

NAL Call #: TA455.C55 ; ISSN: 0169-1317

Descriptors: analysis / ash/ cadmium/ characterization/ chemical composition/ coal/ composition/ contamination/ copper/ fly ash/ formation/ heavy metals/ ions/ metals/ minerals/ pollution/ soil/ structure/ structures/ X radiation/ X ray diffraction/ zeolites/ environmental pollution/ remediation/ X rays

Abstract: In the perspective of the development of new soil remediation technologies, zeolites can be directly synthesized in soil from fused coal fly ash to reduce heavy metal mobility and availability. Such a process promotes the formation of metal hydroxide/oxide precipitates which can be also occluded inside the structure of the forming minerals. In this study, different types of zeolites (zeolite X, P, and A) were synthesized by treating soil samples, artificially contaminated by high concentrations of Cu or Cd ions, with fused coal fly ash at 30 and 60 degrees C. The formed zeolites were characterized for their amount, structure, chemical composition and size. To accomplish this survey, besides quantitative X-ray diffraction analyses (XRD), an automated single particle analysis (ASPA) method using electron probe X-ray microanalysis (EPXMA) was employed for the first time for direct zeolite characterization in soil samples. The obtained results provide new information for assessing the role of heavy metals in zeolite crystallization in coal fly ash-treated soils. Heavy metal contamination, while not significantly hindering the zeolite formation process, can influence crystal size and preferentially drive zeolite synthesis toward the formation of sodalite unit-based zeolite X and zeolite A, even at 60 degrees C. The presence and nature of metal precipitate occlusions inside the forming zeolite minerals might have also favoured the preferential synthesis of certain zeolitic structures.
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383. Mineral acquisition by maize grown in acidic soil amended with coal combustion products.

Clark, R. B.; Zeto, S. K.; Ritchey, K. D.; and Baligar, V. C. *Communications in Soil Science and Plant Analysis* 32(11-12): 1861-1884. (2001)

NAL Call #: S590.C63; ISSN: 0010-3624 [CSOSA2]

Descriptors: zea mays / fly ash/ trace element fertilizers/ coal/ combustion/ gypsum/ nutrient uptake/ nutrient content/ mineral content/ shoots/ nutrient deficiencies/ phytotoxicity/ acid soils/ calcium carbonate/ calcium sulfate/ application rate/ sulfites (salts)/ mineral nutrition/ mineral uptake/ fluidized bed wastes/ fluidized bed combustion products/ flue gas desulfurization products/ calcium sulfite

Abstract: Large amounts of coal combustion products (CCPs) are produced when coal is burned for generation of electricity. Some of these CCPs could potentially be used as soil amendments, and information about their effects on plant mineral nutrition is needed. Glasshouse experiments were conducted to test the effects of different levels of 15 CCPs and chemical grade CaCO₃, CaSO₄, and CaSO₃ added to acidic soil (Umbric Dystrochrept) on shoot calcium (Ca), sulfur (S), phosphorus (P), potassium (K), magnesium (Mg), manganese (Mn), iron (Fe), zinc (Zn), copper (Cu), and aluminum (Al) concentrations of maize (*Zea mays* L.). The CCPs consisted of two fly ashes (FAs), one CaO material, three fluidized bed combustion products (FBCs), three "non-stabilized" flue gas desulfurization products (FGDs), three "stabilized" FGDs, and three "oxidized" (FGD gypsum) FGDs. Level of CCP added to soil ranged from beneficial to detrimental effects on plants. Differences in shoot mineral element concentrations were related to kind and amount of CCP added and soil pH. Plants grown in unamended (pH 4) soil had symptoms of P and Mg deficiencies and Al toxicity. High concentrations of Ca, S, Mg, and Mn accumulated when plants were grown with some CCPs, but most mineral nutrients were at concentrations considered normal for maize. Shoot concentrations of P, K, Zn, Mn, Fe, and Al decreased when soil pH became high (>7). Even though detrimental mineral element acquisition effects were imposed on plants at high levels of CCP application, shoot element concentrations were usually normal when applied at levels near those commonly used as soil amendments.

This citation is from AGRICOLA.

384. The mineralogical characteristics of coal ash, reservoir sediments and sewage sludge and the significance for soil improvement; an example from Baotou City, Inner Mongolia, China.

Shen, J.; Li, S.; Sun, D.; and Parsons, Ian.

In: Abstracts of the ... General Meeting of the International Mineralogical Association, Edinburgh, United Kingdom.; Vol. 18.; pp. 178; 2002.

Notes: 18th general meeting of the International Mineralogical Association.

Descriptors: agriculture/ arid environment/ ash/ Asia/ Baotou China/ biochemistry/ biogenic processes/ China/ clay mineralogy/ crystal structure/ Far East/ geochemistry/ Inner Mongolia China/ lacustrine environment/ lake sediments/ nutrients / reservoirs/ sediments/ semi-arid environment / sewage sludge/ soil treatment/ soils/ solid waste/ terrestrial environment/ waste disposal/ Soils/ Environmental geology

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385. Mitotic study of radish grown on flyash amended soil.

Mishra, P. K.; Das, R. K.; and Mehta, U. C.

Cruciferae Newsletter 21: 49-50. (1999); ISSN: 0263-9459

Descriptors: cell division/ chromosome aberrations/ fly ash/ mitosis/ mutagens/ radishes/ root crops/ soil amendments/ Capparales/ chromosome abnormalities / karyokinesis

Abstract: Fly ash generated from thermal power plants is a potential pollutant, but has been suggested for use as a soil amendment. Here, information is tabulated on mitotic indices of 2 radish (*Raphanus sativus*) cultivars (Japanese White and Pusha Himani) grown on soil amended with 10 to 50% fly ash. Fly ash treatment increased the mitotic index of the radish varieties, with the 30% treatment giving the greatest number of dividing cells in both varieties. At the higher concentrations of flyash, clastogenicity and clumping of chromosomes was observed during mitotic division. Reproduced with permission from the CAB Abstracts database.

386. Mixtures of coal ash and compost as substrates for highbush blueberry.

Black, B. L. and Zimmerman, R. H.

Journal of the American Society for Horticultural Science 127(5): 869-877. (2002); ISSN: 0003-1062

Descriptors: ash/ blueberries/ chemical composition/ clay loam soils/ coal/ composts/ culture media/ fertilizers/ pH/ plant composition/ sandy soils/ chemical constituents of plants/ hydrogen ion concentration/ potential of hydrogen

Abstract: Bottom ash from a coal-fired power plant and two composts were tested as components of soil-free media and as soil amendments for growing highbush blueberry (*Vaccinium corymbosum*). Combinations of ash and compost were compared to Berryland sand, and Manor clay loam, and compost amended Manor clay loam. The pH of all treatment media was adjusted to 4.5 with sulfur at the beginning of the experiment. In 1997, plants of 'Bluecrop' and 'Sierra' were planted in 15-dm³ pots containing the pH-adjusted treatment media. The first substantial crop was harvested in 1999. At the end of the 1999 season, one half of the plants were destructively harvested for growth analysis. The remaining plants were cropped again in 2000. Yield and fruit size data were collected in both seasons, and leaf and fruit samples were collected in 1999 for elemental analysis. The presence of coal ash or composted biosolids in the media had no detrimental effect on leaf or fruit elemental content. Total growth and yield of both cultivars was reduced in clay loam soil compared to Berryland sand, whereas growth and yield of plants in coal ash-compost was similar to or exceeded that of plants in Berryland sand.

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387. Mobility and bioavailability of selected heavy metals in coal ash and sewage sludge amended acid soil.

Chaudhuri, D.; Tripathy, S.; Veeresh, H.; Powell, M. A.; and Hart, B. R.

Environmental Geology 44(4): 419-432. (July 2003)

NAL Call #: QE1.E5; ISSN: 1073-9106 [ENG0E9]

Descriptors: acid soils/ soil amendments/ fly ash/ sewage sludge/ liming/ peanuts/ *Arachis hypogaea*/ bioavailability/ chemical constituents of plants/ India/ acid lateritic soils/ coal fly ash

Abstract: A sequential extraction procedure has been used to study the changes in the distribution and mobility of Cd, Cr, Cu, Ni, Pb and Zn in an acid lateritic soil amended with alkaline coal ash and neutral sludge individually and with their mixture of equal proportions at 25, 50 and 75 Mg/ha application rates and grown in a crop with peanuts. A separate set of experiments consisting of the same treatments was repeated with the addition of lime at 2 Mg/ha. Increases in total heavy-metal levels with application of various amendments were mainly associated with increases in the insoluble and less mobile forms of metals except for Cd, which showed an increase in its exchangeable form. An increase in pH of the amended soil restricted the metal mobility in their labile forms and was more pronounced after liming the treatments. Positive yield responses were observed in the amended soil, the magnitude being higher in only sludge-applied treatments. The vegetative plant parts showed maximum accumulation of metals indicating a physiological barrier in the transfer of metals from the root to the kernel. Linear relationships of total concentrations of heavy metals in soil with that in the crop were observed. Lime addition to the treatments further reduced the transfer and accumulation of metals from the soil to the plant, even though the relationship remained linear.

This citation is from AGRICOLA.

388. The mobility of chosen pollutants from ash-sludge mixtures.

Rosik Dulewska, C.; Gowala, K.; Karwaczynska, U. ; and Szodo, E.

Polish Journal of Environmental Studies 15(6): 895-904. (2006); ISSN: 1230-1485

Descriptors: calcium/ contaminants/ fly ash/ heavy metals/ magnesium/ nitrogen/ nitrogenous compounds/ phosphorus/ pollutants/ sewage sludge/ soil amendments/ waste utilization/ waste water

Abstract: Both sewage sludge and fly ash are wastes. Their granulation can decrease their adverse effect. Due to the contents of biogens in the sewage sludge the granulates will have fertilizing and soil-forming properties. The aim of this study was to find such proportion of components used for production of ash-sludge granulates that would decrease the volume of extracted contaminants to meet the requirements of regulation preserving their amendment properties. Two types of fly ash were mixed in various proportions with municipal stabilized sewage sludge, i.e., fly ash from lignite combustion the aziska Power Plant and sewage sludge from the Zabrze-Srodmiestcie Municipal Wastewater Treatment Plant in Poland. The obtained granulates were subjected to one- and three-stage elution tests. In the eluates the concentration of nitrogen compounds, phosphorus, magnesium, calcium and heavy metals was determined. The mixture with the same share of sewage sludge and fly ash proved to be of high fertilizing value at the same time. Reproduced with permission from the CAB Abstracts database.

389. Modulation of flyash-induced genotoxicity in *Vicia faba* by vermicomposting.

Kavindra Jain; Jitendra Singh; Chauhan, L. K. S. ; Murthy, R. C.; and Gupta, S. K.

Ecotoxicology and Environmental Safety 59(1): 89-94. (2004); ISSN: 0147-6513

Descriptors: bioassays/ bioremediation/ cattle manure/ chemical analysis/ chromium/ copper/ cytogenetics/ faba beans/ fly ash/ genotoxicity/ heavy metals/ lead/ modulation/ nickel/ polluted soils/ root meristems/ roots/ seedlings/ soil pollution/ soil types/ toxicity/ vermicomposting/ zinc/ broad beans/ fava beans/ field beans/ horse beans/ tic beans

Abstract: Cytogenetic effects of pre- and postvermicomposted flyash samples were evaluated on the root meristem cells of *Vicia faba*. Seedlings of *V. faba* were directly sown in flyash and cow dung-soil mixtures (20%, 40%, 60%, and 80%) and the lateral roots grown in these test mixtures were sampled at 5 days. Negative control was run parallel in cow dung-soil (CS) mixture alone. One set of flyash-cow dung-soil (FCS) mixture was subjected to vermicomposting by introducing *Eisenia foetida* species of earthworms for 30 days and the cytogenetic effects were reinvestigated through *V. faba* root meristems. Chemical analysis carried out prior to vermicomposting revealed high concentrations of heavy metals such as Cr, Cu, Pb, Zn, and Ni in FCS samples. CS samples also showed the presence of these metals. Cytogenetic examinations of root meristems exposed to the FCS mixtures showed significant inhibition of mitotic index (MI), induction of chromosome aberrations (CA), and a significantly increased frequency of mitotic aberrations (MA). The increase of the aberrations was dependent on the flyash concentrations. Roots grown in CS samples also showed chromosomal and MAs; however, the percentage was lower than that observed with FCS and also statistically nonsignificant. Cytogenetic analysis of vermicomposted samples of FCS revealed a 15-45% decline in the aberration frequencies whereas chemical analysis showed a 10-50% decline in the metal concentrations, viz. Cr, Cu, Pb, Zn, and Ni, which indicates *E. foetida* a potential accumulator of heavy metals and the decline in metal concentrations may be the cause of the decrease in aberration frequencies. The present study indicates the genotoxicity potential of flyash and also the feasibility of vermicomposting for cleanup of metal-contaminated soil to mitigate the toxicity/genotoxicity. Reproduced with permission from the CAB Abstracts database.

390. Native grass facilitates mycorrhizal colonisation and P uptake of tree seedlings in two anthropogenic substrates.

Enkhtuya, B.; Poschl, M.; and Vosatka, M.

Water, Air and Soil Pollution 166(1/4): 217-236. (2005)
NAL Call #: TD172 .W36; ISSN: 0049-6979

Descriptors: coal mine spoil/ colonization/ degraded land/ fly ash/ fungal spores/ growth/ mycelium/ mycorrhizal fungi/ mycorrhizas/ nutrient uptake/ phosphorus/ revegetation/ roots/ seedlings/ substrates/ vesicular arbuscular mycorrhizas/ arbuscular mycorrhizas/ colliery spoil/ microcosm

Abstract: Two microcosm experiments were conducted to study the role of extraradical mycelium (ERM) of arbuscular mycorrhizal fungi (AMF) in establishment and growth of tree species used for revegetation in anthropogenic substrates. Inoculated or non-inoculated *Acer pseudoplatanus*, *Alnus glutinosa* or *Salix purpurea* seedlings were grown with *Calamagrostis epigejos* (a grass spontaneously colonizing degraded ecosystems) in two substrates (fly ash and coal mine spoil) either in direct root contact or in rhizoboxes with interaction only via ERM network. In both

experiments, inoculation with AMF mostly had a positive effect on the growth of trees and increased the aggregation of fly ash. When plants grew in direct root-to-root contact, grass presence negatively affected tree growth, but it significantly improved mycorrhizal development (colonization of tree seedlings, spore number and ERM length). When grass and tree roots interacted via the ERM network, tree seedlings were successfully colonized by the ERM spreading from the *C. epigejos* roots. Mechanical disturbance of the ERM links between plants reduced AMF development and tree height in both substrates, but tree shoot biomass was not affected. In fly ash, inoculated, non-disturbed treatments showed significant transfer of 32P from the grass to the tree seedlings. It can be concluded that roots of *A. pseudoplatanus*, *A. glutinosa* or *S. purpurea* seedlings can be colonized from the ERM network radiating from quickly growing grasses, which can act as important agents for AMF distribution and facilitate mycorrhization of planted trees. In particular for willow, grass seems to be an essential nurse plant to achieve successful root colonization.

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391. Numbers of microorganisms and enzymatic activity in soil polluted by coal ash.

Kuczynska, L.

Roczniki Gleboznawcze (Poland) 54(1-2): 99-106. (2003); ISSN: 0080-3642.

Notes: Original title: Liczebność drobnoustrojów i aktywność enzymatyczna gleby skażonej popiołem z węgla kamiennego. 4 fig., 3 tables; 22 ref. Summary (En). Citation notes: PL (Poland).

Descriptors: microorganisms/ enzymatic activity/ soils/ coal ash

Abstract: The effects of soil pollution with coal ash on the number and enzymatic activity of soil microorganisms were investigated. Soil samples were treated with three different rates of ash and two rates of nitrogen fertilization. Coal fly ash pollution resulted in increase of soil fungi and cellulolytic microorganisms and the simultaneous decrease of *Azotobacter* spp. Coal ash enhances the urease activity in the soil whereas phosphatases activity remains unaffected. The nitrogen level determines the yield of the studied plants but not presence of coal ash.

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392. Nutrient dynamics, dehydrogenase activity, and response of the rice plant to fertilization sources in an acid lateritic soil.

Rautaray, S. K.

Acta Agriculturae Scandinavica: Section B, Soil and Plant Science 55(3): 162-169. (2005)

NAL Call #: 11 Ac82 ; ISSN: 0906-4710

Descriptors: acid soils/ ammonium nitrogen/ application methods/ application rates/ crop growth stage/ crop yield/ enzyme activity/ flooded rice/ flooding/ fly ash/ green manures/ lateritic soils/ microbial activities/ NPK fertilizers/ nutrient availability/ nutrient content/ nutrient uptake/ organic carbon/ organic fertilizers/ oxidoreductases/ phosphorus / plant nutrition/ potassium/ rice/ rice straw/ sandy loam soils/ soil enzymes/ soil organic matter/ soil pH/ soil types/ straw/ use efficiency/ ammonia nitrogen/ flooded conditions/ organic matter in soil/ paddy/ redox enzymes
Abstract: Rice variety IR 36, grown under flooding, was

studied during June-October 1998 at the experimental farm of the Indian Institute of Technology, Kharagpur (West Bengal, India) to determine the effects of fly ash, organic, and inorganic fertilizers on changes in pH and organic carbon, release of nutrients ($\text{NH}_4^+\text{-N}$, Bray's P, and $\text{NH}_4\text{OAc K}$), and dehydrogenase activity in an acid lateritic (sandy loam) soil at 15-day intervals. Application of fly ash at 10 t ha⁻¹ alone did not improve the availability of $\text{NH}_4^+\text{-N}$, or P, as well as the rice grain yield. Availability of $\text{NH}_4^+\text{-N}$ (35.3-36.9 mg kg⁻¹), and P (12.3-14.6 mg kg⁻¹) at 15 days after transplanting, and rice grain yields (48.0-51.7 g per pot) were similar under the various fertilizer application sources such as inorganic fertilizer alone, inorganic fertilizer+fly ash or inorganic fertilizer+green manure (with *Sesbania rostrata*)+fly ash. Mean dehydrogenase activity was the highest (8.47 micro g triphenyl formazon g⁻¹ 24 h⁻¹) under the mixed fertilizer application treatments with green manure. At the end of the cropping season (75 days after transplanting), pH, organic carbon, and dehydrogenase activity were higher under the mixed fertilizer application treatments involving green manure by 3, 15 and 154%, respectively, compared with the inorganic fertilizer alone.

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393. Nutrient flux in a submerged rice soil amended with organics and industrial wastes: An incubation study.

Bhuvaneswari, R.; Sriramachandrasekharan, M. V.; and Ravichandran, M.

Journal of Interacademia 10(2): 197-202. (2006); ISSN: 0971-9016

Descriptors: application rates/ clay loam soils/ electrical conductivity/ electrochemistry/ farmyard manure/ filter cake/ fly ash/ green manures/ industrial wastes/ nitrogen/ nutrient availability/ nutrients/ nutritional state/ organic amendments/ organic carbon/ phosphorus/ potassium/ rice soils/ soil amendments/ soil fertility/ soil pH/ soil types/ sulfur/ Vertisols/ wetland soils/ clarification mud/ elemental sulphur/ FYM/ Madras/ nutritional status/ pressmud/ sulphur

Abstract: An incubation experiment was conducted in a clay loam soil (Kondal series; Typic Haplusterts) to investigate the nutrient flux from press mud, fly ash, green manure and farmyard manure (FYM) incorporated in rice soil over 60 days period. Soil samples were collected from the wetland farm of Annamalai University, Tamil Nadu, India. All wastes were incorporated at the rate of 12.5 t/ha and samples were drawn in duplicate at 15, 30, 45 and 60 days after incubation (DAI). Results revealed that soil pH and available sulfur increased up to 45 DAI, electrical conductivity, organic carbon and available K increased up to 60 DAI while available N and P increased up to 30 and 15 DAI, respectively. Farmyard manure recorded higher soil pH and EC. While pressmud recorded higher release of organic carbon, available N, P, K and S followed by green manure and fly ash.

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394. Nutrient management in paddy through low cost inorganic sources in a sodic soil.

Dinesh Kumar and Sharma, K. N.

Annals of Agri Bio Research 12(2): 145-150. (2007); ISSN: 0971-9660

Descriptors: application rates/ crop yield/ electrical conductivity/ fertilizers/ fly ash/ gypsum/ mineral content/ nitrogen/ nutrient content/ phosphorus/ potassium/ reclamation/ rice/ sodic soils/ soil amendments/ soil fertility/ soil pH/ soil types/ paddy

Abstract: A greenhouse experiment was conducted at Ludhiana, Punjab, India, for three years to explore the feasibility of using coal fly ash for reclamation of sodic soils and determine the effect of duration of pre-submergence on the yield and mineral composition in paddy crop. The treatments comprised three levels of fly ash (F_0 , $F_{4.0}$ and $F_{8.0\%}$), two pre-submergence periods (S_0 and S_1) and two levels of basal rates of fertilizers (R_{100} and $R_{120\%}$ of the recommended). There was a slight reduction in soil pH. Soil electrical conductivity decreased significantly with the addition of fly ash. The sodium adsorption ratio of the soil decreased with increasing fly ash levels, while one week pre-submergence considerably added to its favourable effects. Fly ash application increased the available elemental status of N and K, but decreased P in the soil. Application of fly ash also increased the concentration of elements except P in the seeds and straw of paddy. Application of fly ash (4%) with one week pre-submergence period increased the yield attributing characters as well as yield of paddy. At one week pre-submergence period, no significant difference in the yield and its attributing characters occurred between 100 and 120% of recommended basal rate of fertilizer application. The results indicated that gypsum could possibly be substituted with the addition of 4% acidic fly ash with one week pre-submergence period for the reclamation of waterlogged sodic soil.
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395. Nutrient uptake by blackgram as influenced by integrated use of inorganic fertilisers and industrial wastes.

Deepa, B. and Poonkodi, P.

Advances in Plant Sciences 17(1): 243-245. (2004)

NAL Call #: QK1.A38; ISSN: 0970-3586

Descriptors: agrichemicals/ horticulture: agriculture/ nutrition/ soil science/ Leguminosae: angiosperms, dicots, plants, spermatophytes, vascular plants/ clay loam soil/ recommended dose

Abstract: A field experiment was conducted on a clay loam soil to study the effect of inorganic fertilizers, lignite fly ash (LFA) and press mud (PM) on nutrient uptake of blackgram. The results revealed that application of 100% recommended dose of fertilizers (RDF) along with LFA @ 5t ha⁻¹ and press mud @ 6t ha⁻¹ significantly enhanced the nutrient uptake and yield in blackgram. This was followed by 75% RDF. But 100 and 75% RDF were comparable with each other when applied along with LFA @ 5t ha⁻¹ and 6t ha⁻¹ on benefit : cost ratio basis.

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396. Nutrient use efficiency of sabai grass-legumes intercropping system grown under integrated nutrient management.

Manisha Basu; Bhadoria, P. B. S.; Mahapatra, S. C.; and Das, S.

Environment and Ecology 25S(Special 4): 1065-1067. (2007)

NAL Call #: TD172.E5; ISSN: 0970-0420

Descriptors: acid soils/ black gram/ cropping systems/ farmyard manure/ fly ash/ groundnuts/ intercropping/ lateritic soils/ legumes/ lime/ nitrogen/ NPK fertilizers/ nutrients/ phosphorus/ plant nutrition/ potassium/ soil types/ use efficiency/ FYM/ peanuts

Abstract: Effect of integrated nutrient management on nutrient use efficiency (NUE) of sabai grass-legumes intercropping system was studied for three years (2003-2005) on the acid lateritic uplands of West Bengal in eastern India under rainfed condition. Chemical fertilizers (CF) at 50:25:25 kg NPK/ha respectively alone and in conjunction with farmyard manure (FYM), along with lime and fly ash (FA) were tested on sole sabai grass, sabai grass-groundnut and sabai grass-blackgram intercropping system. Results revealed that NUE for N, P and K was higher under sabai grass-legume intercropping system as compared to sole sabai grass. Integrated use of CF, FYM and FA resulted in maximum NUE, which was comparable with FYM + lime + CF.

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397. Occurrence of trace elements in coal ash and sludge amended soils in India.

Datta, S.; Hart, B.; Powell, M. A.; Fyfe, W. S.; and Tripathy, S.

In: Ninth annual V. M. Goldschmidt conference. Cambridge, MA, United States.) Agee, C.; Bowers, T.; Bowering, S. A.;

Frey, F. A.; Hayes, J. M.; Holland, H.; Jacobsen, S. B.; McDonough, W. F.; Murray, R.; Rudnick, R. L.; Shimizu, N.; Schrag, D. P.; and Van Baalen, M. (eds.)

Report: LPI-CONTRIB-971: LPI Contribution; pp. 66-67; 1999.

Descriptors: ash/ Asia/ geochemistry/ India/ Indian Peninsula/ laterites/ monitoring/ pH/ pollution/ sampling/ sludge/ soil pollution/ soils/ spectra/ toxicity/ trace metals/ waste disposal/ X-ray diffraction data/ X-ray photoelectron spectra/ Geochemistry of rocks, soils, and sediments/ Soils/ Environmental geology

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398. Optimizing fly-ash dose for better tree growth and nutrient supply in an agroforestry system in semi-arid tropical India.

Ramesh, V.; Korwar, G. R.; Mandal, U. K.; Sharma, K. L.; and Venkanna, K.

Communications in Soil Science and Plant Analysis 38(19-20): 2747-2766. (2007)

NAL Call #: S590.C63; ISSN: 0010-3624

Descriptors: fly ash/ Alfisols/ soil fertility/ tree growth/ agroforestry/ nutrient availability/ plant nutrition/ plant micronutrients/ minerals/ heavy metals/ composts/ *Leucaena leucocephala*/ *Tectona grandis*/ phosphorus/ potassium/ calcium/ sodium/ exchangeable aluminum/ India
Abstract: Research on fly-ash utilization in dryland Alfisols in semi-arid tropical India may help successful establishment of agroforestry systems. A field study was conducted during 2001-2004 with the objective of evaluating fly-ash using different levels (0, 17, 33, and 66% v/v) in tree microsites along with compost and tank silt mixtures. Specifically, the focus was to find the optimum dose of fly-ash mixtures for tree growth and nutrient release with time of both essential and heavy elements in fly-ash and soil: phosphorus (P), potassium (K), calcium (Ca), sodium (Na), aluminium (Al), zinc (Zn), and cadmium (Cd)

and their effect on plant tissues with respect to copper (Cu), Zn, Cd, nickel (Ni), chromium (Cr), and lead (Pb). The changes in plant-available or extractable status of elements and the growth of two major tree species viz., teak (*Tectona grandis*) and leucaena (*Leucaena leucocephala*) were monitored at 6-month intervals during 2002-2004 in an agrisilvicultural system. Pit mixtures with 66% fly-ash by volume of pit significantly increased the tree growth of teak throughout the study period. For leucaena, it positively influenced the growth at initial stages. The dose increased the status of available P, K, Ca, and Na during the study period. The exchangeable Al and available Zn content of microsites corresponding to the dose significantly increased during 2001 - 2003 but the levels were less than the toxic limits. The available Cd content showed an increase only during the initial stage of the study period. The variation in heavy-metal content (Cu, Cd, Cr, Ni, Pb, and Zn) in plant tissues among the different treatments was found to be nonsignificant.

This citation is from AGRICOLA.

399. Particulate and dissolved phosphorus chemical separation and phosphorus release from treated dairy manure.

Dao, T. H. and Daniel, T. C.

Journal of Environmental Quality 31(4): 1388-1398. (2002)
NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: aluminium/ aluminium sulfate/ animal wastes/ cattle manure/ electrical conductivity/ fly ash/ immobilization/ iron/ nitrogen/ organic amendments/ phosphorus/ polymers/ soil acidity/ soil types/ suspended solids/ Ultisols/ waste treatment/ aluminium sulphate/ aluminum / aluminum sulfate/ livestock wastes

Abstract: In confined animal feeding operations, liquid manure systems present special handling and storage challenges because of the large volume of diluted wastes. Water treatment polymers and mineral phosphorus (P) immobilizing chemicals [$Al_2(SO_4)_3 \cdot 18H_2O$, $FeCl_3 \cdot 6H_2O$, and Class C fly ash] were used to determine particulate and dissolved reactive phosphorus (DRP) reduction mechanisms in high total suspended solid (TSS) dairy manure and the P release from treated manure and amended soils. Co-application exceeded the aggregation level achieved with individual manure amendments and resulted in 80 and 90% reduction in metal salt and polymer rates, respectively. At marginally effective polymer rates between 0.01 and 0.25 g litre⁻¹, maximal aggregation was attained in combination with 1 and 10 g litre⁻¹ of aluminium sulfate (3 and 30 mmol Al³⁺ litre⁻¹) and iron chloride (3.7 and 37 mmol Fe³⁺ litre⁻¹) in 30 g litre⁻¹ (TSS30) and 100 g litre⁻¹ TSS (TSS100) suspensions, respectively. Fly ash induced particulate destabilization at rates ≥ 50 g litre⁻¹ and reduced solution-phase DRP at all rates ≥ 1 g litre⁻¹ by 52 and 71% in TSS30 and TSS100 suspensions, respectively. Aluminium and Fe salts also lowered DRP at rates ≤ 10 g litre⁻¹ and higher concentrations redispersed particulates and increased DRP due to increased suspension acidity and electrical conductivity. The DRP release from treated manure solids and a Typic Paleudult amended with treated manure was reduced, although the amendments increased Mehlich 3-extractable P. Therefore, the synergism of flocculant types allowed input reduction in

aggregation aid chemicals, enhancing particulate and dissolved P separation and immobilization in high TSS liquid manure.

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400. Performance of seed germination and growth of *Vicia faba* L. in fly ash amended soil.

Rai, U. N.; Gupta, D. K.; Akhtar, M.; and Amit Pal
Journal of Environmental Biology 24(1): 9-15. (2003)
NAL Call #: QH540.J65; ISSN: 0254-8704

Descriptors: application rates/ faba beans/ fly ash/ growth stages/ metal tolerance/ seed germination/ seedling growth/ soil amendments/ survival/ toxic substances/ broad beans/ fava beans/ field beans/ horse beans/ poisons/ tic beans

Abstract: This study was conducted to assess the feasibility of growing *Vicia faba* in soils amended with fly ash. The difference between the growth performance and tolerance of *V. faba* under different fly ash concentrations were compared. Results showed that amending the soil with fly ash at low concentration improved growth during the initial stage but inhibit growth at higher concentration. Although no difference was observed in survival rates, the seedling growth was low in control plants. Fly ash delayed the nodulation, and less nodules were recorded at higher concentration. It is suggested that *V. faba* can be grown in areas contaminated with fly ash.

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401. Permissible concentrations of arsenic and lead in soils based on risk assessment.

Dudka, S. and Miller, W. P.

Water, Air and Soil Pollution 113(1-4): 127-132. (July 1999)
NAL Call #: TD172 .W36; ISSN: 0049-6979 [WAPLAC]

Descriptors: soil pollution/ polluted soils/ arsenic/ lead/ land application/ fly ash/ sewage sludge/ silt loam soils/ wheat soils/ risk assessment/ children/ environmental exposure/ biosolids/ corn soils

This citation is from AGRICOLA.

402. Persistency of bacterial indicators in biosolids stabilization with coal fly ash and lime.

Wong, J. W. C.; Fang Min; and Jiang RongFeng
Water Environment Research 73(5): 607-611. (2001)
NAL Call #: TD419.R47; ISSN: 1061-4303

Descriptors: application to land/ biological activity in soil/ biological indicators/ bioremediation/ coal/ coliform bacteria/ fly ash/ lime/ liming/ pathogens/ pH/ sewage sludge/ soil amendments/ soil bacteria/ stabilization/ hydrogen ion concentration/ land application/ microbial communities/ potential of hydrogen

Abstract: Alkaline coal fly ash and lime were tested for their effectiveness in pathogen removal from biosolids at different time intervals and temperatures. Coal fly ash at 10 and 35% w/w was mixed with dewatered biosolids and then the ash-biosolids mixture was mixed separately with 0, 1.1, 2.2, 4.4, 8.5, 11, and 18% calcium oxide (w/w on a dry weight basis) with and without heating to 55 degrees C. Total bacteria, Salmonella, and total coliforms were monitored at various time intervals. Both ash-biosolids mixtures with or without lime amendment had a significantly

lower total bacterial population than the biosolids control, but the residual indigenous bacterial flora in the ash and lime stabilized biosolids still maintained a population of greater than 10^4 g⁻¹ dry biosolids. Alkaline-stabilized biosolids with a lime amendment rate greater than 8.5% could maintain pH greater than or equal to 12 for more than 2 hours, which effectively removed total coliforms and Salmonella in the mixture. Heat treatment to 55 degrees C and a storage time of 14 days provided an added advantage resulting in a further reduction in pathogens for all treatments. It is recommended that 10% ash-biosolids mixture should be amended with a minimum of 8.5% lime on a dry weight basis for at least 2 hours to achieve acceptable levels of Salmonella and total coliforms to ensure no pathogenic risk following land application. Reproduced with permission from the CAB Abstracts database.

403. Petroleum coke circulating fluidized bed combustion product as a sulfur source for alfalfa.

Chen, L.; Kost, D.; and Dick, W. A.

Communications in Soil Science and Plant Analysis 39(13-14): 1993-2008. (2008)

NAL Call #: S590.C63; ISSN: 00103624 [CSOSA].

Notes: doi: 10.1080/00103620802134826.

Descriptors: alfalfa/ flue gas desulfurization/ nickel/ plant sulfur nutrient/ soil sulfur/ trace elements/ vanadium/ alfalfa/ combustion/ environmental impact/ nickel/ nutrient/ petroleum/ soil pollution/ sulfur/ trace element/ vanadium/ medicago sativa

Abstract: Petroleum coke circulating fluidized bed (CFB) combustion product is created when petroleum coke is combusted with limestone in a circulating fluidized bed boiler. The CFB product contains high concentrations of sulfur (S), nickel (Ni), and vanadium (V). Using it as a S source is encouraged, but little information is available related to plant responses and environmental impact. The CFB product was applied at rates of 0, 11, 33, and 110 kg S ha⁻¹ to two agricultural soils (Canfield silt loam and Wooster silt loam). Dry weight of alfalfa (*Medicago sativa* L.) and S in plant tissue was increased by the S treatments. Concentrations in alfalfa of V were increased but did not reach environmental concern levels. Concentrations in alfalfa of Ni were not increased. In the soils, only total S and plant available S were increased by these materials. No soil contamination problems were observed when CFB product was used as an S source. Copyright © Taylor & Francis Group, LLC.

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404. [Phosphate adsorption and desorption characteristics of several fly ashes].

Feng, Y.; Hu, R.; Zhang, Y.; Zou, Y.; Huang, Y.; Wang, C.; and Li, F.

Ying Yong Sheng Tai Xue Bao 16(9): 1756-60. (Sept. 2005); ISSN: 1001-9332 .

Notes: Original language of article: Chinese.

Descriptors: adsorption/ carbon: chemistry/ coal/ incineration/ particulate matter: chemistry/ phosphates: chemistry

Abstract: Through adsorption-desorption experiment and incubation test, this paper studied the phosphate adsorption and desorption characteristics of several fly ashes. The test fly ashes contained 0.545 - 4.540 g x kg⁻¹

of total P and 19.55 - 163.0 mg x kg⁻¹ of available P, which were significantly higher than those in soils. The P adsorption capacity of fly ashes increased with increasing added P, while their P adsorption rate was in adverse. Fly ashes had a higher P adsorption rate but a lower P desorption rate than soils, mainly because fly ashes had more P adsorption sites and stronger bound energy. In this study, Langmuir, Freundlich, and Temkin equations were fit to the measured data, and the MBC value in Langmuir equation, a value in Freundlich equation, and k₂ value in Temkin equation could be used as a comprehensive index to characterize the potential phosphate adsorptivity of fly ashes. The larger these values were, the stronger the P adsorptivity was. The MBC, a and k₂ value of 5 fly ashes collected from different locations was in order of Xiangtan power factory (5 167.7, 4 056.2 and 831.5) > Yueyang paper factory (1 650.7, 2803.4 and 711.9) > Huaneng power factory (303.0, 1677.6 and 368.7) > Zhuzhou power factory (34.7, 413.48 and 213.8) > Dongting nitrogen fertilizer factory (34.7, 413.48 and 213.8). The P fixation by fly ashes generally increased with their increasing water content, and their phosphate adsorption was mainly specific adsorption and chemical precipitation, suggesting that the P fixation and the water content of fly ashes should be considered when fly ash was used as soil amendment or as compound fertilizer filling substance.

This citation is from PubMed.

405. Phosphorus adsorption characteristics in a flyash amended Vertisol.

Veeresh, H.; Patil, C. V.; Vishwanath, J.; and Doyel Chaudhuri

Journal of the Indian Society of Soil Science 49(2): 255-259. (2001)

NAL Call #: 56.9 IN2; ISSN: 0019-638X

Descriptors: adsorption/ application rates/ desorption/ fly ash / phosphorus/ soil amendments/ soil chemical properties/ Vertisols/ chemical properties of soil

Abstract: A laboratory experiment was conducted to study the adsorption of added phosphorus in a Vertisol amended with different rates of wet and dry fly ashes (0-30% w/w). The adsorption data were fitted to Langmuir isotherm. The phosphorus (P) adsorption maxima (b) varied greatly with the type of soil-ash mixture. Among fly ashes, dry fly ash had more effect on P adsorption than wet fly ash. Fly ashes had little effect on P desorption except at higher ash rates (20% or more). The soil-ash mixtures even though had high P adsorption capacity, because of very low bonding energy, most part of the adsorbed P was easily desorbable. Supply parameter value varied with the type of soil-ash mixture and also with the equilibrating P concentration.

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406. Physical and chemical properties of fragipan horizon materials amended with fluidized bed combustion ash.

Rhoton, F. E.; Edwards, J. H.; and Norton, L. D

Soil Science 166(7): 465-474. (July 2001)

NAL Call #: 56.8 So3; ISSN: 0038-075X.

Notes: References: 22; illus. incl. 5 tables.

Descriptors: Alfisols / alkaline earth metals/ amendments/ amorphous materials/ ash/ chemical properties/ fragipans/ Fraglossudalfs/ Gulf Coastal Plain/ Holly Springs

Mississippi/ magnesium/ Marshall County Mississippi/
metals/ Mississippi/ pedogenesis/ pH/ physical properties/
regression analysis/ silica/ silicon/ slaking/ soil
management/ soil treatment/ soils/ statistical analysis/
strength/ United States/ Soils
© American Geological Institute

407. Physical and chemical properties of Koradi fly ash of Maharashtra for its utilization in agriculture.

Dubey, P. N.; Sangal, S. P.; Sen, T. K.; Chatterji, S.; Murali, S.; and Patil, V. P.

Agropedology (India) 9(1): 71-76. (June 1999); ISSN: 0971-1570.

Notes: 5 tables, 2 ref. Summary (En); Citation Notes: In (India); NBSS&LUP, Nagpur 440010, India.

Descriptors: physical properties/ chemical properties/ fly ash/ agriculture

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408. Physico-chemical properties of vertisols as affected by fly ash and fym under sweet potato.

Birajdar, R. R.; Chalwade, P. B.; Badole, S. B.; Shelage, B. S.; and Hangarge, D. S.

Journal of Soils and Crops 11(1): 63-65. (2001); ISSN: 0971-2836

Descriptors: bulk density/ electrical conductivity/ farmyard manure/ fly ash/ infiltration/ physicochemical properties/ porosity/ sweet potatoes/ Vertisols/ water holding capacity/ FYM

Abstract: The effect of fly ash and farmyard manure on physicochemical properties of Vertisols were evaluated under sweet potato cultivation in Maharashtra, India. Bulk density, porosity and infiltration rate were improved significantly with increasing doses of fly ash from 5-15 t/ha. The application of farmyard manure also indicated that significant decreased in bulk density from 1.28 g/cm³ in control to 1.91 g/cm³ due to application of farmyard manure at 10 and 15 t/ha, respectively. Increasing level of farmyard manure increased porosity, water holding capacity, electrical conductivity and organic carbon content in soil. Reproduced with permission from the CAB Abstracts database.

409. Physiological responses of certain ornamental plants to sludge and artificial topsoils derived from flyash, sludge, and Rengam series subsoil.

Tan, L. P.; He, J.; and Lee, S. K.

Journal of Plant Nutrition 22(6): 987-999. (1999)

NAL Call #: QK867.J67; ISSN: 0190-4167 [JPNUDS]

Descriptors: ornamental plants/ plant physiology/ fly ash/ subsoil/ topsoil/ heavy metals/ chemical composition/ chlorophyll/ fluorescence/ symptoms/ phytotoxicity/ soil organic matter/ metal tolerance/ species differences/ sludges

Abstract: In this study, four artificial topsoil mixtures were produced by mixing incinerator flyash, sewage sludge, and subsoil (from granite origin) in various proportions. Each mixture had a different heavy metal content. Both sludge and the artificial topsoils were used to grow certain ornamental plants, namely, *Bougainvillea spectabilis*, *Ixora coccinea*, and three *Heliconia* taxa: *H. psithacorum* x *H. spathocircinata* cv. "Golden Torch", *H. rostrata* and *H. psithacorum* cv. "Tay". Their physiological responses were monitored using chlorophyll fluorescence Fv/Fm ratio and their general appearance was also recorded. All the five

plants grown in sludge were observed to show no symptoms of heavy metal toxicity. However, it was found that *I. coccinea* and all three *Heliconias* were susceptible to heavy metal toxicity when grown in all the four mixtures of artificial topsoil. *Bougainvillea spectabilis* is capable of tolerating the heavy metal present in the artificial topsoil with the least amount of heavy metals but they showed different levels of toxicity symptoms when grown at the other three mixtures with higher heavy metal content. These findings indicate that *B. spectabilis* is the most tolerant plant to heavy metals among the tested plants grown in the different artificial topsoils.

This citation is from AGRICOLA.

410. Plant and soil responses to field-applied flue gas desulfurization residue.

Sloan, J. J.; Dowdy, R. H.; Dolan, M. S.; and Rehm, G. W. 78(2): 169-174. (1999); ISSN: 00162361 [FUELA]

Descriptors: alfalfa/ boron/ FGD residue/ molybdenum/ sulfur/ boron/ crops/ cultivation/ desulfurization/ flue gases/ molybdenum/ silt/ soils/ sulfur/ flue gas desulfurization (FGD)/ waste utilization

Abstract: The objective of this study was to document the availability of flue gas desulfurization (FGD) residue-borne boron (B), sulfur (S), and molybdenum (Mo) for alfalfa (*Medicago sativa* L.) uptake when applied at agronomic rates to marginally B deficient soils. The FGD residue was applied at rates of 0, 0.46 and 3.75 Mg ha⁻¹ on a silt loam soil immediately prior to alfalfa seeding. Alfalfa yields were unaffected by these rates of residue applications, but shoot concentrations of B and S in the second cutting, and B, S, and Mo in the third cutting were increased by residue applications. Hence, FGD residue is a readily available B source, particularly later in the growing season when native soil B availability decreased. © 1998 Elsevier Science Ltd. © 2009 Elsevier B.V. All rights reserved.

411. Plant growth response in experimental soilless mixes prepared from coal combustion products and organic waste materials.

Bardhan, Sougata; Watson, Maurice; and Dick, Warren A. *Soil Science* 173(7): 489-500. (July 2008)

NAL Call #: 56.8 So3; ISSN: 0038-075X

Descriptors: soil amendments/ coal fly ash/ composted manure/ cattle manure/ yard waste composts/ biosolids composts/ soilless media/ soilless culture/ water content/ pH/ gypsum/ peat/ perlite/ plant growth/ *Lolium perenne*/ *Cupressus sempervirens*/ coal combustion products/ bottom ash

This citation is from AGRICOLA.

412. Plant nutrient availability from mixtures of fly ashes and biosolids.

Schumann, A. W. and Sumner, M. E.

Journal of Environmental Quality 28(5): 1651-1657. (1999)

NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: adsorption/ analysis/ application rates/ chemical analysis/ deficiency/ extraction/ fly ash / maize/ manures/ mixtures/ nutrient availability/ nutrient balance/ nutrient deficiencies/ nutrition/ phytotoxicity/ plant nutrition/ poultry manure/ sewage/ sewage sludge/ sludges/ soil fertility/ wastes/ corn/ poultry litter

Abstract: Two greenhouse experiments were established using 24 different fly ashes with sewage sludge and poultry manure to estimate nutrient availability and imbalances to

maize. The maximum maize growth attained with fly ash amendment of 80 t ha⁻¹ was significantly less (50%) than a fertilized control treatment. The additional growth improvements obtained from mixtures with sewage sludge or poultry manure ranged from 30 to 49% and 30 to 71%, respectively. Organic materials applied alone achieved only 54 and 62% of the maximum potential, while growth on poultry manure mixtures was up to 94% of the best performing fertilized treatment. Results of foliage and soil analyses suggest that P and K were the main nutrient deficiencies, while B phytotoxicity and an imbalance in the K:Ca:Mg ratio also were likely causes of plant growth reduction. Fly ashes did not contribute significant P or K to correct soil and plant deficiencies, but more often exacerbated the imbalances by precipitation or adsorption of soil P. Sewage sludge mixed at 26% and poultry manure at 13% (DM [dry matter]) with fly ash had negligible effect on availability of phytotoxic fly ash B, but were good sources of P (both) and K (poultry manure). Good agreement between plant nutrition in pot experiments and previous laboratory extraction studies implies that chemical analysis, efficient formulation and optimized application rates may overcome nutrient limitations for use of wastes as fertilizer substitutes.

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413. Plant uptake of selenium arsenic and molybdenum from soil treated with coal combustion byproducts.

Codling, E. E. and Wright, R. J.

Fresenius Environmental Bulletin 7(1/2): 118-125. (1998); ISSN: 1018-4619

Descriptors: arsenic/ byproducts/ coal/ combustion/ fly ash/ molybdenum/ plant composition/ risk assessment/ selenium/ soil/ uptake/ chemical constituents of plants/ Mo
Abstract: Three coal combustion byproducts, fly ash (FA), scrubber sludge (SS) and gypsum (G), added to soil at rates of 0, 20, 40 and 80 g/kg only limited annual ryegrass (*Lolium multiflorum*) growth at the 80 g/kg rate. FA and SS increased selenium (Se), arsenic (As) and molybdenum (Mo) concentrations in ryegrass but only Se from FA would present a potential food chain risk. G did not significantly increase ryegrass concentrations of Se, As and Mo and should not produce elevated trace element levels in plant material or the environment when added to soil at high rates.

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414. Plasticity and density-moisture-resistance relations of soils amended with fly ash.

Mapfumo, E. and Chanasyk, D. S.

Environmental Technology 19(6): 543-554. (1998)

NAL Call #: TD1.E59; ISSN: 0959-3330

Descriptors: bulk density/ clay loam soils/ fly ash/ loam soils / plasticity/ sandy loam soils/ soil amendments/ soil compaction/ soil types/ soil water content

Abstract: The impact of fly ash amendments on the plasticity, water retention and penetration resistance-density-moisture relationships of sandy loam, loam and clay loam soils in Alberta, Canada, was studied to determine the potential compaction of soil/fly ash mixtures if they were worked at different moisture ranges. For all soils the addition of fly ash decreased the plasticity index, but slightly increased the Proctor maximum density. This implies that

fly ash amendments reduce the range of moisture within which soils are most susceptible to compaction. However, for the sandy loam and loam textured soils amended with fly ash, cultivation must be avoided at moisture contents close to field capacity since maximum densification occurs at these moisture contents. In all three soils the addition of fly ash increased water retention, especially in the sandy loam. Correlation analysis showed significant ($P \leq 0.05$) positive correlation between critical moisture content and field capacity, critical moisture content and plastic limit, and plastic limit and field capacity. Fly ash amendments increased penetration resistance of the clay loam, but decreased penetration resistance of the sandy loam. For the loam there was an inconsistent response of penetration resistance to fly ash additions. Regression analysis showed that penetration resistance of sandy loam/fly ash mixtures and loam/fly ash mixtures was significantly ($P \leq 0.05$) dependent on bulk density. For the clay loam/fly ash mixtures penetration resistance was significantly ($P \leq 0.05$) dependent on bulk density and volumetric moisture content. Reproduced with permission from the CAB Abstracts database.

415. Pollution character analysis of filling reclaimed soil with fly ash in subsided land; a case study in Henan, China.

Hu Zhenqi; Wei Zhongyi; and Qin Ping

China Environmental Science 24(3): 311-315. (2004);

ISSN: 1000-6923.

Notes: Language: Chinese. References: 7; illus. incl. 4 tables. Original journal title: Zhonggou Huanjing Kexue.

Descriptors: ash/ Asia/ case studies/ China/ Far East/ geologic hazards / heavy metals/ Henan China/ land subsidence/ pollution/ properties/ reclamation/ soils/ environmental geology

© American Geological Institute

416. Possibility of using flyash as a source of silica for increasing rice productivity on a reclaimed alkali soil.

Mongia, A. D.; Chhabra, R.; and Khajanchi Lal

Journal of the Indian Society of Soil Science 51(1): 89-91. (2003)

NAL Call #: 56.9 IN2; ISSN: 0019-638X

Descriptors: Alfisols/ alkaline soils/ crop yield/ fly ash/ leaching/ nutrient availability/ nutrient uptake/ plant nutrition/ reclaimed soils/ reclamation/ rice/ rice straw/ silica/ soil amendments/ soil types/ straw/ paddy

Reproduced with permission from the CAB Abstracts database.

417. Possible incentive to diffuse desulfurization equipment in China.

Nitta, Y.; Sadakata, M.; Matsumoto, S.; and Yoshioka, K.

85(3): 191-196. (2006); ISSN: 09168753 [NENGE].

Notes: Language of Original Document: Japanese.

Descriptors: Gypsum/ Soil remediation/ Briquetting/ Byproducts/ Coal combustion/ Coal fired boilers/ Flue gases/ Gypsum/ Soil pollution control/ Alkaline soil/ Bio-briquette/ Soil degradation/ Soil remediation/ Desulfurization

Abstract: This paper describes our challenge to diffuse desulfurization equipments such as flue gas desulfurization (FGD) plants or bio-briquettes in Shenyang, China. Gypsum, which is a major material in by-product from the desulfurization process or burnt ash of the bio-briquettes, is

a key material to remediate alkaline soil. Since alkaline soil is found in typical soil degradation in dry land agriculture, gypsum production from coal combustion has a potential to contribute agriculture land remediation in China. Almost eight years of our efforts confirmed that FGD gypsum can remediate heavily eroded alkaline soil and that the ash of the bio-briquettes can also do it although it contains gypsum only about ten percents. A simple but well performed FGD plant was constructed and attached to an old coal firing boiler. The gypsum from the plant was also confirmed to have high performance in alkaline soil remediation.

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418. Potassium kinetics in solid wastes amended vertisols of north eastern arid zone of Karnataka.

Yeledhalli, N. A.; Prakash, S. S.; Patil, C. V.; Ravi, M. V.; and Rao, K. N.

Karnataka Journal of Agricultural Sciences 20(3): 518-523. (2007)

NAL Call #: S471.I42K37; ISSN: 0972-1061

Descriptors: application to land/ arid zones/ buffering capacity/ fly ash/ kinetics/ nutrient availability/ potassium/ sewage sludge/ soil amendments/ soil fertility/ soil types/ solid wastes/ Vertisols/ waste disposal/ waste management/ waste utilization/ arid regions/ land application/ Mysore

Abstract: Laboratory equilibration studies were undertaken to evaluate the effect of solid wastes application individually or in co-application on Q/I relationship and soil properties. Amending the soil, with fly ash/sewage sludge with or without 50 ppm K increased the equilibrium activity ratio (AR_eK) values, decreased the labile pool (-K_o) K and Gibb's free energy (-ΔG) values in vertisols. Whereas, potential buffering capacity (PBCK) values decreased. Prolonged equilibration of soils for 50 days decreased the AR_eK values, -ΔK_o values and PBCK values.

Application of fly ash and sewage sludge as soil amendment increased the immediate availability of potassium, labile pool and PBCK to a greater extent in vertisols.

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419. Potassium silicate fertilizer using Chinese fly ash and a fertilizer response test.

Goto, S.; Aoki, M.; Long, C. de; Takada, C.; Hayashi, H.; and Chino, M.

Japanese Journal of Soil Science and Plant Nutrition 71(3): 378-384. (2000); ISSN: 0029-0610

Descriptors: absorption/ analysis/ calcination/ chemical analysis/ comparisons/ controlled release/ fertilizer analysis/ fertilizers/ fly ash/ mixtures/ nutrients/ potassium/ potassium fertilizers/ potassium silicates/ power stations/ responses/ silicon fertilizers/ slow release fertilizers/ temperature/ uptake / wheat/ potash fertilizers/ slow release

Abstract: The effects of the potassium silicate fertilizers, made of fly ash from Chinese power stations, on the growth and absorption of nutrients (K, Si and others) were compared with those from Japanese fly ash. Three types of fly ash mixture were prepared for calcination: (1) Japanese fly ash mixed with KOH and Mg(OH)₂ (Japanese ash); (2) Chinese fly ash mixed with KOH and Mg(OH)₂ (Chinese ash I); and (3) Chinese fly ash mixed with KOH, Ca(OH)₂ and Mg(OH)₂ (Chinese ash II). Each fly ash mixture was

calcined at 750, 850 or 950 degrees C for 30 min., respectively. Chemical analysis of these nine potassium silicate fertilizer samples showed that six samples calcined at 850 or 950 degrees C almost cleared the Japanese official standard for commercial fertilizer, but those calcined at 750 degrees C did not. Wheat plants were grown in pots for 55 d using these potassium silicate fertilizers. Dry weight and K uptake of the plants grown with the fertilizers prepared from Chinese ash I and II calcined at 850 degrees C were greater than those grown with the fertilizers prepared from Japanese ash or ordinary chemical fertilizer. The weights of the ears and polished grains of the plants grown with potassium silicate fertilizer prepared from Chinese ash II calcined at 750 or 850 degrees C were greater than those of the control plot. In this case, the K uptake in the whole plant was almost equal to that of the control plot. In conclusion, the potassium silicate fertilizer prepared from Chinese ash II calcined at 850 degrees C was effective as a silicate fertilizer as well as a slow-release potassium fertilizer. It is also presumed that Chinese ash I calcined at 850 degrees C is also effective.

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420. Potential error associated with measurement of carbon mineralization in soil treated with coal combustion byproducts.

McCarty, G. W.; Siddaramappa, R.; and Wright, R. J.

Soil Biology and Biochemistry 30(1): 107-109. (Jan. 1998)

NAL Call #: S592.7.A1S6; ISSN: 0038-0717 [S BIOAH]

Descriptors: soil analysis/ carbon/ mineralization/ measurement/ microbial activity/ carbon dioxide/ coal/ combustion/ byproducts/ fly ash/ ash/ soil amendments/ gas production/ fluidized beds/ respiration/ determination/ errors/ microbial respiration

This citation is from AGRICOLA.

421. Potential of Eisenia foetida for sustainable and efficient vermicomposting of fly ash.

Gupta, S. K.; Anamika Tewari; Richa Srivastava; Murthy, R. C.; and Saurabh Chandra

Water, Air and Soil Pollution 163(1/2/3/4): 293-302. (2005)

NAL Call #: TD172 .W36; ISSN: 0049-6979

Descriptors: cattle dung/ chemical analysis/ copper/ feeds/ fly ash/ heavy metals/ lead/ liveweight gain/ nickel/ sustainability/ toxicity/ vermicomposting/ waste management/ waste utilization/ zinc/ liveweight gains/ reactors

Abstract: Vermicomposting of fly ash has been attempted, using red earthworm, *Eisenia foetida*. Fly ash, which was obtained from thermal power station, was mixed with cowdung in different proportions (20,40, 60 and 80%). These mixtures were used as feed for earthworms, and after 30 days, vermicast recovery, worm zoomass and numbers of juveniles produced were recorded. A total of six runs each of 30 days were conducted during the whole study. Concentrations of heavy metals in different mixtures of fly ash-cowdung, before and after vermicomposting and in the earthworms used in the study were also estimated. Results show maximum output of vermicasts and maximum number of juveniles produced was in reactors with 40% fly ash while maximum weight gain by earthworm was in 20% fly ash vermireactors. Performance of vermireactors up to 60% fly ash was more or less similar but at 80% fly ash, there is a marked reduction in overall performance of the

reactors. Chemical analysis of different samples of fly ash-cowdung mixtures prior to vermicomposting revealed high concentrations of zinc, chromium, lead, nickel and copper. Chemical analysis of vermicomposted samples showed 30-50% reduction in heavy metals up to 60% fly ash and 10-30% reduction in 80% fly ash. Metal analysis of earthworms revealed considerable bioaccumulation of heavy metals in their body. The Present study indicates the feasibility of *E. foetida* for mitigating the toxicity of metals and up to 60% fly ash-cowdung mixtures can be used for sustainable and efficient vermicomposting.

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422. Potential of fly ash and organic wastes for uses as amendments to agricultural soils: A review.

Ghuman, G. S.; Sajwan, K. S.; and Paramasivam, S. In: 7th International Conference on Biogeochemistry of Trace Elements. Coal Combustion Byproducts and Environmental Issues. Uppsala, SWEDEN.; pp. 216-224; 2006. ISBN: 0387258655

Descriptors: Pollution Assessment Control and Management/ Soil Science/ Agronomy: Agriculture/ Waste Management: Sanitation/ agricultural soil amendment: applied and field techniques / Fly Ash/ Organic Waste

Abstract: Among the naturally available resources, coal plays a predominant role as a source of energy. It was estimated that by the year 2000, the production of coal in the United States would reach 1.91×10^9 tons(1). The coal excavated from different parts of the country or of the world such as lignite, bituminous, subbituminous and Australian hard and soft brown coals are different in their chemical composition and physical characteristics. Increased use of coal in power plants has resulted in the accumulation of vast quantities of coal residues of which fly ash is the major fraction. Approximately 63 million tons of fly ash is generated annually in the U.S. Of this amount, about 66% is discarded in lagoons or landfills. Half of the utilized fly ash is used in concrete as pozzolanic material because it contains constituents that combine with lime at ordinary temperatures and in the presence of water form cementitious compounds(3). A great deal of research has been done to find the proper utilization and disposal of waste products of coal-fired power plants 4,5,6. Fly ash is commonly used in landfilling, in construction industry, as filler in asphalt mix, stabilizer for road bases, thermal insulation, and deodorization of animal wastes 7. Fly ash usually contains high concentrations of Ca, K, Na, Mg, B, Ni and Mn. Earlier reports indicated that the elements present in crude coal are partitioned not only among the different types of coal ash residues but also among particles of different sizes in fly ash (8,9). Fly ash consists of particles of all sizes ranging from 2 to 1000 μm in diameter. Much of the earlier work conducted to utilize fly ash was centered on efforts to amend the soil characteristics for proper vegetation growth. Fly ash usually contains high concentrations of Ca, K, Na, Mg, B, Ni and Mn. Alkaline fly ash due to the presence of oxides has been used to neutralize acidity(10). Furr et al.(11) studied the uptake of several elements by vegetables grown in potted soil amended with 10% by weight of fly ash and found that As, B, Ca, Cu, Fe, Hg, I, K, Mg, Mo, Ni, Sb and Se were higher in concentration in the edible portions of at least three of the crops grown on fly ash amended soil as compared to control crops. Massive applications are usually associated

with adverse effects to soils and growing plants. The effect of fly ash amended compost application to agricultural crops was not investigated in earlier studies. Adriano et al.(12) suggested that the use of coal residues in conjunction with other materials such as sewage sludge, peat and animal manures needs to be explored. Menon et al.(13) studied the utilization of fly ash to amend the characteristics of organic compost for agricultural use in acid soil. Menon et al.(14) studied the effects of coal fly ash-amended composts on the yield and elemental uptake by plants. Ghurnan et al.(15) studied the up take of multielements by corn from fly ash-compost amended soil. Compost contains relatively lower concentrations of several elements present in fly ash particularly the Ca, B and Cd. © Thomson Reuters

423. Potential of fly ash as a soil conditioner for desert ecosystem.

Oswal, M. C.; Singh, C. B.; and Grewal, K. S. In: Recent Advances in Management of Arid Ecosystem. Proceedings of a Symposium. India.; pp. 469-474; 1999.

Descriptors: ash/ capacity/ coal/ crusts/ disposal/ ecosystems/ fly ash/ germination/ grain/ loam soils/ millets / mulches/ particles/ pearl millet/ properties/ responses/ sand/ sandy loam soils/ soil/ straw/ water holding capacity/ yields/ bulrush millet/ mulching materials

Abstract: Laboratory studies showed that fly ash produced by a thermal power plant in Haryana, India had a high water holding capacity and the dominant particles were sand sized. These properties suggest that it may serve as a soil conditioner for crusting soils, mulch for medium to fine textured soils and water retainer for coarse soils. Screen and field experiments indicated that mixing, of fly ash at 2.5, 5.0 and 10.0% (w/w) decreased crust strength in loam and sandy loam soils, while no crust was formed with application of 2.5 cm fly ash as a layer on the soil surface. The germination of pearl millet improved from 30.8 to 80.0% in loam and from 36.3 to 69.3% in sandy loam soil when fly ash was added. Water consumption decreased slightly, while grain and straw yields of pearl millet and water-use efficiency improved substantially in loam, sandy loam and sand soils. The maximum response was observed with application of 2.5 cm fly ash layer. Reproduced with permission from the CAB Abstracts database.

424. Potential uses of fluidised bed boiler ash (FBA) as a liming material, soil conditioner and sulfur fertilizer.

Wang, Hailong; Bolan, Nanthi; Hedley, Mike; and Horne, Dave.

In: Coal Combustion Byproducts and Environmental Issues. Uppsala, Sweden.; Springer; pp. 202-215; 2006. Notes: 7th International Conference on Biogeochemistry of Trace Elements.

Descriptors: fluidised bed boiler ash/ liming material/ soil conditioner/ sulfur fertilizers

Abstract: To meet the Clean Air standard, many North American and European power plants have adopted fluidized bed combustion techniques. These systems require lower capital investment, to reduce the sulfur-dioxide (SO₂) emissions in flue gases, than the wet flue gas desulfurization process. In the former system, limestone chip mixed with the fine coal is burnt in a bed suspended by compressed air. Sulfur dioxide released as the coal is burnt, reacts with CaO generated in the furnace

therefore minimizing SO₂ emissions from the stack. The resulting ash from the boiler bed and trapped fly ash, known as fluidized bed boiler ash (FBA), contains CaSO₄ and unreacted CaO. Mixing this ash with water, to overcome dust problems, subsequently converts CaO to Ca(OH)₂. The chemical composition of FBA is highly dependent on the efficiency of the boilers and the nature of the fuel and limestone sources. As many countries including Australia and USA are rich in coal resources, coal plays a significant role in supplying energy. But, some of the coal resources are rich in sulfur (S) and with increasing concern for environmental pollution, low cost techniques, such as fluidized bed combustion, are required to reduce SO₂ emission from the burning of such high S coal.

Consequently, large quantities of FBA or similar by-products would be expected. Although the resulting large volumes of FBA materials are generally disposed of in landfills, limited landfill space and increased costs, however, have stimulated investigations in many countries to develop and demonstrate agricultural and environmentally safe uses for FBAs, thereby reducing the Cost Of SO₂ scrubbing. Agricultural utilization of FBA overcomes a waste problem and at the same time provides a liming material and an inexpensive form of S source. Furthermore, FBA also has potential as a micro-nutrient fertilizer, providing elements such as boron and selenium. In this chapter the chemical characteristics of FBA and its potential uses as a liming material, soil conditioner and S fertilizer are reviewed.

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425. Power station fly ash: A review of value-added utilization outside of the construction industry.

Iyer, R. S. and Scott, J. A. 31(3): 217-228. (2001); ISSN: 09213449 [RCREE].

Notes: doi: 10.1016/S0921-3449(00)00084-7.

Descriptors: Agriculture/ Fly ash/ Materials/ Materials recovery/ Power station/ Utilization/ Waste management/ aluminum/ aluminum oxide/ aluminum silicate/ arsenic/ cadmium/ calcium/ calcium oxide/ cement/ chromium/ fluoride/ glass/ lead/ limestone/ magnesium/ mercury/ molybdenum/ nickel/ selenium/ silicate/ silicon dioxide/ zeolite/ fly ash/ waste disposal/ waste management/ adsorption/ agriculture/ building industry/ fly ash/ review/ waste management

Abstract: The disposal of fly ash from coal-fired power stations causes significant economic and environmental problems. A relatively small percentage of the material finds application as an ingredient in cement and other construction products, but the vast majority of material generated each year is held in ash dams or similar dumps. This unproductive use of land and the associated long-term financial burden of maintenance has led to realization that alternative uses for fly ash as a value-added product beyond incorporation in construction materials are needed. Utilization of fly ash in such areas as novel materials, waste management, recovery of metals and agriculture is reviewed in this article with the aim of looking at new areas that will expand the positive reuse of fly ash, thereby helping to reduce the environmental and economic impacts of disposal. Copyright _ 2001 Elsevier Science B.V. © 2009 Elsevier B.V. All rights reserved.

426. Principal chemical properties of artificial soil composed of fly ash and furfural residue.

Feng YongJun; Li Fen; Wang XiaoLing; Liu XiMin; and Zhang LeiNa

Pedosphere 16(5): 668-672. (2006)

NAL Call #: S590 .P43 ; ISSN: 1002-0160

Descriptors: agriculture/ fly ash/ furfural/ nitrogen/ nutrient availability/ phosphorus/ potassium/ reclaimed soils/ reclamation/ salts/ soil analysis/ soil chemical properties/ soil organic matter/ soil ph/ soil suitability/ soil types/ chemical properties of soil/ organic matter in soil

Abstract: To solve soil shortage in reclaiming subsided land of coal mines, the principal chemical properties of artificial soil formed by mixing organic furfural residue and inorganic fly ash were examined. The results indicated that the artificial soil was suitable for agriculture use after irrigation and desalination, the available nutrients in the artificial soil could satisfy the growth demand of plants, and the pH tended to the neutrality.

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427. Principal physicochemical properties of artificial soil composed of fly ash, sewage sludge and mine tailing.

Zhang, H.; Sun, L.; Sun, T.; and Ma, G.

Bulletin of Environmental Contamination and Toxicology 79(5): 562-5. (Nov. 2007)

NAL Call #: RA1270.P35A1; ISSN: 0007-4861.

17940713

Descriptors: Carbon: chemistry/ Electric Conductivity/ Environmental Pollutants/ Hydrogen-Ion Concentration/ Iron/ Mining/ Particulate Matter: chemistry/ Sewage: chemistry/ Soil: analysis/ Time Factors/ Water This citation is from PubMed.

428. Production of compost from sewage sludge and fly ash and subsequent evaluation of growth enhancement and heavy metal translocation in crops.

Yeledhalli, N. A.; Prakash, S. S.; and Ravi, M. V.

Environment and Ecology 26(1): 64-71. (2008)

NAL Call #: TD172.E5; ISSN: 0970-0420

Descriptors: cadmium/ composting/ composts/ copper/ fly ash/ groundnuts / heavy metals/ lead/ nickel/ NPK fertilizers/ nutrient deficiencies/ nutrient transport/ phytotoxicity/ sewage sludge/ sunflowers/ translocation/ uptake/ zinc/ Mysore/ peanuts

Abstract: The combustion of coal in India produces approximately 99 million tonnes of fly ash annually. This fly ash has to be handled and stored on ash dumps, which in turn have to be rehabilitate, increasing the cost of ash handling. Sewage sludge is classified as a organic toxic waste, which requires some treatments for use in agriculture. This investigation was made to innovate the utilization of these waste products viz. composting, blending/mixing to produce a new product SLASH compost that would enhance economic value or fulfill a predetermined need like, to correct a known nutrient deficiency or aid in remediating a potential phytotoxicity. Different levels of SLASH compost with or without NPK fertilizer were added to soil to determine the effect on productive parameters of sunflower and groundnut. Soil amended with graded levels of SLASH compost showed

significantly enhanced seed/pod/biomass yield with or without recommended dose of NPK fertilizer. The concentration and uptake of potentially toxic elements (Zn, Cu, Ni, Cd, Pb) by crops were similar to those observed with NPK fertilizer control, whereas the values increased significantly with increasing levels of SLASH compost application.

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429. Properties of several fly ash materials in relation to use as soil amendments.

Pathan, S. M.; Aylmore, L. A. G.; and Colmer, T. D. *Journal of Environmental Quality* 32(2): 687-693. (2003) NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: bulk density/ cation exchange capacity/ chemical composition/ electrical conductivity/ Entisols/ fly ash/ hydraulic conductivity/ matric potential/ particle density/ particle size distribution/ phosphorus/ Podzols/ sandy soils/ soil amendments/ soil chemical properties/ soil composition/ soil ph/ soil physical properties/ soil types/ Spodosols/ surface area/ trace elements/ water holding capacity/ chemical properties of soil/ microelements/ physical properties of soil

Abstract: Fly ash samples from five power stations in Western Australia and Queensland, and two soils used for horticulture in Western Australia, were evaluated for a series of physical and chemical properties. Soils were comprised primarily of coarse sand-sized particles, whereas most of the fly ashes were primarily fine sand- and silt-sized particles. Hydraulic conductivities in the fly ashes were 105- to 248-fold slower than in the soils. The water-holding capacities of fly ashes at "field capacity" were three times higher than those of the soils. Extractable P in the fly ashes (except Tarong and Callide) were 20- to 88-fold higher than in the soils. The pH showed considerable variation among the different sources of fly ash, with samples from Muja being the most acidic (pH=3.8; 1:5 in CaCl₂ extract) and from Gladstone the most alkaline (pH=9.9). The toxicity characteristic leaching procedure (TCLP) values indicate that the potential for release of trace elements from the fly ashes was well below regulatory levels. When applied at sufficient rates (e.g., to achieve 10% w/w in surface layers) to sandy soils, fly ash altered texture and increased water-holding capacity. Depending on the source of fly ash used, such amendments could also provide P and aid nutrient retention by increasing the phosphorus retention index (PRI) and/or cation exchange capacity (CEC). The considerable variability in physical and chemical properties among the fly ash samples evaluated in the present study supports the notion that field trials are essential to the future development of soil amendment strategies making use of any particular source of fly ash. Reproduced with permission from the CAB Abstracts database.

430. Properties of Urbic Anthrosols from an abandoned shunting yard in the Ruhr area, Germany.

Hiller, D. A. 39(4): 245-266. (2000); ISSN: 03418162 [CIJPD].

Notes: doi: 10.1016/S0341-8162(00)00081-3.

Descriptors: Classification/ Magnetic susceptibility/ Revegetation/ Soil quality/ Urban environment/ abandoned land/ growth/ nutrient cycling/ plant/ railway/ soil property/ Germany

Abstract: The soil conditions of an abandoned shunting yard in the Ruhr area were studied to find the most important factors influencing plant growth and nutrient cycling. The chemical and physical conditions of five Urbic Anthrosols with different development histories were compared with those of a nearby Calcic Cambisol under agricultural use. In the second half of the 19th century, the ground level of the shunting yard site was raised about 2 m. The soils are now mainly Regosols, mostly well drained in the topsoil. The coarse material contents (> 2 mm), which are up to 100% in base layers of railway tracks, and the quality of the man-made substrates (crushed rock, slags, ashes, coke) are the most important factors influencing plant growth. Poor physical structure and low contents of fine fraction (< 2 mm) lead to low water storage. Together with a low available nutrient stock, these properties lead to poor establishment of vegetation. The burning of coal by steam engines produced highly polluted ashes that fill pore spaces in the railway ballast layers. All the investigated fine substrata of the shunting yard layers exhibit a higher magnetic susceptibility than the rural soil. The ashes still contain unburned coal so that, although the total organic C content of the man-made soils reaches 37%, the wide C:N ratio does not indicate the actual quality of humic substances. The acid neutralization potential of the topsoil layers of the shunting yard will be consumed by acidic atmospheric deposition within a few decades, whereas in the surrounding Calcic Cambisols, it will take more than a thousand years. This may cause further problems of groundwater quality, as the heavy metals will become more soluble. The low soil quality makes such sites suitable for vegetation species that cannot compete in the surrounding very eutrophic agricultural landscape. (C) 2000 Elsevier Science B.V.

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431. Quality assessment of compost prepared from fly ash and crop residue.

Gaind, S. and Gaur, A. C.

Bioresource Technology 87(1): 125-127. (Mar. 2003) NAL Call #: TD930.A32 ; ISSN: 0960-8524 [BIRTEB]

Descriptors: composts / composting

Abstract: Fly ash was co-composted with wheat straw and 2% rock phosphate (w/w) for 90 days and different chemical and microbiological parameters monitored to evaluate its effect on the composting process. Fly ash addition at 20% level resulted in the lowest C/N of 16.4:1 and highest available and total phosphorus. Increasing the addition of fly ash from 40 to 60% (w/w) did not exert any detrimental effect on either C:N or the microbial population. This citation is from AGRICOLA.

432. Quality characteristics of some grass species cultivated on fly ash deposits of a thermal power station.

Maksimovic, S.; Blagojevic, S.; Pivic, R.; and Stanojkovic, A. 17(5): 584-588. (2008); ISSN: 10184619 [FENBE]

Descriptors: Deposits / Fly ash/ Grass/ Macroelements/ Thermal power station/ Trace elements

Abstract: This paper presents data on the content of macronutrients and trace elements in different grass species cultivated for the purpose of forming a grass cover on fly-ash deposits of a thermal power station in Serbia. The purpose of this grass cover is the fixation of the so-called "fly ash" and reduction of environmental pollution.

The thermal power station is situated near Belgrade, and its fly-ash deposits cover a large area (about 400 ha). The chemical composition of fly-ash on these deposits was rather heterogeneous: it had rather different pH values, concentrations of organic matter, as well as different contents of macro- and microelements. The total nitrogen and available phosphorus concentrations in fly-ash were low, that of available Ca and Mg - medium, those of available potassium and some microelements (Fe, Mn and Zn) - elevated, while the total contents of some toxic elements (As, Hg and Ni) were rather high, or even higher than the admissible levels for agricultural soils. In the cultivated grass species, the concentrations of macroelements (N, P, K, Ca and Mg) were favourable, with the expected differences for different species and locations. The concentrations of micronutrients were at normal levels for the cultivated grass species. The same also refers to potentially toxic trace elements, with individual minor increases (above the usual natural levels) for As and Ni. _ by PSP.

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433. Reclamation of spoil and refuse material produced by coal mining using bottom ash and lime.

Tedesco, M. J.; Teixeira, E. C.; Medina, C.; and Bugin, A. 20(5): 523-529. (1999); ISSN: 09593330 [ENVTE]

Descriptors: Heavy metals/ Plants/ Soil/ cadmium/ calcium oxide/ chromium/ lead/ nickel/ sulfur/ coal mining/ land reclamation/ liming/ soil remediation/ spoil heap/ acidity/ ash/ Brazil/ coal mining/ land use/ nonhuman/ oxidation/ plant growth/ waste management

Abstract: Brazil's coal production is about five million tonnes per year, mostly on open mining operations. Mined land reclamation is difficult due to the high acidity generated by the sulphur compounds' oxidation. In order to evaluate the feasibility to use bottom ash and lime for land reclamation of coal mining and processing refuse deposit areas, a field experiment was carried out in a coal waste dumping area over 20 m deep, that was previously leveled off, located on the Butia County Recreio mine, in Rio Grande do Sul state, Brazil in 1992 and 1993. Trenches 10 m width and 50 m length were dug in the coal refuse and filled with bottom ash covered with a layer of soil of different depths. Several summer and winter plant species were grown on 10 x 10 m subplots. A minimum of 0.1 m soil layer over 0.2 m bottom ash with proper liming and fertilization was required to promote plant growth. Low soil pH due to sulphur compounds' oxidation was the most limiting factor for plant growth. Heavy metals Cr, Cd, Ni and Pb concentrations in the plants' shoots were in the range usually determined for plants grown on uncontaminated soils.

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434. Recycling of fly ash in the consolidation of clay soils.

Temimi, M.; Rahal, M. A.; Yahiaoui, M.; and Jauberthie, R. *Resources, Conservation and Recycling* 24(1): 1-6. (1998)

NAL Call #: TP156.R38R47; ISSN: 0921-3449

Descriptors: clay/ clay soils/ coal/ compressibility/ disposal/ economics/ fly ash/ incorporation/ mechanical properties/ properties/ recycling/ soil/ soil amendments/ soil mechanics/ wastes/ engineering properties of soil/ mechanical properties of soil

Abstract: The use of fly ash in the consolidation of clays was shown to have a double advantage: (i) it is a economical way to consolidate soils; and (ii) it contributes to reduce disposal and environmental problems. The incorporation of fly ash in the clay material has a beneficial action on mechanical properties of the clay, such as the compressibility and the consolidation. Reproduced with permission from the CAB Abstracts database.

435. Reduced leaching of nitrate, ammonium, and phosphorus in a sandy soil by fly ash amendment.

Pathan, S. M.; Aylmore, L. A. G.; and Colmer, T. D. *Australian Journal of Soil Research* 40(7): 1201-1211. (2002)

NAL Call #: 56.8 Au7; ISSN: 0004-9573

Descriptors: ammonium / application rates/ desorption/ fly ash/ hydraulic conductivity/ leaching/ nitrate/ nutrients/ phosphorus/ sandy soils/ soil amendments/ soil types/ sorption

Abstract: Low ionic sorption capacities and high hydraulic conductivities of sandy soils contribute to the potential for leaching of nutrients applied to these soils. Batch sorption experiments were used to examine NO₃⁻, NH₄⁺, and P sorption/desorption isotherms for Karrakatta sand and Kwinana fly ash from Kwinana Power Station in Western Australia. Column experiments assessed leaching of these nutrients from this sandy soil, when amended with 4 rates (0, 5, 10, and 20%, wt/wt) of fly ash. The sorption of NO₃⁻, NH₄⁺, and P was higher for fly ash than the sandy soil. Phosphorus sorption was greatest for unweathered fly ash, followed by weathered fly ash and then the soil; for example, sorption from a solution containing 20 mg/litre P was 90, 28, and 14%, respectively. Desorption of P was much slower in the unweathered fly ash than weathered fly ash or the soil. Leachates collected from columns containing fly ash amended soil (5, 10, and 20%, wt/wt) generally had lower concentrations of NO₃⁻ and NH₄⁺ than leachates from non-amended soil. Prior to adding fertilizer, the concentration of P was greater in leachate from fly ash amended soil than from the native soil, due to fly ash (weathered) itself containing 92.5 mg/kg of extractable P. However, from day 35 onwards, the concentration of P was lower in leachates from soil amended with 10 or 20% fly ash than from non-amended soil. Thus, fly ash amendment retarded NO₃⁻, NH₄⁺, and P leaching in the sandy soil and may therefore be a useful tool for improvement of nutrient management in sandy soils.

Reproduced with permission from the CAB Abstracts database.

436. Reducing phosphorus release from paddy soil by coal ash and phospho-gypsum mixture.

Lee, C. H.; Lee, Y. B.; Lee, H.; Ha, B. Y.; and Kim, P. J. *Korean Journal of Environmental Agriculture* 24(1): 12-16. (Mar. 2005); ISSN: 1225-3537.

Notes: Summary(En). Citation Notes: KR (Korea-Republic-of).

Descriptors: phosphorus/ rice paddy/ soils/ coal ash/ phospho-gypsum

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437. Reducing phosphorus release from paddy soils by a fly ash-gypsum mixture.

Lee, C. H.; Lee, Y. B.; Lee, H.; and Kim, P. J. *Bioresource Technology* 98(10): 1980-1984. (July 2007)
 NAL Call #: TD930.A32; ISSN: 0960-8524
Descriptors: phosphorus/ rice paddy/ soils/ fly ash/ gypsum
Abstract: A mixture of fly ash and phospho-gypsum (50:50, wt wt-1) was selected to study its potential to supply Ca and Si to rice while reducing B toxicity. We expected that the high Ca content in this mixture might convert water-soluble P to less soluble forms and thereby reduce the loss of soil P to surface runoff. The mixture was applied at rates of 0, 20, 40, and 60 Mg ha⁻¹ in two paddy soils of contrasting textures (silt loam in Yehari and loamy sand in Daegok). The mixture significantly reduced water-soluble phosphate (W-P) in the surface soils by shifting from W-P and iron bound-P (Fe-P) to calcium bound-P (Ca-P) and aluminum bound-P (Al-P) during rice cultivation in both soils. Lancaster and Mehlich 3 extractable P increased significantly with application rate due to high contents of P and Si in the mixture. Mixtures of fly ash and phospho-gypsum should reduce P loss from rice paddy soils and increase soil fertility.

This citation is from AGRICOLA.

438. Reducing soil phosphorus solubility with coal combustion by-products.

Stout, W. L.; Sharpley, A. N.; and Pionke, H. B. *Journal of Environmental Quality* 27(1): 111-118. (1998)
 NAL Call #: QH540.J6; ISSN: 0047-2425
Descriptors: byproducts/ coal/ combustion/ desulfurization/ fluidized bed wastes/ fly ash/ liming materials/ phosphorus/ shale soils/ soil/ solubility/ desulphurization/ United States of America
Abstract: In NE USA, most soil samples analysed for soil test P (STP) in 1990 exceeded P levels needed for plant production. Converting soil P to less soluble forms with applications of materials containing lime or Ca may reduce the release of soil P to runoff. The effect of several coal combustion byproducts on STP (Bray-1 and Mehlich-III), water extractable P, and equilibrium P concentration (EPC₀) of high P soils was investigated in a soil from Pennsylvania, USA. The byproducts used were: fluidized bed combustion fly ash (FBC), flue gas desulfurization byproduct (FGD), and pulverized coal fly ash (PC). In a byproduct type and rate experiment, a shale soil with high STP was incubated for 21 d with each byproduct (0, 10, 20, 40, and 80 g kg/soil). The highest rates of FBC and FGD reduced Mehlich-III P (45%), Bray-I P (50%), water extractable P (72%) and EPC₀ (37%). The PC had no effect on soil P solubility due to the addition of P with this byproduct. For eight soils ranging in physical and chemical properties, FBC at 10 g/kg soil reduced Mehlich-III P 13%, and water-extractable P 71%, while FGD reduced Mehlich-III P 8% and water-extractable P 48%. These reductions resulted from the conversion of readily desorbable soil P to less soluble Ca-bound or Al- and Fe-bound pools. Amending high P soils with FBC or FGD byproducts can reduce P enrichment of runoff by decreasing the solubility of soil P without reducing STP below optimum levels for plant growth.

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439. Reduction of Pb, Zn and Cd availability from tailings and contaminated soils by the application of lignite fly ash.

Stouraiti, C.; Xenidis, A.; and Paspaliaris, I. *Water, Air and Soil Pollution* 137(1/4): 247-265. (2002)
 NAL Call #: TD172 .W36; ISSN: 0049-6979
Descriptors: bioavailability/ bioremediation/ cadmium/ chemical speciation/ fly ash/ hydroxides/ lead/ lignite/ mine tailings/ oxides/ polluted soils/ soil ph/ soil pollution/ soil toxicity/ sorption/ stabilization/ zinc/ toxic soils
Abstract: The effectiveness of lignite fly ash for stabilization of Pb, Zn and Cd in tailings and contaminated soils was examined. Fly ash was mixed with the contaminated soil or oxidic tailings samples at various doses and pot experiments were performed. The effectiveness of stabilization was mainly evaluated by the standard US EPA TCLP toxicity test. The 5-stage sequential extraction procedure was also applied to determine the form of contaminants in the fly ash amended soil or tailings samples. Complementary EDTA extraction tests were also carried out. The fly ash treatment resulted in the reduction of TCLP solubility of Pb, Zn and Cd to below the respective regulatory limits at 5 and 10% w/w fly ash addition rates in tailings and soil, respectively. Speciation of lead, in the treated soil and tailings samples indicated that there was a significant transition of the heavy metals form from the exchangeable and carbonate fractions to reducible and residual, suggesting that the potential mechanisms of heavy metals retention are, apart from increase of pH, sorption on the oxides and hydroxides surfaces and binding with the hydrated fly ash compounds.
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440. Rehabilitation of red mud ponds at Indal, Belgaum (Karnataka).

Sharma, J. V.; Lhouvum, G.; Suresh Chauhan; Banwari Lal; Singh, T. P.; and Varghese Paul *Indian Forester* 130(5): 481-497. (2004); ISSN: 0019-4816
Descriptors: bauxite/ bauxite residues/ clay minerals/ farmyard manure/ fly ash/ gypsum/ mud/ multipurpose trees/ mycorrhizal fungi/ mycorrhizas/ nonclay minerals/ ponds/ rehabilitation/ revegetation/ soil amendments/ trees/ woody plants/ FYM/ Mysore
Abstract: Bauxite residue, also known as red mud, is a by-product of the Bayer Process. Bauxite is composed principally of the monohydrate and trihydrate forms of alumina in varying proportions. The research study was conducted to rehabilitate used red mud ponds of INDAL (Indian Aluminium Company Ltd.), Belgaum, Karnataka, India, by identifying suitable trees, grasses, and legume species as well as amenders, including bacteria and mycorrhizae, to improve the physico-chemical condition of red mud deposits and convert it to a substrate. Amenders such as gypsum, FYM (farmyard manure), fly ash/vegetative dust in different proportions, forming three basic combinations, A, B, and C, were developed. These three combinations were then treated with the bacteria and mycorrhizae both alone, and in combination, to form twelve treatments and one control. The research study showed that there is remarkable change in the physical and chemical properties of red mud after amendment, which provides the platform for plantation growth. The best

combination found for treating red mud ponds was: Red mud+20% FYM+10% Gypsum+15% Fly ash+Bacteria+Mycorrhizae for four tree species, *Prosopis juliflora*, *Acacia nilotica*, *Pangamia pinnata* and *Melia azedarach*, and three grass/legume species *Brachiaria mutica*, *Chloris gayana*, and *Sesbania sesban*.
Reproduced with permission from the CAB Abstracts database.

441. Relationship of chemical fractions of heavy metals with microbial and enzyme activities in sludge and ash amended acid lateritic soil from India.

Chaudhuri, D.; Tripathy, S.; Veeresh, H.; Powell, M. A.; and Hart, B. R.

Environmental Geology 45(1): 115-123. (2003)

NAL Call #: QE1.E5; ISSN: 0943-0105

Descriptors: acid soils/ cadmium/ chromium/ copper/ enzyme activity/ fly ash/ heavy metals/ lateritic soils/ lead/ microbial activities/ nickel/ organic carbon/ sewage sludge/ soil amendments/ soil enzymes/ soil types/ zinc/ microbial biomass

Abstract: The influence of metals, Cd, Cr, Cu, Ni, Pb and Zn, on the microbial biomass and enzyme activities of an amended acid lateritic soil were investigated under field conditions receiving a one-time application of 52 t ha⁻¹ of sludge, coal ash and their mixtures at 1:3, 1:1 and 3:1 proportions, and including control and chemical fertilizer treatment at crop-specific recommended doses. Paddies and groundnuts were grown in the experimental plots and soil was sampled twice after 6 months and 1 year after amendment application. The heavy metals in the soil were fractionated using sequential extraction and the increments in their concentrations in amended soil with respect to the control were determined. Concentrations of Cd, Ni and Zn were determined to have increased in their mobile fractions and were more pronounced in soil collected during the second sampling, which was associated with a decrease in soil organic carbon. The size of the microbial biomass carbon and the soil enzyme activities increased with the addition of an amendment and was highest at equal proportions of coal ash and sludge. Further increase in the proportion of sludge resulted in a significant decrease in biomass carbon. Simple correlation revealed significant and strong negative relations of mobile fractions of Cd and Ni with the ratio between microbial biomass C and organic carbon in soil, while the organic carbon content and the pH were positively correlated. The microbial activities were determined to be sensitive to the concentrations of some heavy metals in mobile fractions and therefore indicated possibilities of being useful as indicators for evaluation of toxic effects of sludge-borne metals on soil organisms.
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442. Relationship of ryegrass growth to extractable phosphorus in acidic soil amended with phosphate rock, coal combustion by product, limestone, and cellulose.

He, Z. L.; Baligar, V. C.; Martens, D. C.; Ritchey, K. D.; and Elrashidi, M. A.

Communications in Soil Science and Plant Analysis 30(3/4): 457-470. (1999)

NAL Call #: S590.C63; ISSN: 0010-3624

Descriptors: acid soils/ application/ cellulose/ coal/ fly ash/ growth/ magnesian limestone/ phosphorus/ rock phosphate/ soil/ soil test values/ magnesium limestone/ phosphate rock

Abstract: Laboratory analyses and greenhouse experiments were conducted to evaluate effects of phosphate rock (PR), coal combustion byproduct (BP), limestone, and cellulose application on the relationship between soil test P and crop growth in acidic soil.

Application of PR, BP, limestone, and cellulose increased soil pH, exchangeable calcium and magnesium, and extractable P, and decreased free aluminium ion in the acid soil. Addition of BP or limestone increased P availability efficiency [PAE, mg dry matter yield (DMY) of plant per mg soil extractable P by Olsen-P procedure] and P utilization efficiency (PUE, mg DMY of plant per mg P in the plant). There was significant positive correlation between the PAE and BP rates applied alone ($r^2 = 0.979$, $P < 0.01$) or with either PR ($r^2 = 0.972$, $P < 0.01$) or PR plus cellulose ($r^2 = 0.985$, $P < 0.01$). The PUE of ryegrass [*Lolium perenne*] was significantly correlated with BP rates alone ($r^2 = 0.957$, $P < 0.01$) or with either PR ($r^2 = 0.906$, $P < 0.01$) or PR plus limestone ($r^2 = 0.699$). The increase in PAE and PUE of ryegrass caused by BP and limestone reflected more plant root growth from increased availability of Ca and Mg and higher soil pH.

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443. Residue-management practices using fly ash and various crop residues for productivity of rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system under limited moisture conditions.

Dileep Kachroo and Dixit, A. K.

Indian Journal of Agronomy 50(4): 249-252. (2005)

NAL Call #: 22 IN235; ISSN: 0537-197X

Descriptors: application rates/ crop production/ crop residues/ crop yield/ cropping systems/ fly ash/ microbial flora/ nutrient uptake/ nutrients/ physicochemical properties/ productivity/ rice/ soil chemical properties/ soil physical properties/ soil water/ stubble/ wheat/ chemical properties of soil/ Hyphomycetes/ Kashmir/ microbial communities/ microflora/ paddy/ physical properties of soil/ soil moisture

Abstract: A field experiment was conducted at the Sher-e-Kashmir University of Agricultural Sciences and Technology, R.S. Pura, Jammu, India, during 2001-03, to evaluate the effect of fly ash and residue incorporation on the productivity and soil health in rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system under limited moisture conditions. Incorporation of residues of rice in wheat and wheat in rice not only increased the yield and yield components of rice and wheat but also increased the nutrient uptake besides improving the physico-chemical and biological properties of the soil which provide better soil environment for growth. Alternatively, the incorporation of fly ash and left-over stubbles of previous crops as residues were found equally effective in increasing the productivity and soil environment in rice-wheat cropping system. For quick and better decomposition the application of *Trichoderma viride* + 20 kg N/ha as starter dose influenced the yield, available nutrients, microbial population and physical properties of the soil significantly compared with no starter dose application.

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444. Response of mustard cultivars when grown in soil amended with fly ash under conditions of induced drought.

Singh, S. and Khan, N. A.

Tests of Agrochemicals and Cultivars 24: 14-15. (2003)

NAL Call #: S587.T47; ISSN: 0951-4309

Descriptors: application rates/ cultivars/ drought/ fly ash/ growth/ Indian mustard/ leaf area/ plant height/ soil amendments/ stress/ stress response/ water stress/ Capparales/ cultivated varieties

Abstract: An experiment was conducted to investigate the effects of fly ash on the growth of Indian mustard (*Brassica juncea* cultivars Alankar, PBM16, Varuna, Pusa Barauni and Pusa Bahar) seeds sown in clay pots under induced drought conditions. Treatments comprised: fly ash mixed with soil in 0, 20, 40, 60 and 80% proportion (w/w), and kept in a greenhouse under natural light (mean 23 degrees C). Two mustard plants per pot for each cultivar and two sets of pots were maintained; one was continuously irrigated and in another, water was withheld for 20 days from 55 days after sowing, to induce drought. Fly ash treatment significantly reduced plant growth under both normal and induced drought conditions. Under 20% fly ash-amended soil, both plant height and leaf area increased compared to their respective controls. Soil nutrient deficiencies were supplemented by the addition of fly ash to the soil. The addition of fly ash at 80% concentration reduced the growth in all cultivars under both normal and induced drought conditions. To avoid the risk of accumulating toxic substances, fly ash at 20% concentration should not be used more than once every three years, whether grown under irrigated or rainfed conditions.

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445. Response of pearl millet (*Pennisetum glaucum*) to fly ash clay and nitrogen levels in loamy sand soil.

Mani Ram; Balai, C. M.; Kumawat, B. L.; and Majumdar, S. P.

Indian Journal of Agricultural Sciences 74(2): 95-97. (2004)

NAL Call #: 22 AG831; ISSN: 0019-5022

Descriptors: application rates/ clay/ crop yield/ fly ash/ millets/ nitrogen fertilizers/ pearl millet/ returns/ sandy loam soils/ seed weight/ soil types/ stover/ tillers/ yield components/ bulrush millet

Abstract: A field experiment was conducted during the rainy seasons of 1999 and 2000 at a research farm of Jobner, Rajasthan, India, to study the effect of fly ash, clay mixing and nitrogen application on pearl millet (*P. glaucum*). Increasing levels of both fly ash and clay up to 4% significantly enhanced the effective tillers per metre row length, 1000-grain weight, grain and stover yields of pearl millet. The yield attributes (effective tillers and 1000-grain weight) and grain and stover yields of pearl millet increased significantly up to 90 kg N/ha. The combined application of 4% clay+60 kg N/ha recorded significantly higher values of effective tillers, grain and stover yields over other combinations of clay and N. The 2% clay and 60 kg N/ha recorded the significantly highest net returns of Rs 6284 and Rs 7391/ha, respectively.

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446. Restoration of drastically eroded land using coal fly ash and poultry biosolid.

Punshon, T.; Adriano, D. C.; and Weber, J. T.

Science of the Total Environment 296(1/3): 209-225. (2002)

NAL Call #: RA565.S365; ISSN: 0048-9697

Descriptors: application rates/ arsenic/ biomass/ biomass production/ boron/ bulk density/ calcium/ chemical composition/ electrical conductivity/ eroded soils/ erosion/ erosion control/ fly ash / groundwater/ magnesium/ manganese/ nutrient content/ pH/ phosphorus/ plant composition/ plant nutrition/ potassium/ poultry manure/ selenium/ sewage sludge/ soil amendments/ soil density/ soil organic matter/ soil pH/ soil salinity/ soil types/ trace elements/ water holding capacity/ water quality / chemical constituents of plants/ eroded sites/ hydrogen ion concentration/ microelements/ Mn/ organic matter in soil/ *Panicum amarum*/ potential of hydrogen/ poultry litter/ soil quality/ United States of America/ water composition and quality

Abstract: A 3-year field study was conducted at a 12 ha soil-borrow area adjacent to the Columbia Metropolitan Airport, South Carolina to investigate the restorative effects of co-application of coal fly ash (FA) and a poultry biosolid (PB). FA was applied at 0, 22, 280, 560 and 1120 Mg (tonne) ha⁻¹, and PB at 5 and 10 Mg ha⁻¹. The area was seeded with erosion-control species Atlantic Coastal panic grass (*Panicum amarum* var *amarum* L.), sericea (*Lespedeza cuneata* var. *appalaw* [Dumont] G. Don.) and weeping love grass (*Eragrostis curvula* Wolf.). Plant biomass and elemental composition were analyzed in sequential harvests. Soil and groundwater quality characteristics including pH, EC and elemental composition were also monitored throughout the study. In addition, the effect of amendments on the water holding capacity and bulk density of the soil was investigated. Amendment addition significantly increased plant biomass production by a maximum of 26% using 1120 Mg ha⁻¹ FA and 10 Mg ha⁻¹ PB. Application of the highest rate of FA significantly increased the plant tissue concentrations of Mn, As, Se and B. Soil pH was initially increased from 4.6 to 6.1 by amendments. Soil salinity was increased in the initial year only. Amended soils had higher concentrations of Ca, Mg, P and K, higher organic matter content and water holding capacity than unamended soil. Concentrations of plant-essential trace elements (B, Cu and Zn) that were marginally deficient in the unamended eroded soil increased to within typical soil concentrations following amendment with FA and PB. Groundwater quality was unaffected throughout the study. The co-application of FA and PB successfully promoted the revegetation of the eroded borrow area with no apparent adverse environmental side effects.

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447. Results from field trials the use of coal combustion wastes for soil remediation in Orissa, India.

Hart, Brian; Powell, Michael; Fyfe, W. S.; and Tripathy, S. In: Geological Society of America, 1998 Annual Meeting. Toronto, ON, Canada.; Vol. 30 (7).; pp. 341-342; 1998.

Notes: Abstracts with Programs: Geological Society of America.

Descriptors: ash/ Asia/ biomass/ bulk density/ cation exchange capacity/ combustion/ copper/ degradation/ field studies/ forests/ India/ Indian Peninsula/ metals/ nitrogen/ nutrients/ Orissa India/ pH/ remediation/ sewage sludge/ soils/ waste disposal/ water/ zinc/ environmental geology
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448. Revegetating fly ash landfills with *Prosopis juliflora* L.: Impact of different amendments and *Rhizobium* inoculation.

Rai, U. N.; Pandey, K.; Sinha, S.; Singh, A.; Saxena, R.; and Gupta, D. K.

Environment International 30(3): 293-300. (2004)

NAL Call #: TD169 .E54; ISSN: 0160-4120

Descriptors: bioavailability/ biomass/ carotenoids/ chemical composition/ chlorophyll/ chromium/ copper/ enzyme activity/ farmyard manure/ filter cake/ fly ash/ growth/ inoculation/ iron/ landfills/ leaves/ manganese/ nitrate reductase/ nitrogen fixation/ nitrogen fixing trees/ nodulation/ nutrient availability/ organic amendments/ phosphorus/ photosynthesis/ phytoremediation/ plant composition/ plant pigments/ polluted soils/ protein content/ revegetation/ root nodules/ soil pollution/ soil types/ stress/ stress response/ sugar factory waste/ tolerance/ trees/ uptake/ woody plants/ zinc/ biofertilizers/ carbon assimilation/ carbon dioxide fixation/ chemical constituents of plants/ clarification mud/ FYM/ Mn/ sugar factory effluent/ tetraterpenoids

Abstract: A revegetation trial was conducted to evaluate the feasibility of growing a legume species, *Prosopis juliflora* L., on fly ash ameliorated with combination of various organic amendments, blue-green algal biofertilizer and *Rhizobium* inoculation. Significant enhancements in plant biomass, photosynthetic pigments, protein content and in vivo nitrate reductase activity were found in the plants grown on ameliorated fly ash in comparison to the plants growing in unamended fly ash or garden soil. Higher growth was obtained in fly ash amended with blue-green algae (BGA) than farmyard manure or press mud (PM), a waste from sugar-processing industry, due to the greater contribution of plant nutrients, supply of fixed nitrogen and increased availability of phosphorus. Nodulation was suppressed in different amendments of fly ash with soil in a concentration-duration-dependent manner, but not with other amendments. Plants accumulated higher amounts of Fe, Mn, Cu, Zn and Cr in various fly ash amendments than in garden soil. Further, inoculation of the plant with a fly ash tolerant *Rhizobium* strain conferred tolerance for the plant to grow under fly ash stress conditions with more translocation of metals to the above ground parts. The results showed the potential of *P. juliflora* to grow in plantations on fly ash landfills and to reduce the metal contents of fly ash by bioaccumulation in its tissues. Reproduced with permission from the CAB Abstracts database.

449. Revegetation of waste fly ash landfills in a semiarid environment.

Pierzynski, G. M.; Heitman, J. L.; Kulakow, P. A.; Kluitenberg, G. J.; and Carlson, J.

Journal of Range Management 57(3): 312-319. (May 2004); ISSN: 0022-409X.

Notes: Summary in Spanish.

Descriptors: land restoration/ landfills/ fly ash/ semiarid zones/ electric power/ industrial byproducts/ soil salinity/

salt tolerance/ endemic species/ *Sporobolus airoides*/ *Bouteloua gracilis*/ *Sorghum bicolor*/ *Andropogon hallii*/ *Bouteloua curtipendula*/ soil chemical properties/ electrical conductivity/ ground cover plants/ conservation plants/ soil amendments/ animal manures/ available water capacity/ seed germination/ biomass/ height/ soil water content/ soil depth/ Kansas

Abstract: This study investigated vegetation strategies for a fly ash landfill in a semi-arid environment. Ten plant species adapted to the local climate were initially evaluated for their germination characteristics in various mixtures of Tivoli fine sand, fly ash, and cattle manure. Alkali sacaton (native, *Sporobolus airoides* (Torr.) Torr.), blue grama (native, *Bouteloua gracilis* (H.B.K.) Lag. Ex Griffiths), a forage sorghum (variety Canex, *Sorghum bicolor* (L.) Moench), sand bluestem (variety Woodward, *Andropogon hallii* Hack.), and sideoats grama (variety El Reno, *Bouteloua curtipendula* (Michx.) Torr.) were selected for further evaluation. Concurrently, mixtures were evaluated to determine the effects of the soil amendments on soil saturated paste electrical conductivity (EC) and pH. The addition of even 50 g kg⁻¹ fly ash increased EC values above 4.0 dS m⁻¹, indicating salt tolerant species may be needed. Six mixtures were selected for use in a greenhouse study and for further study of moisture retention characteristics. Using an X/Y format, where X is fly ash content and Y is manure content (g kg⁻¹) and the balance of the mixture was Tivoli fine sand, those mixtures were 0/0, 200/0, 200/100, 200/200, 100/100, and 300/100. The addition of manure provided ample quantities of plant nutrients. Alkali sacaton was the only plant species not adversely affected by the addition of fly ash. For biomass production, height, vigor and leaf tip burn, all remaining species had significantly better growth or ratings with 0/0 as compared to any other mixture. Soil moisture retention characteristics of the Tivoli fine sand can be significantly changed through amendment with fly ash or manure. Sixty cm of Tivoli sand was estimated to have the same available water holding capacity as 45 cm of 200/0, 39 cm of 200/100, 34 cm of 200/200, 47 cm of 100/100, and 33 cm of 300/100.

This citation is from AGRICOLA.

450. Role of blue green algae biofertilizer in ameliorating the nitrogen demand and fly ash stress to the growth and yield of rice (*Oryza sativa* L.) plants.

Tripathi, R. D.; Dwivedi, S.; Shukla, M. K.; Mishra, S.; Srivastava, S.; Singh, R.; Rai, U. N.; and Gupta, D. K.

Chemosphere 70(10): 1919-1929. (2008)

NAL Call #: TD172 .C54; ISSN: 0045-6535

Descriptors: application rates/ arsenic/ cadmium/ copper/ crop yield/ cysteine/ fly ash/ grain/ growth/ iron/ leaves/ manganese/ nickel/ nitrogen/ nitrogen fertilizers/ nutrient content/ nutrient requirements/ phytotoxicity/ plant nutrition/ rice/ rice husks/ roots/ silicon/ soil amendments/ soil inoculation/ stress/ stress response/ thiols/ zinc/ dietary standards/ food requirements/ mercaptans/ Mn/ nutritional requirements/ paddy/ rice hulls

Abstract: Rice is a major food crop throughout the world; however, accumulation of toxic metals and metalloids in grains in contaminated environments is a matter of growing concern. Field experiments were conducted to analyze the growth performance, elemental composition (Fe, Si, Zn, Mn, Cu, Ni, Cd and As) and yield of the rice plants (*Oryza sativa* L. cv. Saryu-52) grown under different doses of fly-

ash (FA; applied @ 10 and 100 t ha⁻¹ denoted as FA₁₀ and FA₁₀₀, respectively) mixed with garden soil (GS) in combination with nitrogen fertilizer (NF; applied @ 90 and 120 kg ha⁻¹ denoted as NF₉₀ and NF₁₂₀, respectively) and blue green algae biofertilizer (BGA; applied @ 12.5 kg ha⁻¹ denoted as BGA_{12.5}). Significant enhancement of growth was observed in the plants growing on amended soils as compared to GS and best response was obtained in amendment of FA₁₀+NF₉₀+BGA_{12.5}. Accumulation of Si, Fe, Zn and Mn was higher than Cu, Cd, Ni and As. Arsenic accumulation was detected only in FA₁₀₀ and its amendments. Inoculation of BGA_{12.5} caused slight reduction in Cd, Ni and As content of plants as compared to NF₁₂₀ amendment. The high levels of stress inducible non-protein thiols (NP-SH) and cysteine in FA₁₀₀ were decreased by application of NF and BGA indicating stress amelioration. Study suggests integrated use of FA, BGA and NF for improved growth, yield and mineral composition of the rice plants besides reducing the high demand of nitrogen fertilizers.

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451. Role of CFRI's fly ash soil amendment technology (FASAT) in improving the socio-economic condition of farmers or a improvement in soil fertility and crop productivity.

Srivastava, N. K.; Ram, L. C.; Jha, S. K.; Tripathi, R. C.; and Singh, G. 3(1-2): 127-142. (2003); ISSN: 09724397 [JEOHA]

Descriptors: Environmental Concerns/ Fly Ash/ Soil Amendment/ Solid Waste Management/ Wasteland Reclamation / coal/ fertilizer/ heavy metal/ agriculture/ biotechnology/ Brassica/ climate/ combustion / cotton/ crop/ crop production/ environmental reclamation/ fly ash/ forestry/ fruit growing/ harvest/ India/ landfill/ linseed/ maize/ nonhuman/ peanut/ pond/ radioactivity/ review/ socioeconomics/ soil fertility/ soil treatment/ sugarcane/ wheat/ Arachis hypogaea/ Brassica/ Fraxinus/ Gossypium hirsutum/ Saccharum hybrid cultivar/ Triticum aestivum/ Zea mays

Abstract: During the combustion of coal in thermal power plants (TPPs), huge quantities of fly ash (ca. 100 million tons/annum) from existing 82 TPPs are being generated in India. Despite number of technologies developed/available in the country for bulk use of fly ash/pond ash in different areas, hardly 10-15% of the total fly ash/pond ash is being currently utilised mainly for brick/cement making, land fill etc., and the rest is unutilized. However, the potentialities of bulk use of fly ash in agriculture/forestry sector and for wasteland management has now been well established. In this direction, CFRI has been conducting large scale field demonstration studies on the bulk use of fly ash in agriculture/forestry sector and for wasteland/mine spoil management and bio-reclamation of abandoned ash ponds for the last ten years in different soil types and varied agro-climatic conditions on growth and yield of a variety of crops/forestry species in the vicinity of different TPPs such as Farakka and Bakreshwar TPPs (W. B.), Neyveli TPP (Tamil Nadu), Ramagundam STPP (A.P.), Chandrapur and Bhusawal TPPs (Maharashtra), Anpara, Obra and Harduaganj TPPs (U.P.) etc. Based on these experimentation, CFRI has developed fly ash soil amendment technology (FASAT) through which it is now

possible to use fly ash/pond ash in bulk quantities on sustainable basis for improving the various physico-chemical/biological properties of different agricultural lands/problematic soil/wasteland/mine spoil/abandoned ash pond and increasing the yield (20-60%) of different crops such as wheat, paddy, maize, sugarcane, groundnut, mustard, gram, arhar, cotton, linseed, vegetable crops as also in the growth and yield of different forestry/ornamental and fruit tree species to an appreciable extent. Significant residual effect of pond ash on the yield of succeeding crops at least for a period of six years without any adverse effect due to carry over/uptake of trace heavy metal/radioactivity has also been observed. The results of such investigations have been incorporated and discussed in the present paper. An appraisal has also been made on the possible bulk use of pond ash as soil amendment ranging from 25-200 t/ha; as a source and carrier of in situ plant nutrients; as a liming agent; as a fertiliser additive etc. The cost benefit ratio of pond ash application in agriculture is also discussed. Apart from this, CFRI has played an important role in popularising various beneficial effects of pond ash among the local farmers in the vicinity of different TPPs to improve the fertility status of their field soil and in significantly increasing the yield of various crops to a great extent through various extension programs; personal contacts, pamphlets, audio-visual aids, Kisan Mela/Gosthi etc, involving different concerned organisation. The farmers are now fully convinced of beneficial uses of pond ash and coming forward in utilising it in their fields. Thus in the course of adoption and use of FASAT, the farmers will be greatly benefited and subsequently their socio-economic condition and quality of life is also likely to be improved to a major extent.

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452. Role of soil amendments in improving groundnut productivity of acid lateritic soils.

Manisha Basu; Bhadoria, P. B. S.; and Mahapatra, S. C. *International Journal of Agricultural Research* 2(1): 87-91. (2007); ISSN: 1816-4897

Descriptors: crop yield/ farmyard manure/ fly ash/ green manures/ groundnuts/ lateritic soils/ nitrogen fertilizers/ NPK fertilizers/ phosphorus fertilizers/ potassium fertilizers/ soil amendments/ vermicompost/ FYM/ peanuts/ phosphate fertilizers/ potash fertilizers

Abstract: The present field experiment was conducted in sandy loam acid lateritic soil to study the effect of Fly Ash (FA), organic wastes like farmyard manure (FYM), vermicompost (VC) and green manure (*Sesbania rostrata*) (GM) and chemical fertilizers on growth and yield of groundnut during rainy season. A uniform fertilizer dose of 20:40:40 kg N:P:K ha⁻¹ was maintained through CF alone or through CF+organic wastes by supplementing 50% of N dose. Nine treatment combinations were tested under completely randomized block design. Application of organic wastes in combination with CF recorded better growth and yield as compared to sole application of CF. Among three organic sources of nutrients GM showed superior performance of the crop over FYM and VC. Integrated application of FA, organic wastes and chemical fertilizers increased the pod yield to the extent of 24.7% over sole application of CF.

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453. Root growth and metal uptake in four grasses grown on zinc-contaminated soils.

Palazzo, A. J.; Cary, T. J.; Hardy, S. E.; and Lee, C. R. *Journal of Environmental Quality* 32(3): 834-840. (2003)
NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: fly ash/ growth/ lime/ nutrient uptake/ plant nutrition/ polluted soils/ roots/ sewage sludge/ shoots/ soil amendments/ soil pollution/ soil types/ survival/ topsoil/ zinc/ *Festuca brevipila*/ *Festuca elatior*

Abstract: Depth and area of rooting are important to long-term survival of plants on metal-contaminated, steep-slope soils. We evaluated shoot and root growth and metal uptake of four cool-season grasses grown on a high-Zn soil in a greenhouse. A mixture of biosolids, fly ash, and burnt lime was placed either directly over a Zn-contaminated soil or over a clean, fine-grained topsoil and then the Zn-contaminated soil; the control was the clean topsoil. The grasses were 'Reliant' hard fescue (*Festuca brevipila* R. Tracey), 'Oahe' intermediate wheatgrass [*Elytrigia intermedia* (Host) Nevski subsp. *intermedia*], 'Ruebens' Canada bluegrass (*Poa compressa* L.), and 'K-31' tall fescue (*Festuca arundinacea* Schreb.). Root growth in the clean soil and biosolids corresponded to the characteristic rooting ability of each species, while rooting into the Zn-contaminated soil was related to the species' tolerance to Zn. While wheatgrass and tall fescue had the strongest root growth in the surface layers (0-5 cm) of clean soil or biosolids, wheatgrass roots were at least two times more dense than those of the other grasses in the second layer (5-27 cm) of Zn-contaminated soil. When grown over Zn-contaminated soil in the second layer, hard fescue (with 422 mg/kg Zn) was the only species not to have phytotoxic levels of Zn in shoots; tall fescue had the highest Zn uptake (1553 mg/kg). Thus, the best long-term survivors in high-Zn soils should be wheatgrass, due to its ability to root deeply into Zn-contaminated soils, and hard fescue, with its ability to effectively exclude toxic Zn uptake.

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454. Root growth and trace element uptake in acid soils treated with coal combustion by-products.

Wright, R. J.; Codling, E. E.; and Wright, S. F. *Chemosphere* 36(6): 1463-1474. (1998)

NAL Call #: TD172 .C54; ISSN: 0045-6535

Descriptors: acid soils/ fly ash/ growth/ industrial wastes/ mineral uptake/ plant nutrition/ roots/ scrubber sludge/ sludges/ soil amendments/ trace elements/ uptake/ waste utilization/ wheat/ microelements

Abstract: Root growth of wheat seedlings and trace element levels in ryegrass (*Lolium multiflorum*) were determined in acid soils treated with 1.25 to 80 g kg⁻¹ of eight coal combustion by-products: fly ash (FA), bed ash (BA), cyclone ash (CA), limestone injection residue (LIMB), spray drier residue (SD), scrubber sludge (CS), stabilized scrubber sludge (SS) and gypsum-like material (G). Low application rates of by-products did not inhibit wheat seedling root growth. FA and G did not limit root growth at any application rate while BA, LIMB, SD and CA inhibited root growth at high rates. Ryegrass concentrations of Cu, Zn, Ni, Pb, Cd and Cr were similar in treated and untreated soil. B, Se, As and Mo were increased in ryegrass grown in treated soil, but Se from FA treatments was the only potential food chain risk from a single application of these materials. It is suggested that the G material is the most

benign for land application because it improved root growth without producing elevated trace element levels in plant material or soil solution.

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455. Root penetration of sealing layers made of fly ash and sewage sludge.

Neuschutz, C.; Stoltz, E.; and Greger, M.

Journal of Environmental Quality 35(4): 1260-1268. (July 2006-Aug. 2006)

NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: root systems/ soil surface sealing/ fly ash/ sewage sludge/ soil penetration resistance/ resistance to penetration/ root growth/ plant growth/ plant stress/ *Betula pendula*/ *Pinus sylvestris*/ *Poa pratensis*/ *Salix viminalis*/ *Phalaris arundinacea*/ *Pisum sativum*/ soil ph/ phytotoxicity/ Internet resource

Abstract: Fly ash and sewage sludge are suggested materials for constructing sealing layers covering mine tailings impoundments. Little is known, however, of their effect on vegetation or resistance to root penetration. We investigate: (i) the ability of different plant species to grow in sealing layers comprising fly ash and sewage sludge, (ii) the impact on plant growth of freshly hardened fly ash compared to aged and leached ash, and (iii) the plant stress response to fly ashes of different properties. A 6-mo greenhouse study using birch (*Betula pendula* Roth.), Scots pine (*Pinus sylvestris* L.), Kentucky bluegrass (*Poa pratensis* L.), and willow (*Salix viminalis* L.) demonstrated that no roots could grow into a compacted layer consisting only of ash, while a 6:4, ash-sludge mixture admitted roots into the upper part and a 1:9, ash-sludge mixture was totally penetrated (to 15 cm in depth) by roots of willow and Scots pine. Freshly hardened ash prevented root growth more effectively than aged ash did, as was observed in tests using reed canarygrass (*Phalaris arundinacea* L.) and pea (*Pisum sativum* L.). Furthermore, extracts of highly alkaline ash were more toxic to pea in a 48-h toxicity test than less alkaline ash was. However, stress responses to diluted ash extracts of lower pH, measured as enzyme capacities in dwarf bean (*Phaseolus vulgaris* L.), were more related to the metal and ion contents. Root penetration of sealing layers is most effectively prevented if little sewage sludge is added, and if ash of high alkalinity is chosen. This citation is from AGRICOLA.

456. Seed germination and growth performance of *Acacia auriculiformis* and *Azadirachta indica* in response to different germination media of flyash.

Kashyap, M. K. and Gupta, R. K.

Vaniki Sandesh 25(2): 22-27. (2001); ISSN: 0972-5598

Descriptors: biomass/ fly ash/ growing media/ growth/ multipurpose trees/ sand/ seed germination/ trees/ woody plants/ neem/ potting composts/ rooting media

Reproduced with permission from the CAB Abstracts database.

457. Selection of suitable substrates for mass multiplication of *Glomus mosseae* and mixed VAM fungi isolated from coal mine overburden.

Chandra, K. K. and Jamaluddin

Biotechnology of Microbes and Sustainable Utilization: 232-238. (2002)

Descriptors: clay minerals/ coal mine spoil/ colonization/

culture media/ endomycorrhizas/ fly ash/ fungal spores/ mycorrhizal fungi/ mycorrhizas/ nutrients/ nutritional state/ polluted soils/ roots/ sand/ soil/ soil organic matter/ soil pollution/ soil types/ sporulation/ substrates/ vermiculite/ vesicular arbuscular mycorrhizas/ Acaulosporaceae/ arbuscular mycorrhizas/ colliery spoil/ Glomaceae/ nutritional status/ organic matter in soil

Abstract: This study was conducted to investigate the suitable substrates for mass multiplication of *Glomus mosseae* and mixed vesicular arbuscular mycorrhizas (VAM, such as *G. intraradices*, *G. mosseae* and *Acaulospora* sp.) isolated from coal mine overburden of Kusmunda, Korba, Madhya Pradesh, India. Different sterilized substrates including soilrite, mixed soilrite, vermiculite, overburden soil, fly ash and their combinations were used in various proportion to compare with the traditional substrate, i.e., sand:soil (1:1). Sand:soil:mixed soilrite (1:1:1) was found to be the best substrate for mass multiplication of both the inocula *G. mosseae* and mixed VAM fungi in *Panicum maximum* trap plants. This exhibited maximum percentage of root colonization and spore population. Mixed soilrite:sand:soil combination having low nutrients and organic matter supported inoculum production, phosphorus status in substrates have played a major role in multiplication of VAM fungi in *P. maximum*. Reproduced with permission from the CAB Abstracts database.

458. Short-term responses of two contrasting species of earthworms in an agricultural soil amended with coal fly-ash.

Muir, M. A.; Yunusa, I. A. M.; Burchett, M. D.; Lawrie, R.; Chan, K. Y.; and Manoharan, V.

Soil Biology and Biochemistry 5(987-992)(May 2007)
NAL Call #: S592.7.A1S6; ISSN: 0038-0717

Descriptors: agricultural soils/ soil pollution/ polluted soils/ heavy metals/ worm casts/ earthworms/ endemic species/ Megascolecidae/ indicator species/ Aporetodea caliginosa/ introduced species/ coal fly ash/ soil amendments/ viability/ mortality/ body weight/ phosphorus/ solubilization/ soil ph/ population density/ New South Wales/ Internet resource

Abstract: With the renewed interest in the use of coal fly-ash for amendment of agricultural soils in Australia, we assessed how earthworms, as indicators of soil health, responded to this ameliorant. We assessed survival, weight, burrowing and elemental concentrations for earthworms of a native unnamed Megascolecid species and of exotic Aporetodea trapezoides in intact soil cores treated with an alkaline fly-ash at rates equivalent to 0, 5 and 25 t/ha over 6 weeks. Fly-ash did not affect survival, growth, number of burrows created or phosphorus solubilisation. Transfer of the earthworms to the new environment having vastly different pH from where they were collected, and possibly overcrowding, caused mortality in the soil cores for all treatments. *A. trapezoides* that had smaller individuals suffered mortality of 12% compared with 23% for the larger earthworms of Megascolecids. Earthworms of Megascolecids each increased their weight by 0.24g (25% of their original weight) while those of *A. trapezoides* lost 0.18g each (21% of their original weight). The difference in growth between the two earthworms was associated with grazing habit and

probably with the large difference in the pH between source soil and that of the core soil. Megascolecids appeared to minimize grazing on ash-tainted soil and so ingested less Zn, which was more abundant in the fly-ash than in the soil, compared with *A. trapezoides* that had elevated concentration of this metal. Extractable P in the soil was increased with both species of earthworms, more so with the exotic species that solubilized 11% more P than the native Megascolecids. The benign influence of fly-ash on survival and growth of worms was associated with the pH of soil remaining unchanged during the six weeks of incubation.

This citation is from AGRICOLA.

459. Silicon-mediated resistance of sugarcane to Eldana saccharina Walker (Lepidoptera: Pyralidae): Effects of silicon source and cultivar.

Keeping, M. G. and Meyer, J. H.

Journal of Applied Entomology 130(8): 410-420. (Sept. 2006); ISSN: 0931-2048

Descriptors: Eldana saccharina/ Saccharum officinarum/ sugarcane/ cultivars/ pest resistance/ varietal resistance/ silicon/ calcium silicate/ fly ash/ soil amendments/ application rate/ soil ph/ nutrient uptake/ crop damage/ silicon content/ Internet resource

Abstract: The effects of four silicon sources - a USA calcium silicate, a local (South African) calcium silicate, Slagment and fly ash - on the resistance of sugarcane cultivars (two resistant and two susceptible) to *Eldana saccharina* Walker (Lepidoptera: Pyralidae) were studied in a potted sugarcane trial. Silicon sources were applied at 5000 or 10 000 kg/ha for the calcium silicates and Slagment; fly ash was applied at 15 000 or 30 000 kg/ha. The greatest increase in plant silicon content (particularly in stalks) was recorded for plants treated with local calcium silicate. Silicon uptake did not vary significantly between the susceptible and resistant cultivars, although the resistant cultivars had inherently higher silicon content than the susceptible ones. Treatment with silicon significantly reduced borer damage and borer performance at the higher treatment level. In general, borer damage and performance decreased with increasing rates of applied silicon and both variables were inversely related with per cent stalk silicon. On average, the higher silicon rate reduced damage by 34% in the susceptible cultivars and by 26% in the resistant cultivars, supporting the argument that susceptible cultivars benefit more from silicon treatments than resistant ones. We propose that calcium silicate amendments could be employed in the integrated, area-wide management of *E. saccharina* and in the management of soil acidity, both of which are widespread problems in the South African sugar industry.

This citation is from AGRICOLA.

460. Sodic soils reclaimed with by-product from flue gas desulfurization: Corn production and soil quality.

Chun, S.; Nishiyama, M.; and Matsumoto, S.

Environmental Pollution 114(3): 453-459. (2001)

NAL Call #: QH545.A1E52; ISSN: 0269-7491.
11584643

Descriptors: Conservation of Natural Resources/ Electrochemistry/ Gases/ Hydrogen-Ion Concentration/ Ion Exchange/ Plant Leaves: chemistry/ Sodium:

pharmacokinetics/ Soil Pollutants: adverse effects/ Sulfur: chemistry/ Trace Elements: analysis: pharmacokinetics/ Zea mays: growth & development: physiology
Abstract: Interest is growing in the use of by-product from flue gas desulfurization (FGD) to reclaim sodic soils by controlling the pH and excessive Na⁺. This study evaluated the effects on corn (*Zea mays*) production and pH and electrical conductivity (EC) of calcareous sodic soil during four times of cultivation when the by-product was applied once at the first cultivation (Study I) and the impacts on plant and soil quality at first cultivation when the by-product was applied to the soil at 23,000 kg ha⁻¹ (Study II). In Study I, the germination rate and corn production increased by applying the by-product (0, 5,800, 11,600, and 23,100 kg ha⁻¹), and the greatest total amounts of corn production during the four times of cultivation was when the by-product was applied at 23,100 kg ha⁻¹. In Study II, the pH, exchangeable sodium percentage (ESP), clay dispersion and soluble Na⁺ in the soil decreased and soluble Mg²⁺ and soluble K⁺ in the soil increased. The soil pH was reduced from 9.0 to 7.7 by applying the by-product. However, the by-product decreased the concentrations of total N and P in corn leaves in this study. No significant difference in the concentrations of Mo, Zn, Pb, Ni, Cd, Mn, Cr, Cu, and Al in corn leaves and the soil was observed between the by-product addition and the control except for B in the soil and Fe in corn leaves. The concentration of B in the soil was reduced from 28.7 mg kg⁻¹ to 25.4 mg kg⁻¹ and the concentration of Fe in corn leaves increased from 17.5 mg kg⁻¹ to 22.6 mg kg⁻¹ by applying the by-product in our study.

This citation is from PubMed.

461. Soil amendment effects on the yield and terpene contents of the flowerhead of *Chrysanthemum boreale* M.

Lee, K. D. and Yang, M. S.

Agrochimica 50(1/2): 62-71. (2006)

NAL Call #: 385 AG84; ISSN: 0002-1857

Descriptors: chemical composition/ crop quality/ crop yield/ essential oils/ flowers/ fly ash/ lime/ monoterpenoids/ pig manure/ plant composition/ poultry manure/ sesquiterpenes/ soil amendments/ terpenoids/ chemical constituents of plants/ *Chrysanthemum boreale*/ poultry litter/ terpenes

Abstract: We investigated the effects of soil amendments on the growth and essential oil content of *C. boreale*. Plants were cultivated on soil amended with lime, fly ash, poultry manure (PM) or swine manure (SM) at 2, 20, 120 or 120 t ha⁻¹, respectively. PM and SM application increased the flower yields by 37 and 27%, and the essential oil contents by 37 and 39%, respectively, compared with the control. Lime and fly ash, both of which had high calcium contents, increased the contents of germacrene-D content by 44.8 and 38.9%, monoterpenoids by 16 and 15%, and sesquiterpenes by 33 and 28%, respectively, compared to the control. Lime and fly ash also increased the cumambrin A content by 34 and 19%, respectively. Cumambrin A was correlated with calcium content in flowers of *C. boreale* M. The experiment suggests that soil amendments using compost and lime could improve the yields and quality of *C. boreale*.

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462. Soil biochemical activity and growth response of rice *Oryza sativa* in flyash amended soil.

Sarangi, P. K.; Dharitri Mahakur; and Mishra, P. C.

Bioresource Technology 76(3): 199-205. (2001)

NAL Call #: TD930.A32 ; ISSN: 0960-8524

Descriptors: enzyme activity/ fly ash/ growth/ industrial wastes/ pigments/ plant development/ rice/ soil amendments/ soil organic matter/ soil ph/ organic matter in soil/ paddy

Abstract: Soil amended with different proportions of flyash, a solid waste generated from coal-fired thermal power plants, was evaluated as a soil conditioner and nutrient supplement during a field study on the growth of rice, *Oryza sativa*. Generally, pH and organic carbon (OC) content did not increase significantly ($P > 0.05$) in flyash amended soil, but significant increases ($P < 0.05$) in soil conductivity (32%), available phosphorus (48%) and organic matter (OM, 29%) were observed during harvest at the 20 t ha⁻¹ flyash application rate. Amylase, invertase, dehydrogenase and protease activities, and CO₂ evolution increased in flyash amended soil over the control. The pigment (chl-a, chl-b, and carotenoid) content in rice plants did not vary significantly ($P > 0.05$) between different flyash amendments. Total plants biomass and aboveground biomass increased ($P < 0.05$) significantly (17% and 25%, respectively) at the 20 t ha⁻¹ flyash application. However, there was a retarded growth of underground biomass. Grain and straw yield increased by 21% and 18%, respectively, at 17.5 t ha⁻¹ flyash amendment when compared to the control. Although, a significant increase ($P < 0.05$) in plant biomass and grain yield in flyash amended soil is encouraging from the point of waste disposal and management, elucidation of reasons for retarded growth in underground biomass will require additional research based on long-term studies. Reproduced with permission from the CAB Abstracts database.

463. Soil improvement with coal ash and sewage sludge: A field experiment.

Shen, Junfeng; Zhou, Xuewu; Sun, Daisheng; Fang, Jianguo; Liu, Zhijun; and Li, Zhongmin

Environmental Geology 53(8): 1777-1785. (Feb. 2008)

NAL Call #: QE1.E5; ISSN: 0943-0105

Descriptors: sewage sludge/ tree growth/ China/ Sandy soil/ Coal ash/ Soil amelioration/ Internet resource

Abstract: A field experimental study was carried out successfully to improve the quality of the sandy soil by adding coal ash and sewage sludge. One ha of barren sandy soil field was chosen for the experiment in Shanghe County, Shandong Province, China. For soil amelioration and tree planting, two formulas of the mixture:coal ash, sewage sludge and soil, in ratios of 20:10:70 and 20:20:60, respectively, were used. Poplar trees were planted in pits filled with soils with additives (mixture of ash and sludge) as well as in the original sandy soil. In the 19th months after the trees were planted, the soils with additives were sampled and analyzed. The results show that the barren sandy soil was greatly improved after mixing with coal ash and sludge. The improved soils have remarkably higher nutrient concentrations, better texture, smaller bulk density, higher porosity and mass moisture content, and higher content of fine-grained minerals. During the first 22 months after planting, the annual increase in height of the trees grown in the soil with additives (4.78 m per year) was 55%

higher than that of the control group (3.07 m per year), and the annual increase in diameter at the breast height (1.3 m) was 33 % higher (43.03 vs. 32.36 mm). Trees planted in soils with additives appeared healthier and shed leaves later than those in the control group. As the volume of the additives (30-40% in both formulas) is less than that of the sandy soil in and around the tree pits, it appears that the use of coal ash and sludge for tree planting and soil amelioration is environmentally safe even though the additives have relatively high heavy metal concentrations. This citation is from AGRICOLA.

464. Soil microbial community responses to fly ash amendment as revealed by analyses of whole soils and bacterial isolates.

Schutter, M. E. and Fuhrmann, J. J.

Soil Biology and Biochemistry 33(14): 1947-1958. (Nov. 2001)

NAL Call #: S592.7.A1S6; ISSN: 0038-0717 [SBOAH]

Descriptors: Triticum aestivum/ Festuca arundinacea/ soil amendments/ loam soils/ fly ash/ bitumen/ Zea mays/ fatty acid esters/ soil properties/ Arthrobacter/ Gram negative bacteria/ crop rotation/ continuous cropping/ soil bacterial/ microbial physiology/ Delaware/ utilization/ substrates/ aerobic heterotrophic bacteria/ carbon substrate utilization patterns

Abstract: Due to its silty texture and plant nutrient content, coal fly ash may prove a valuable amendment to coarse-textured soils. Its effects on soil chemical and physical properties in the field have been studied, but little is known regarding effects on soil microbial communities. In this study, field plots were amended with fly ash at rates of 0 or 505 Mg fly ash ha⁻¹ and subsequently cropped to a fallow-corn-wheat rotation or continuous fescue. Twenty months later, microbial responses to the fly ash were assessed by analyzing the fatty acid composition and carbon substrate utilization potential of microbial communities and aerobic heterotrophic bacteria isolated from the field plots cropped to wheat and fescue.

Differences in whole-soil fatty acid profiles from amended and non-amended soils were found. Soils amended with fly ash were enriched in fatty acid 16:1(omega)5c and elevated quantities of 17:0 cy and 16:1(omega)7c were present in fly ash-amended soils cropped to fescue and wheat, respectively. Fatty acid profiles also were affected by cropping system. Extracts from wheat-cropped soils were enriched in 17:1(omega)7c, while those from fescue plots had greater amounts of 18:2(omega)6c and 18:1(omega)9c. Carbon substrate utilization patterns of microbial communities were affected by cropping system but not by fly ash amendment; communities from soils cropped to wheat utilized more carbon substrates than did communities from fescue-cropped soils at the soil dilution tested. Studies of bacterial isolates revealed that Arthrobacter species dominated the culturable, aerobic heterotrophic population, accounting for 25-42% of the total number of isolates recovered from the field plots. Percentages of unidentified isolates also were significant and ranged from 27 to 45% of isolate totals. Effects of fly ash on soil isolates were detected within species of Arthrobacter, with reduced numbers of A. protophormiae in soils amended with fly ash relative to non-amended soils. Overall, the structure of the culturable, aerobic heterotrophic population did not reflect that of the soil community, as fatty acids reported to be markers for Gram-

positive organisms were not the major community fatty acids. Enhanced crop growth and soil texture, pH, and nutrient content as a result of fly ash amendment may explain why no detrimental effects to the microbial community were found. Instead, whole-soil fatty acid data indicates that fly ash amendment may benefit fungi and Gram-negative bacteria relative to other components of the soil microbial community.

This citation is from AGRICOLA.

465. Soil physical and chemical properties as influenced by flyash addition in soil and yield of wheat.

Sharma, S. K.; Naveen Kalra; and Singh, G. R.

Journal of Scientific and Industrial Research 61(8)(2002)

NAL Call #: 475 J82; ISSN: 0022-4456

Descriptors: application rates/ calcium/ chemical composition/ crop yield/ electrical conductivity/ fly ash/ hydraulic conductivity/ macropores/ micropores/ organic carbon/ phosphorus/ pore size distribution/ potassium/ sodium/ soil amendments/ soil chemical properties/ soil composition/ soil ph/ soil physical properties/ soil water retention/ trace elements/ wheat/ wilting point/ yield increases/ chemical properties of soil/ microelements/ physical properties of soil

Abstract: Field experiments were conducted in villages around the National Capital Power Project in Dadri, Uttar Pradesh, and Indian Agricultural Research Institute Farm in New Delhi during 1995-1996 to evaluate the effects of fly ash addition on soil and on the yield of wheat crop. Up to 50 tonnes/ha of fly ash was applied to the soil. Results show that wheat yield increased up to 20 tonne/ha ash addition, and declined thereafter but still higher than the yield from plots not treated with fly ash. Fly ash treated plots had marginally higher uptake of trace elements, reduced soil hydraulic conductivity and soil pH, and improved moisture retention at field capacity and permanent wilting point. The amended soil also showed increased electrical conductivity and organic C and Na content, and decreased P, K and Ca contents. These changes in soil properties might be due to the modifications in the macro- and micropore size distribution which contributed to increased yield of wheat.

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466. Soil properties and crop productivity as influenced by flyash incorporation in soil.

Naveen Kalra; Jain, M. C.; Joshi, H. C.; Chaudhary, R.; Sushil Kumar; Pathak, H.; Sharma, S. K.; Vinod Kumar; Ravindra Kumar; Harit, R. C.; Khan, S. A.; and Hussain, M. Z.

Environmental Monitoring and Assessment 87(1): 93-109. (2003)

NAL Call #: TD194 .E5 ; ISSN: 0167-6369

Descriptors: application rates/ bulk density/ crop production/ crop yield/ electrical conductivity/ fly ash/ growth/ Indian mustard/ lentils/ maize/ productivity/ rice/ silty soils/ soil amendments/ soil chemical properties/ soil density/ soil organic matter/ soil ph/ soil physical properties/ soil types/ soil water retention/ sowing/ transmission/ transplanting/ wheat/ Capparales/ chemical properties of soil/ corn/ organic matter in soil/ paddy/ physical properties of soil/ seed sowing

Abstract: Field experiments were carried out during 1996-97 at Gulawathi, Muthiani and Salarpur Villages, IARI Farm,

New Delhi and NCPP Campus, Dadri to evaluate changes in soil characteristics and growth of wheat (*Triticum aestivum*), mustard (*Brassica juncea*), lentil (*Lens culinaris*), rice (*Oryza sativa*) and maize (*Zea mays*) by varying amounts of flyash addition (up to 50 t ha⁻¹) in soils at sowing/transplanting time of crops. Flyash addition in areas adjoining the NCPP Thermal Power Plant, Dadri, Ghaziabad, Uttar Pradesh, ranged from 5-12 t ha⁻¹ yr⁻¹ in 1995-96. Shoot and root growth and yield of test crops at different locations after flyash incorporation resulted in beneficial effects of flyash addition in most cases. The silt dominant texture of flyash improved loamy sand to sandy loam textures of the surface soils at the farmers' fields. The increased growth in yield of crops with flyash incorporation was possibly due to modifications in soil moisture retention and transmission characteristics, bulk density, physico-chemical characters such as pH and EC and organic carbon content. The response of flyash addition in the soil on soil health and crop productivity needs to be evaluated on long-term sustainable aspects. Reproduced with permission from the CAB Abstracts database.

467. Soil properties and performance of marigold (*Tagetes erecta*) as affected by flyash and distillery effluent.

Anandhkumar, S. P.; Sanjeev Tripathi; Sharma, D. K.; Misra, R. L.; and Joshi, H. C.
Indian Journal of Agricultural Sciences 74(12): 675-677. (2004)

NAL Call #: 22 AG831; ISSN: 0019-5022

Descriptors: application rates/ carotenoids/ chemical composition/ chlorophyll/ crop yield/ distillery effluent/ flowers/ fly ash/ leaves/ plant composition/ plant height/ soil chemical properties/ soil physical properties/ chemical constituents of plants/ chemical properties of soil/ physical properties of soil/ tetraterpenoids

Abstract: A field experiment was conducted during the winter season of 2002/03 in Uttar Pradesh, India to study the soil properties and the performance of marigold (*Tagetes erecta*) as affected by different doses of mixtures of fly ash and distillery effluent. Incorporation of fly ash and distillery effluent mixture either in 1:1 or 1:2 at 20 tonnes/ha markedly improved the plant height, flower yield, total chlorophyll in leaves and carotenoid content in flowers. Use of these organic wastes in raising the horticultural crops not only improved the physical and chemical soil properties as affected through improvement in qualitative and quantitative characters of marigold but also saved the environment from its degradation through their disposal in nearby vicinity of the distillery.

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468. Soil properties and turf growth on a sandy soil amended with fly ash.

Pathan, S. M.; Aylmore, L. A. G.; and Colmer, T. D.

Plant and Soil 256(1): 103-114. (2003)

NAL Call #: 450 P696; ISSN: 0032-079X

Descriptors: application rates/ fly ash/ growth/ lawns and turf/ leaching/ nitrogen fertilizers/ nutrients/ phosphorus fertilizers/ sandy soils/ soil amendments/ soil properties/ soil types/ soil water content/ uptake/ Bermuda grass/ lawns and sports turf/ phosphate fertilizers

Abstract: Field lysimeters of a sandy soil were amended to a depth of 100 mm with four rates (0, 5, 10 and 20%, wt/wt) of fly ash, and effects on soil water content, nutrient leaching, turf growth and nutrition, and uptake of trace elements by turf were assessed. Measurements were taken for 70 days for lysimeters either planted with rhizomes of *Cynodon dactylon* (L.) Pers., cv. 'Wintergreen', or left bare. When irrigated daily, soil water content increased progressively with increasing rates of fly ash and leachate volumes were decreased by 17-52% for lysimeters containing fly ash amended soil. Fertiliser was applied equivalent to 28.4 g N m⁻² and 10.3 g P m⁻² for the entire 70 days (including pre-plant application). Macronutrient concentrations in leaf tissue were within levels regarded as sufficient. Total dry mass (root plus shoot) decreased when fertiliser application rates were reduced by 25%, irrespective of fly ash treatment. In 'bare' lysimeters containing fly ash amended soil, cumulative leaching of NO₃⁻, NH₄⁺ and P were 0.32-0.88 of the values in non-amended soil. When planted with turf, leaching of those nutrients was minimal (equivalent to 3% of total N applied) and leaching losses did not differ among fly ash rates. Extractable soil P levels were increased 2.5-4.5-fold in the fly ash amended zone, compared with non-amended soil. Root mass in the top 100 mm was 1.2-1.5-fold larger for turf in fly ash amended soil, compared to non-amended soil. The Se concentrations were higher in leaf tissue grown in fly ash amended soil (being at most 0.63 micro g g⁻¹), but there was no effect of fly ash amended soil on As, Ba, B, Cd, Co, Cr, Cu, Pb, Hg, Mn, Ni, Ag or Zn in leaf tissues. Thus, fly ash amendment may be a suitable management option for turf culture on sandy soils, since fly ash improved soil water holding capacity and root growth in the amended zone.

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469. Soil properties as influenced by fly ash application.

Anjali Deshmukh; Matte, D. B.; and Bharti Bhaire
Journal of Soils and Crops 10(1): 69-71. (2000); ISSN: 0971-2836

Descriptors: ash/ bulk density/ calcium/ cation exchange capacity/ copper/ electrical conductivity/ fly ash/ iron/ magnesium/ manganese/ NPK fertilizers/ nutrient availability/ soil chemistry/ soil fertility/ soil ph/ soil properties/ trace elements/ water holding capacity/ wheat/ zinc/ microelements/ Mn

Abstract: Application of graded levels of fly ash was studied on the farm of Agriculture College, Nagpur, India, during the rabi season of 1993-94. Wheat CV AKW-381 was grown as test crop. Application of fly ash decreased bulk density and maximum water holding capacity of soil, while no marked effects on pH, EC, CEC and lime content were observed. The available NPK and micronutrients like Cu, Fe, Zn, Mn and exchangeable Ca and Mg increased with fly ash application.

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470. Soil solution chemistry of a fly ash, poultry litter, and sewage sludge-amended soil.

Jackson, B. P. and Miller, W. P.

Journal of Environmental Quality 29(2): 430-436. (2000)

NAL Call #: QH540.J6; ISSN: 0047-2425

Descriptors: amendments/ application rates/ arsenic/ carbon/ centrifugation/ chlorine/ coal/ copper/ extraction/ fly ash/ magnesium/ mixtures/ moisture/ moisture content/ molybdenum/ nitrate/ nutrients/ organic wastes/ phosphorus/ pollution/ potassium/ poultry manure/ sandy loam soils/ selenium/ sewage sludge/ sludges/ sodium/ soil/ soil amendments/ soil solution/ sulfate/ trace elements/ treatment/ Ultisols/ wastes/ competition/ environmental pollution/ microelements/ Mo/ poultry litter

Abstract: Mixing coal fly ash (FA) with organic wastes to provide balanced soil amendments offers a potential viable use of this industrial by-product. When such materials are land-applied to supply nutrients for agronomic crops, trace element contaminant solubility must be evaluated. In this study, major and trace element soil solution concentrations arising from application of fly ash, organic wastes, and mixtures of the two were compared in a laboratory incubation. Two fly ashes, broiler poultry litter (PL), municipal sewage sludge (SS), and mixtures of FA with either PL or SS were mixed with a Cecil sandy loam (fine, kaolinitic, thermic Typic Kanhapludult) at rates of 32.3, 8.1, and 16.1 g kg⁻¹ soil for FA, PL, and SS, respectively. Treatments were incubated at 22 degrees C at 17% moisture content and soil solution was periodically extracted by centrifugation over 33 d. Initial soil solution concentrations of As, Mo, Se, and Cu were significantly greater in FA/PL treatments than the respective FA-only treatments. For Cu, increased solution concentrations were attributable to increased loading rates in FA/PL mixtures. Solution Cu concentrations were strongly correlated with dissolved C ($R^2 > 0.96$) in all PL treatments. Significant interactive effects for solution Mo and Se concentrations were observed for the FA/PL and may have resulted from the increased pH and competing anion concentrations of these treatments. Solution As concentrations showed a significant interactive effect for one FA/PL mixture. For the individual treatments, As was more soluble in the PL treatment than either FA treatment. Except for soluble Se from one FA/SS mixture, trace element solubility in the FA/SS mixtures was not significantly different than the respective FA-only treatment. Reproduced with permission from the CAB Abstracts database.

471. Soil solution chemistry of two reclamation sites in the Lusitan lignite mining district as influenced by organic matter application.

Wilden, R.; Schaaf, W.; and Huttli, R. F.
Plant and Soil 213(1/2): 231-240. (1999)
NAL Call #: 450 P696; ISSN: 0032-079X

Descriptors: acidity/ application rates/ ash/ chemical composition/ composition/ composts/ fly ash/ ions/ lignite/ limestone/ minerals/ mining/ organic amendments/ organic matter/ oxidation/ pyrites/ reclamation/ rehabilitation/ sewage/ sewage sludge/ sludges/ soil solution/ subsoil/ topsoil/ treatment/ weathering

Abstract: A field study was conducted to compare the effects of mineral fertilizer, sewage sludge and compost on soil solution chemistry of both a lignite- and pyrite-containing spoil as well as a lignite- and pyrite-free spoil in Germany. The lignite- and pyrite-containing spoil was ameliorated with fly ash (17-21 t CaO ha⁻¹), whereas the lignite- and pyrite-free site received 7.5 t CaO ha⁻¹ as limestone. Fertilizer application rates were: mineral fertilizer

120 N, 100 P and 80 K kg ha⁻¹. 19 t sewage sludge ha⁻¹ and 22 t compost ha⁻¹ were applied. Soil solution was sampled at 20, 60 and 130 cm depth for 16 months. Solution was collected every fortnight and analysed for pH, electrical conductivity, Ca²⁺, Mg²⁺, K⁺, Na⁺, Fe³⁺, Mn²⁺, Zn²⁺, NO₃⁻, NH₄⁺, SO₄²⁻, Cl⁻, PO₄³⁻, C_{inorg} and dissolved organic carbon. Lignite- and pyrite-containing spoil differed from lignite- and pyrite-free spoil regarding soil solution concentrations and composition. Acidity (H⁺) produced by pyrite oxidation led to enhanced weathering of minerals and, therefore, to at least 10-fold higher soil solution concentrations compared to the lignite- and pyrite-free site. Major ions in solution of the lignite and pyrite-containing site were Ca²⁺, Mg²⁺, Fe³⁺, Al³⁺ and SO₄²⁻, whereas soil solution at the lignite and pyrite-free site was dominated by Ca²⁺, Mg²⁺ and SO₄²⁻. At both sites application of mineral fertilizer led to an immediate but short term increase of NO₃⁻, NH₄⁺ and K⁺ concentrations in soil solution to a depth of 130 cm. Application of sewage sludge caused a long-term (~16 months) increase of NO₃⁻ in the topsoil, whereas NO₃⁻ concentrations in the subsoil were significantly lower compared to the mineral fertilizer plot. Compost application resulted in a strong long-term increase of K⁺ in soil solution, whereas NO₃⁻ concentrations did not increase. Concentrations of PO₄³⁻ in soil solution depend on solution pH and were not correlated with any treatment. Reproduced with permission from the CAB Abstracts database.

472. Soil stabilization in semiarid and arid land agriculture.

Graber, E. R.; Fine, P.; and Levy, G. J. 18(2): 190-205. (2006); ISSN: 08991561.

Notes: doi: 10.1061/(ASCE)0899-1561(2006)18:2(190).

Descriptors: agriculture/ arid lands/ fly ash/ soil stabilization / electrolytes/ flocculation/ fly ash/ gypsum/ ion exchange/ organic polymers/ positive ions/ stabilization/ arid land/ semiarid land/ soil stabilization/ soils/ agriculture/ arid region/ fly ash/ semiarid region/ soil amendment/ soil property/ soil stabilization/ swelling

Abstract: Soil and water conservation is essential for sustaining food production and for preserving the environment. This review considers the potential of four types of soil amendments, namely gypsum, organic polymers, organic matter waste materials, and fly ash, as soil stabilizers. Addition of gypsum to soil can limit clay swelling and dispersion, and thus improve soil structural stability, by both soil solution electrolyte effects and cation-exchange effects. Synthetic organic polymer addition to soil surface aggregates leads to their stabilization, improved bonding between adjacent aggregates, and clay flocculation. Organic matter, also used for promoting aggregate stabilization, enhances soil microbial activity that transforms the newly added organic matter into polysaccharides and long chain aliphatic compounds capable of binding and stabilizing aggregates. Fly ash additives can improve soil physical characteristics including texture, structure, water holding capacity, hydraulic properties, and aeration. However, fly ash has a number of inherent qualities that under certain circumstances may limit its usefulness for soil stabilization, and which may even result in increased erosion and soil loss. _ 2006 ASCE.

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473. Soils and the environment: The past 25 years.

Schoeman, J. L. and Deventer, P. W. van
South African Journal of Plant and Soil 21(5): 369-387.
(2004)

NAL Call #: S596.53.S69; ISSN: 0257-1862

Descriptors: agricultural soils/ bioremediation/ carbon sequestration/ deforestation/ environmental degradation/ environmental impact/ environmental management/ fertilizers/ fires/ fly ash/ housing/ irrigation/ irrigation water/ mine spoil/ natural disasters/ nutrient deficiencies/ organic amendments/ peatlands/ pesticides/ polluted soils/ polluted water/ pollution control/ refuse/ reviews/ sewage sludge/ soil amendments/ soil biology/ soil conservation/ soil degradation/ soil fertility/ soil pollution/ soil types/ urbanization/ environmental effects/ mine wastes/ mining spoil/ mining wastes/ municipal wastes/ soil quality/ soil sodicity/ trash/ watering

Abstract: Local work on selected environmental impacts on soil quality and the role of soils in the attenuation of environmental pollution is reviewed. Examples of negative impacts from mining, industries, urbanization, agriculture and forestry abound. The safe and sustainable use of various waste products may impact positively, but norms and standards are needed. Soil nutrient deficiencies or excesses give rise to nutrition-related disorders in humans and animals. Through bioremediation, soil becomes an ally in restoring environmental health. Harmonization of agricultural production and the environment is a political target towards which science must provide effective decision support. The development and application of a national environmental monitoring and evaluation system is needed for incorporating environmental data, information, norms and standards into a holistic picture. There is a need for improved cross-linking and synergy between various sectors impacting on the environment. The local government level is becoming critical to environmental management. The safe and sustainable use of sewage sludge/fly ash combinations on agricultural soils is suggested to be a highly promising future avenue of environmental R&D.

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474. Soluble arsenic and selenium species in fly ash/organic waste-amended soils using ion chromatography-inductively coupled plasma mass spectrometry.

Jackson, B. P. and Miller, W. P.

Environmental Science and Technology 33(2): 270-275.
(1999)

NAL Call #: TD420.A1E5; ISSN: 0013-936X

Descriptors: analytical methods/ arsenic/ chemical composition/ chemical speciation/ chromatography/ contamination/ fly ash/ litter/ mass spectrometry/ mineralization/ organic wastes/ oxidation/ poultry manure/ selenium/ semimetals/ sewage sludge/ soil amendments/ soil solution/ trace elements/ waste treatment/ analytical techniques/ metalloids/ microelements/ poultry litter

Abstract: Speciation of As and Se in soil solutions of fly ash-, poultry litter- and sewage sludge-amended soils was determined over a 10-day period by ion chromatography coupled to inductively coupled plasma mass spectrometry (IC-ICP-MS). Detection limits were 0.031, 0.028, 0.051, 0.161, 0.497, and 0.660 micro g/litre for dimethylarsinate (DMA), As-(III), monomethylarsonate (MMA), As(V), Se(IV),

and Se-(VI), respectively (100 micro litre injection). Arsenic was highly water-soluble from poultry litter and appeared to be predominantly As(V). Arsenic(V) was the predominant species in soil amended with two fly ashes. Application of fly ash/poultry litter mixtures increased As solubility and led to the prevalence of DMA as the major As species. DMA concentrations in these soil solutions decreased rapidly over the sampling period relative to As(V), which suggested that DMA readily underwent mineralization in the soil solution. Se(VI) was the predominant soluble Se species in all treatments indicating rapid oxidation of Se(IV) initially solubilized from the fly ashes.

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475. Solute leaching from fly ash amended soil under varying degrees of saturation.

Hutchison, J. M.; Seaman, J. C.; Jackson, B. P.; and Aburime, S. A.

In: *Coal Combustion Byproducts and Environmental Issues*. Uppsala, SWEDEN.)

New York, NY: Springer; pp. 134-141; 2006.

Notes: 7th International Conference on Biogeochemistry of Trace Elements.; ISBN: 0387258655

Descriptors: toxicology/ pollution assessment control and management/ soil science/ unsaturated flow apparatus: field equipment/ fly ash/ loamy sand soil/ equilibration time/ solute leaching/ settling pond

Abstract: Most of the fly ash produced in the US is stockpiled or disposed of in settling ponds where solute leaching can pose an environmental and health concern. Therefore, a series of saturated and unsaturated column experiments were conducted to evaluate the impact of saturation and pore solution residence time (i.e., equilibration time) on the leaching of solutes from fly ash when incorporated within surface horizon material from a loamy sand soil. Repacked soil columns were leached at various moisture contents using an Unsaturated Flow Apparatus (UFA), a modified centrifuge for conducting steady-state leaching experiments. Additional column experiments were conducted under saturated conditions to isolate the effects of residence time from that of water content. Addition of 10 percent fly ash (by weight) significantly increased water-holding capacity in the loamy sand. Leachate concentration of As and Se increased as residence time increased. Most Se leaching took place in the first few pore volumes, indicating that weathering the fly ash may help alleviate some of its phytotoxic effects. Since saturation was related to residence time in these experiments, the effect of water content could not be isolated, though there appeared to be a delay in the "leaching front" as the soil became desaturated. However, comparisons of unsaturated leaching studies to saturated leaching studies are difficult due to the variation in water content under unsaturated conditions.

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476. Some cytological observations of radish grown on fly-ash amended soil.

Mishra, P. K. and Mehta, U. C.

Cruciferae Newsletter 24: 15-16. (2002); ISSN: 0263-9459

Descriptors: chromosomes/ cultivars/ cytology/ DNA/ fly ash/ microscopy/ radishes/ root vegetables/ soil amendments/ soil pollution/ vegetables/ Capparales/ cultivated varieties/ deoxyribonucleic acid/ vegetable crops

Abstract: Three varieties of radish (*Raphanus sativus*), Japanese White, Pusa Himani, and Doppel Bock, were grown on 30% fly ash amended soil. DNA estimation, fixation and staining were carried out as described by McLeish and Sunderland [Experimental Cell Research (1961) 24, 527-540]. Measurement of nuclear dry mass was made by interference microscopy, and chromosome volume was estimated using length and width measurements of metaphase chromosomes. In all three varieties DNA content, chromosome volume and nuclear dry mass were increased over levels found in the controls. DNA content of Japanese White, Pusa Himani and Doppel Bock increased by 6.67, 12.16 and 6.28% respectively, while nuclear dry mass showed percentage increases of 5.9, 5.3 and 4.2%, respectively. All variations were significant ($p < 0.05$).

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477. Stabilization of Pb and Cu contaminated soil using coal fly ash and peat.

Kumpiene, J.; Lagerkvist, A.; and Maurice, C. *Environmental Pollution* 145(1): 365-373. (2007)
 NAL Call #: QH545.A1E52; ISSN: 0269-7491

Descriptors: bioavailability/ coal/ copper/ fly ash/ leaching/ lead/ peat/ phytotoxicity/ polluted soils/ seed germination/ shoots/ soil bacteria/ soil pollution/ soil stabilization/ soil toxicity/ soil types/ uptake/ bioaccumulation/ remediation/ toxic soils

Abstract: The stabilization of metal contaminated soil is being tested as an alternative remediation method to landfilling. An evaluation of the changes in Cu and Pb mobility and bioavailability in soil induced by the addition of coal fly ash and natural organic matter (peat) revealed that the amount of leached Cu decreased by 98.2% and Pb by 99.9%, as assessed by a batch test. Metal leaching from the treated soil was lower by two orders of magnitude compared to the untreated soil in the field lysimeters. A possible formation of mineral Cu- and Pb-bearing phases and active surface with oxides were identified by chemical equilibrium calculations. Low metal leaching during a two-year observation period, increased seed germination rate, reduced metal accumulation in plant shoots, and decreased toxicity to plants and bacteria, thereby demonstrating this stabilization method to be a promising technique for in situ remediation of Cu and Pb contaminated soil.

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478. Stabilizing cattle feedlot soil with fluidized bed combustor ash.

Greenlees, W. J.; Pitt, J. M.; Dawson, M. R.; Chriswell, C. D.; and Melvin, S. W. 41(1): 203-211. (1998); ISSN: 00012351 [TAAEA].

Notes: Chapter Number: St. Joseph, MI, United States.

Descriptors: cattle feedlots/ FBC ash/ fluidized bed combustor/ soil stabilization/ agricultural engineering/ engineering research/ fluidized bed combustors/ fly ash/ soil testing/ stabilization/ strength of materials/ soil stabilization/ soils/ animalia/ bos taurus

Abstract: Many cattle feedlots are operated on bare soil because it is expensive to cover the entire lot with concrete. During heavy rainfalls, feedlots built on clay-rich soils often

become muddy as their soils lose strength. These soils cannot support the weight of animals or equipment. As a result, the animals' rate of gain suffers, and feedlot management becomes difficult. Fluidized Bed Combustor (FBC) ash from the Iowa State University Physical Plant was used to produce a significant increase in soil strength on a cattle feedlot near Nevada, Iowa. FBC ash is the residue from burning high-sulfur coal in fluidized bed combustors. Limestone (calcium carbonate) enters the combustor with the coal as a sorbent to reduce sulfur dioxide emissions. FBC ash is considered a 'nuisance' waste, and the cost for disposal exceeds US\$20 per metric ton. Stabilizing cattle feedlot soil with FBC ash represents a recovery of resources because the ash, when combined with clay soil and water, has cementitious properties. Research was conducted with three objectives: (1) to determine whether FBC ash can be used to increase the strength of feedlot soil when applied at a level of quality control attainable by using ordinary agricultural tillage equipment; (2) to compare feedlot soil stabilized with FBC ash to non-stabilized feedlot soil in both laboratory and field tests; and (3) to develop a low-cost alternative to paving a feedlot with concrete. Field results from a feedlot treated with FBC ash show that soil strength was improved 200% to 300% when compared with an adjacent untreated feedlot.

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479. Stressed out? Assessing trace metal uptake and stress in plants grown in coal fly ash-amended soils.

Mattox, Joy M.; Brake, Sandra S.; Jensen, Ryan R.; and Short, Shaun E.

In: Abstracts with Programs: Geological Society of America. Lexington, KY, United States.; Vol. 34(2); pp. 87; 2002.

Notes: Geological Society of America, Southeastern Section, 51st annual meeting; Geological Society of America, North-Central Section, 36th annual meeting.

Descriptors: ash/ chemical composition/ coal/ ecology/ ecosystems/ Plantae/ sedimentary rocks/ soils/ trace metals/ environmental geology

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480. Studies on hydraulic transportation of sewage sludge: Fly ash mixture slurry.

Senapati, P. K.; Panda, D.; and Parida, A. 33(2): 67-74. (2007); ISSN: 10881697

Descriptors: fly ash/ head loss/ hydraulic transportation/ mineralogy/ rheology/ sewage sludge/ fly ash/ mineralogy/ plasticity/ rheology/ rheometers/ slurries/ soils/ transport properties/ head loss/ top soil/ torrance equation/ sewage sludge

Abstract: The present investigation highlights the transport characteristics of sewage sludge - fly ash mixture to be used as top soil in barren agricultural land for enhancing its fertility. Both mineralogical and rheological studies have been carried out. Mineralogical studies indicated the constituents imparting fertility to the soil. The rheological characteristics of the mixture slurry have been determined in a Haake RV100 rheometer at overall slurry concentration between 30-50% by weight. The slurry showed pseudo plastic behaviour within the range of study. The head loss of the mixture slurry has been determined by applying

Torrance equation. Based on the results, the basic design parameters for transporting 0.5-1 million tones of total dry solids (fly ash and sewage sludge) per annum have been worked out.

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481. Studies on the effect of stabilizing materials on the status of heavy metals (Cu, Zn, Mn) during composting of sewage sludge.

Li GuoXue; Meng FanQiao; Jiang Hua; and Shi YaJuan
Journal of China Agricultural University 5(1): 105-111. (2000)

Descriptors: coal/ composting/ fly ash/ heavy metals/ manganese/ peat/ phosphate/ sewage sludge/ soil amendments/ soil pollution/ stabilizing/ zeolites/ zinc/ Mn
Abstract: A series of composting tests were used to study the effect of stabilizing materials including fly ash, rock phosphate, zeolite and peat on the status of heavy metals (Cu, Zn, Mn) through composting. The results indicate that peat, coal fly ash and rock phosphate were effective in stabilization. The suitable amendment rate for coal fly ash and phosphate rock should be 25% and 20% respectively. Reproduced with permission from the CAB Abstracts database.

482. Studies on the effects of fly ash treated soil on the increased protein contents in the seeds of Glycine max (soya bean).

Goyal, V.; Augar, M. R.; and Shrivastava, D. K. 14(1): 328-332. (2002); ISSN: 09707077 [AJCHE]

Descriptors: effect/ fly ash/ glycine max/ protein/ soil/ acidity/ crop production/ fly ash/ parameter/ plant growth/ plant seed/ protein content/ soil chemistry/ soil property/ soybean

Abstract: The soil of Chhattisgarh State has been found to be of acidic nature, which is not conducive to plant growth and better crop yield. In the pot experiments, various proportions of fly ash and soil were used for soya bean plant growth observations. Soil and the fly ash were from Hasdeo-Bango Command Area and NTPC Korba, respectively. Various plant parameters, especially amino acid contents, showed improvement in the modified soil samples.

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483. Study on the effect of application of magnetized fly ash compound fertilizer on soyabeans.

Sun KeGang; Zhang ZhiWu; Song JiangChun; Guo JingShui; and Wang MingTang
Soybean Science 19(4): 381-385. (2000); ISSN: 1000-9841
Descriptors: application rates/ fertilizers/ fly ash/ nodulation / soyabeans/ Honan/ soybeans

Abstract: In a field trial on Shajiang black soils in Nanyang county, Henan, China, soyabeans given 49 kg magnetized fly ash compound fertilizer/667 m² had a yield of 114.9 kg/667 m², which was 23.7 kg or 25.9% higher than that of the control, 15.2 kg or 15.2% higher than with farmers' traditional fertilization practices, 4.9 kg or 4.5% higher than with the same amount of NPK fertilizer, and 2.8 kg or 2.5% higher than with non-magnetized fly ash compound fertilizer. Soyabean yield was highest (130.3 kg/667 m²) with application of 66.4 kg fly ash/667 m², while the optimum application was 49 kg/667 m², giving a yield of

127.18 kg/667 m². The magnetized fly-ash compound fertilizer improved soyabean root nodule formation. Reproduced with permission from the CAB Abstracts database.

484. Study on the fertilization technique of fly ash and nitrate phosphate fertilizer for improving wheat yield on clay soil in south Shanxi.

Li Lianqing
Journal of Shanxi Agricultural University (China) 18(3): 232-235. (Sept. 1998); ISSN: 1000-162X.

Notes: Original title: Nianzhiturang xiaomai gaochan de shiyong fenmeihui ji danlinfei jishu chutan. 5 tables; 1 ill., 3 ref. Summaries (En, Zh). Citation notes: CN (China).

Descriptors: fertilization/ fly ash/ nitrate-phosphate fertilizer/ wheat/ yield/ clay soil/ Shanxi/ China
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485. A study on the formula for polybasic compound fertilizer of powdered coal ash applied in peanut.

Zhao Qing; Shi LiYou; Li GuoZhen; Wang HaiHui; Yao YiYun; Gong QingHong; and Wan FangBao
Acta Agriculturae Universitatis Jiangxiensis 24(2): 200-203. (2002); ISSN: 1000-2286

Descriptors: application rates/ ash/ compound fertilizers/ crop yield/ groundnuts/ peanuts
Abstract: The result of the study indicates that a polybasic compound fertilizer of powder coal ash increases groundnut production. The yields from the treatments with different formulae were higher by 1%, on average, making remarkable difference. Based on economic performance, the formulae of 1:1.5:1 and 1:2:1 were optimum, which increased yield by 9.3 and 8.8%, respectively, compared with that of the control. Reproduced with permission from the CAB Abstracts database.

486. A study on the formula for polybasic compound fertilizer of powdered coal ash applied in rice.

Wang HaiHui; Zhao Qing; Li GuoZhen; Shi LiYou; Yao YiYun; Gong QinHong; and Wan FangBao
Acta Agriculturae Universitatis Jiangxiensis 24(2): 196-199. (2002); ISSN: 1000-2286

Descriptors: coal/ crop yield/ fertilizers/ growth/ nutrient content/ plant development/ rice/ soil fertility/ paddy
Abstract: The results of this study showed that the application of a polybasic compound fertilizer of powdered coal ash increases the content of nutrients in the soil and enhances rice growth, development, production and economic performance. Formulae of 3:1:4 and 3:1:2 were considered optimum and increased the yield of early rice by 13.3 and 10.6% and of late rice by 10.4 and 9.8%, respectively, compared with that of the control. Reproduced with permission from the CAB Abstracts database.

487. Summer cover crops and soil amendments to improve growth and nutrient uptake of okra.

Wang, Q. Li Y and Klassen, W.
HortTechnology 16(2): 328-338. (Apr. 2006-June 2006)
NAL Call #: SB317.5.H68; ISSN: 1063-0198
Descriptors: *Abelmoschus esculentus*/ okra/ cover crops/

nutrient uptake/ plant nutrition/ plant growth/ crop yield/ dry matter accumulation/ biosolids composts/ yard waste composts/ soil fertility/ heavy metals/ trace elements/ coal fly ash/ *Crotalaria juncea*/ *Vigna unguiculata*/ *Mucuna pruriens* var/ *utilis*/ *Sorghum drummondii*/ fallow

Abstract: A pot experiment with summer cover crops and soil amendments was conducted in two consecutive years to elucidate the effects of these cover crops and soil amendments on 'Clemson Spineless 80' okra (*Abelmoschus esculentus*) yields and biomass production, and the uptake and distribution of soil nutrients and trace elements. The cover crops were sunn hemp (*Crotalaria juncea*), cowpea (*Vigna unguiculata*), velvetbean (*Mucuna deeringiana*), and sorghum sudangrass (*Sorghum bicolor* x *S. bicolor* var. *sudanense*) with fallow as the control. The organic soil amendments were biosolids (sediment from wastewater plants), N-Viro Soil (a mixture of biosolids and coal ash, coal ash (a combustion by-product from power plants), co-compost (a mixture of 3 biosolids : 7 yard waste), and yard waste compost (mainly from leaves and branches of trees and shrubs, and grass clippings) with a soil-incorporated cover crop as the control. As a subsequent vegetable crop, okra was grown after the cover crops, alone or together with the organic soil amendments, had been incorporated. All of the cover crops, except sorghum sudangrass in 2002-03, significantly improved okra fruit yields and the total biomass production (i.e., fruit yields were enhanced by 53% to 62% in 2002-03 and by 28% to 70% in 2003-04). Soil amendments enhanced okra fruit yields from 38.3 to 81.0 g/pot vs. 27.4 g/pot in the control in 2002-03, and from 59.9 to 124.3 g/pot vs. 52.3 g/pot in the control in 2003-04. Both cover crops and soil amendments can substantially improve nutrient uptake and distribution. Among cover crop treatments, sunn hemp showed promising improvement in concentrations of calcium (Ca), zinc (Zn), copper (Cu), iron (Fe), boron (B), and molybdenum (Mo) in fruit; magnesium (Mg), Zn, Cu, and Mo in shoots; and Mo in roots of okra. Among soil amendments, biosolids had a significant influence on most nutrients by increasing the concentrations of Zn, Cu, Fe, and Mo in the fruit; Mg, Zn, Cu, and Mo in the shoot; and Mg, Zn, and Mo in the root. Concentrations of the trace metal cadmium (Cd) were not increased significantly in either okra fruit, shoot, or root by application of these cover crops or soil amendments, but the lead (Pb) concentration was increased in the fruit by application of a high rate (205 g/pot) of biosolids. These results suggest that cover crops and appropriate amounts of soil amendments can be used to improve soil fertility and okra yield without adverse environmental effects or risk of contamination of the fruit. Further field studies will be required to confirm these findings.

This citation is from AGRICOLA.

488. Swelling and consolidation behaviour of industrial waste stabilized expansive soil.

Srivastava, R. K.; Patil, P. G.; and Tiwari, R. P.
In: Soil Mechanics and Geotechnical Engineering. Proceedings of the Eleventh Asian Regional Conference. Seoul, Korea.; Vol. 1.; pp. 473-476; 1999.
Descriptors: disposal / evaluation/ fly ash/ interactions/ lime/ pollution/ sludges/ soil stabilization/ swelling/ Vertisols/ waste disposal/ wastes/ environmental pollution
Abstract: Expansive soils [black cotton soils, or Vertisols] cover an area of ~50 000 kmsuperscript 2 of the total Indian

sub-continent. This paper presents the results of experiments carried out to study the interaction of expansive soil with industrial wastes - lime sludge and fly ash. The experimental programme included chemical and geotechnical evaluation of fly ash and lime sludge and their interaction with expansive soil with special reference to swelling and consolidation behaviour. The study indicated that the best stabilizing effect was obtained when 16% of fly ash and 16% lime sludge were mixed with expansive soil. Reproduced with permission from the CAB Abstracts database.

489. Synthesis of artificial zeolite from fly ash for preparing nursery bed soils and the effects on the growth of Chinese cabbage.

Kim, Y. W.; Lee, H. H.; Kim, K. W.; Yoon, C. H.; and Shin, B. S.

Journal of Korean Society of Soil Science and Fertilizer 31(2): 95-106. (June 1998); ISSN: 0367-6315.

Notes: 12 illus.; 11 tables; 14 ref. Summaries (En, Ko).

Descriptors: artificial zeolite/ fly ash/ nursery beds/ soils/ growth/ Chinese cabbage

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490. Temporal and spatial development of soil solution chemistry and element budgets in different mine soils of the Lusatian lignite mining area.

Schaaf, W.; Gast, M.; Wilden, R.; Scherzer, J.;

Blechs Schmidt, R.; and Huttli, R. F.

Plant and Soil 213(1/2): 169-179. (1999)

NAL Call #: 450 P696; ISSN: 0032-079X

Descriptors: acidification/ aluminium/ calcium/ chronosequences/ composition/ ecosystems/ fly ash/ formation/ gradients/ leaching/ lignite/ lime/ mining/ movement/ oxidation/ pines/ pyrites/ revegetation/ salinization/ silicates/ soil/ soil profiles/ soil solution/ substrates/ weathering/ aluminium silicates/ aluminum/ mine soils/ Scotch pine/ Scots pine

Abstract: Lignite and pyrite contents in the dump materials of the Lusatian opencast mining district in East Germany result in high acidification and salinization potentials. These extreme conditions require considerable amounts of alkaline materials like fly ash or lime to enable recultivation and revegetation. Investigations at chronosequence sites on different mining substrates show characteristic developments of the soil solution chemistry. Processes like weathering of primary and formation of secondary mineral phases, acid production and buffering, and their impacts on both the solid and the liquid soil phase result in high temporal and spatial dynamics especially in the initial phase of soil and ecosystem development. Soil solutions were continuously collected from different soil depths at seven sites with two representative soil substrates. All sites were afforested with pine (*Pinus*) and cover stand ages from 1 to 60 years. The results show that actual pyrite oxidation occurs at the youngest sites on lignite and pyrite containing substrates leading to extremely low pH values and high Fe^{3+} and SO_4^{2-} concentrations. The considerable acid production causes weathering of aluminium silicates resulting in high Al^{3+} concentrations. Ca^{2+} concentrations were unexpectedly high even at low pH showing no correlation to amelioration amounts or depths. Therefore it seems most probable that these mining substrates contain geogenic Ca sources. The transport of dissolved weathering products is limited due to low leaching rates

enabling formation of secondary phases which control the actual composition of the soil solution. Depth gradients of the soil solution composition at the chronosequence sites point to a gradual transport and leaching of these secondary phases from the soil profiles. Soil solution composition and dynamics at lignite and pyrite free sites show completely different patterns and have a higher potential for successful sustainable reclamation.

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491. Temporal variations in trace metal uptake measured in plants grown in coal fly ash amended soils.

Mattox, J. M.; Brake, S. S.; and Jensen, R. R.
In: Abstracts with Programs: Geological Society of America. Denver, CO, United States.; Vol. 34.; pp. 417; 2002.

Notes: Geological Society of America, 2002 annual meeting.

Descriptors: ash/ ICP mass spectra/ leaves/ mass spectra/ Plantae/ pollution/ soils/ spectra/ stems/ trace elements/ trace metals/ variations/ environmental geology
© American Geological Institute

492. Trace element mobility in coal fly ash and sewage sludge amended soils.

Yeledhalli, N. A.; Prakash, S. S.; and Ravi, M. V.
Environment and Ecology 25S(Special 4): 990-993. (2007)
NAL Call #: TD172.E5; ISSN: 0970-0420

Descriptors: black soils/ environmental impact/ fly ash/ groundwater/ groundwater pollution/ leachates/ leaching/ red soils/ salinity/ soil amendments/ soil pH/ soil toxicity/ soil types/ solid wastes/ toxic substances/ trace elements/ waste utilization/ environmental effects/ microelements/ poisons/ red earths/ toxic soils

Abstract: Red and black soil samples were collected from the same plot where field experiments on long term effect of co-application of fly ash and sewage sludge were laid. The lower level of quantitation for trace elements specified are more than adequate for determination of potential adverse environmental impact within the frame work of understanding toxicity of inorganic trace elements. The results of the column study indicated that the application of sewage decreased the pH of the leachate, while fly ash increased the pH. Whereas the solid wastes increased the leachate salinity in both in red and black soil. Application of solid wastes in soils did not results in appreciable concentration of potentially toxic heavy metals in the leachate. Alkaline coal fly ash groundwater reacts with water and forms hydration products that are considerably different from the original constituents of the ash when used for soil amendment and source of nutrient for crop production.

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493. Trace element solubility from land application of fly ash.

Jackson, B. P.; Miller, W. P.; Schumann, A. W.; and Sumner, M. E.
Journal of Environmental Quality 28(2): 639-647. (Mar. 1999-Apr. 1999)
NAL Call #: QH540.J6; ISSN: 0047-2425 [JEVQAA]

Descriptors: fly ash/ organic wastes/ mixtures/ solubility/ trace elements/ land application/ availability

Abstract: Use of fly ash (FA) as a soil amendment is hindered by a lack of macronutrients in the ash and concerns about trace element availability. Mixing FA with an organic waste can increase macronutrients while reducing odor and improving material handling, but the trace element solubility requires investigation. This study examined the trace element solubility and availability resulting from land application of such mixed wastes. Two FAs were applied as mixtures with either poultry litter (PL) or sewage sludge (SS) to field plots at rates 100 and 120 Mg ha⁻¹ for FA/PL and FA/SS, respectively. Suction cup lysimeters were used to collect soil solution, and trace element uptake was monitored in maize (*Zea mays* L.) leaf tissue and grain. Soluble B was initially >25 mg L⁻¹ for one high B FA/PL mixture and led to initial toxicity in seedlings. Soil solution concentrations of dissolved C, P, As, Se, Mo, Cu, and Cr were increased in FA/PL field plots. For P, C, As, and Cu, increased solubility was due to increased load in the FA/PL mixtures, while for Mo, Se, and Cr, mixing fly ash with poultry litter appeared to increase solubilization from the ash when compared with an equivalent mass of FA mixed with sewage. Leaf tissue data confirmed an increase in available As from the FA/PL mixtures, while leaf tissue Se was more dependent on the total Se concentrations of the ash.

This citation is from AGRICOLA.

494. Trace element solubility from land application of fly ash/organic waste mixtures with emphasis on arsenic and selenium speciation.

Jackson, Brian Philip
Athens, GA, United States: University of Georgia, 1998.
Descriptors: arsenic/ ash/ carbon/ chemical fractionation/ chromium/ copper/ detection/ experimental studies/ lysimeters/ mass spectra/ metals/ mixing/ organic carbon/ organic compounds/ pH/ pollutants/ pollution/ selenium/ sewage sludge/ soils/ solubility/ spectra/ trace elements/ environmental geology

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495. Trace element toxicity relationships to crop production and livestock and human health: Implications for management.

Gupta, U. C. and Gupta, S. C.
Communications in Soil Science and Plant Analysis 29(11/14): 1491-1522. (1998)
NAL Call #: S590.C63; ISSN: 0010-3624
Descriptors: acid soils/ animal nutrition/ applications/ arsenic/ boron/ cadmium/ chelating agents/ chlorosis/ cobalt/ consumption/ control/ copper/ crop production/ fertilizers/ fly ash/ grazing/ health/ iodine/ iron/ irrigation water/ legislation/ liming/ livestock/ management/ manganese/ mercury/ mineral deficiencies/ mineral nutrition/ minerals/ molybdenum/ nutrients/ pastures/ phytotoxicity/ plant nutrition/ reviews/ selenium/ sewage sludge/ sludges/ soil/ symptoms/ toxicity/ trace elements/ wastes/ zinc/ grazing lands/ microelements/ Mn/ Mo/ pasturing

Abstract: In nature, trace element toxicities occur in all living organisms. The consequences of these toxicities have been described in crops, livestock and humans. In some instances, the toxicities are a direct consequence of the organism's position in the food chain and their

environment, while in others, they are based upon genetic abnormalities resulting in physiological impairment. Nutrient toxicities in crops are more frequent for manganese (Mn) and boron (B) than for other nutrients. Manganese toxicity is found on acid soils in many parts of the world. Boron toxicities occur in irrigated regions where the well or irrigation waters are exceptionally high in B. Most other nutrient toxicities occur when large amounts of nutrients in question have been added in waste, e.g., sewage sludge. Crops grown near mines and smelters are prone to nutrient toxicities. Generally, the symptoms of toxicity in crops occur as burning, chlorosis and yellowing of leaves. Toxicities can result in decreased yield and/or impaired crop quality. Toxicity levels of trace elements range from 20 to 50 micro g g⁻¹ for copper (Cu) and B to several hundred micro g g⁻¹ for Mn, molybdenum (Mo) and zinc (Zn). With the exception of Mo, toxicity of other nutrients can be reduced by liming. Following recommended rates of fertilizers and the safe and controlled use of waste materials, such as sewage sludge and coal fly ash, should reduce metal loading and nutrient toxicity in crops. Use of crop species and genotypes less susceptible to toxicity are recommended where toxicity is suspected. Toxicities of trace elements in animals are caused by the consumption of either feeds or grazing on pastures with high contents of the element in question. Accidental excess applications of minerals in grain mixes or oral ingestions of elements have been described as causing toxicity. Some toxicities, e.g., of Mo result in deficiency of other elements such as Cu. Some of the most toxic elements for livestock include Cu, lead (Pb), mercury (Hg), Mo, and selenium (Se). Under certain conditions, toxicities of arsenic (As), cobalt (Co), fluoride (F), iodine (I), iron (Fe), Mn, and Zn have also been reported. Symptoms of toxicity have been described in detail in the animal section. Trace elements, when in excess quantities, accumulate chiefly in the blood, liver, and kidneys. Measures of control for various trace element toxicities include removal of animals from affected areas or removal of the source of toxicity; gastric lavage and the specific use of oral doses of salts and chelates depending upon the element in question. Trace element/metal toxicities in humans are not common under normal conditions. Most toxicities are caused by environmental and/or genetic abnormalities, from excessive intake, by deliberate or accidental overdose, or from induced deficiencies (e.g. excess Zn causing Fe deficiency). Among the elements causing relatively frequent cases of toxicity are Pb, cadmium (Cd), Hg, Cu, Zn, and Fe. Selenium toxicity is generally limited to those areas/regions of the world, e.g. in certain parts of China, where soils with abnormally high Se content produce food crops containing highly toxic Se concentrations. Effective measures to control metal toxicities include gastric lavage, resuscitation, and the use of chelating agents in the acute phase. Protective legislation against the use of metal alloy utensils used for cooking is the long-term control strategy. Reproduced with permission from the CAB Abstracts database.

496. Trace element uptake in plants grown on fly ash amended soils.

Jensen, R. R.; Brake, S. S.; and Mattox, J. M. 86(1-4): 217-228. (2004); ISSN: 02772248 [TECSD].

Notes: doi: 10.1080/02772240400007070.

Descriptors: ANOVA/ fly ash/ plant uptake/ soil

amendment/ trace elements/ crops/ fly ash/ plants (botany)/ soil pollution/ soils/ tissue/ analysis of variance (ANOVA)/ trace element uptake/ trace elements/ bioaccumulation/ fly ash/ trace element/ farm crops/ fly ash/ plants/ soil/ tissue/ trace elements/ fraxinus

Abstract: Four crop plants were grown in a greenhouse in soils amended with 0, 5, 10, and 20% by weight of coal combustion fly ash to evaluate potential trace element uptake by the vegetation. The leaves and stems from each plant were harvested and analyzed for As, Cd, Co, Cu, Mn, Mo, Pb, Se, Tl, and Zn content during early, middle, and late growth. The trace element data were statistically analyzed using Analysis of Variance (ANOVA) to determine whether the trace element uptake in the four crop plants differed significantly between the soil treatments, and to identify significant differences in trace element uptake through time. The results show that the amount of amended fly ash does not significantly influence the concentration of most trace elements in plant tissue, and that some concentrations actually decrease with time. Although this study did not find a significant increase in trace element uptake, care must be taken in a natural environment where plants may behave differently.

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497. Trace elements in coal ash and sludge amended soils in India; comparison between baseline and monitored soils.

Datta, Saugata; Fyfe, W. S.; Powell, M. A.; Hart, B. R.; and Tripathy, S.

In: International Geological Congress, Abstracts. Rio de Janeiro, Brazil.; Vol. 31.

Brazil; 2000.

Notes: 31st International Geological Congress.

Descriptors: arsenic/ ash/ Asia/ chromium/ coal/ cobalt/ environmental effects/ erosion/ India/ Indian Peninsula/ lead/ metals/ mobilization/ monitoring/ nickel/ pH/ pollution/ red soils/ sedimentary rocks/ SEM data/ sludge/ soil erosion/ soils/ toxicity/ trace elements/ X-ray diffraction data/ environmental geology/ geochemistry of rocks, soils, and sediments

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498. Trace elements in turfgrass clippings collected from coal combustion product-amended putting greens.

Schlossberg, Maxim J

Applied Turfgrass Science(2007); ISSN: 1552-5821

Descriptors: golf courses/ coal fly ash/ soil amendments/ golf course soils/ nutrient uptake/ nutrient content/ *Agrostis stolonifera* var/ *palustris* / bioaccumulation/ arsenic/ cadmium/ copper/ nickel/ lead/ selenium/ zinc/ plant residues/ pollutants/ putting greens/ coal combustion products/ coal bottom ash/ grass clippings

Abstract: Golf course putting green construction methods rely on homogenous mixtures of coarse and medium-sized sands as root zone media, yet limited availability of mineral sands has increased interest in use of more ubiquitous medium- and coarse-textured components. Coal combustion products (CCP) are currently being used as substitutes and/or amendments of soil in golf course construction, including root zones of putting greens. However, the common practice of clipping disposal by surface land-application raises concern for potential trace

element contamination of soil and/or water resources. Three greenhouse studies evaluated the elemental composition of creeping bentgrass (*Agrostis palustris* Huds. cv. Crenshaw) leaf clippings collected over a 6-, 12-, or 18-month period following establishment of putting greens constructed using CCP, sand-sized bottom ash (BA) and/or fly ash (FA), as substitutes for mineral sand. Results showed levels of As, Cd, Cu, Ni, Pb, Se, and Zn in putting green clippings fell well below pollutant concentration regulatory limits, permitting such clippings to be safely land-applied without requiring maintenance of cumulative pollutant loading rate (CPLR) records onsite. This citation is from AGRICOLA.

499. Trace elements solubilization in waste-amended saline-sodic conditions.

Muhammad Irshad; Yamamoto, S.; and Honna, T. *Journal of Food, Agriculture and Environment* 2(3/4): 255-259. (2004); ISSN: 1459-0255

Descriptors: animal manures/ application to land/ composts/ copper/ electrical conductivity/ fly ash/ iron/ manganese/ plant residues/ saline sodic soils/ sandy soils/ slags/ sodium/ soil pH/ soil types/ solubility/ trace elements/ waste management/ waste utilization/ water management/ zinc/ land application/ microelements/ Mn/ saline alkali soils/ water resource management

Abstract: The use of waste for soil amendment is receiving greater research attention but the extent to which saline-sodic waters affect the solubility of trace elements (TE) in waste amended soils is not well documented. In this laboratory study we determined the extent of TE [iron (Fe), manganese (Mn), copper (Cu) and zinc (Zn)] solubility in saline-sodic conditions after waste amendments. Wastes from the following four sources were used for the study: blast furnace slag (BFS), fly ash (FA), livestock manure compost (LC), plant residual compost (PC) and a control (no amendment). A sandy soil was saturated with either deionized water (S0) or 100 mmol cL⁻¹ CaCl₂, MgSO₄ and NaHCO₃ solution prepared at 15 and 45 SAR levels denoted as S1 and S2 respectively. The saturated soil was extracted after 1, 5 and 10 days and the extracts were analyzed for pH, E_{Ce}, SAR and water-soluble plus exchangeable Fe, Mn, Cu and Zn. The levels of TE were higher in LC and PC than BFS and FA amendments regardless of the salt ratios. The magnitude of SAR-induced solubility of TE decreased. Averaged exchangeable TE remained statistically similar in most of the amendments. Waste materials enhanced soil E_{Ce} and pH whereas the SAR was reduced in LC- and PC-treated soils. This is because of the higher amount of soluble Ca and Mg in LC and PC. The TE solubility was positively related to incubation period but the simple regression models showed that TE solubility was inversely related to the soil SAR. We suggest that the availability of TE could potentially be improved by waste amendments under saline-sodic or sodic conditions.

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500. Traditional pest management practices in Kanyakumari district, southern peninsular India.

Kiruba, S.; Mishra, B. P.; Stalin, S. I.; Jeeva, S.; and Dhas, S. S. M.

Indian Journal of Traditional Knowledge 5(1): 71-74. (2006); ISSN: 0972-5938

Descriptors: coconuts / fertilizers/ fly ash/ indigenous knowledge/ insect control/ insect pests/ lime/ pest control/ pest management/ pesticidal plants/ pesticides/ plant pests/ repellents/ rice/ traditional technology/ trapping/ traps/ Aloaceae/ Madras/ neem/ paddy/ pesticide crops

Abstract: The paper deals with pests of paddy crop and coconut plantation, and their management through traditional methods by indigenous people of Kanyakumari district, Tamil Nadu, India. A total of 10 insect pests and 2 non-insect pests were identified in paddy fields. In coconut plantation, only 3 insect pests were recorded. The farmers use lime, fly ash and some plant species, namely *Azadirachta indica*, *Aloe barbadensis* [*Aloe vera*], *Coleus amboinicus* and *Pongamia pinnata* as pest deterrent materials as well as fertilizer. Different types of traps used against insect pests such as fire trap, meat trap, plant trap and pot trap are effective in controlling pests. Reproduced with permission from the CAB Abstracts database.

501. Transformation of nitrogen during vermicomposting of fly ash.

Bhattacharya, S. S. and Chattopadhyay, G. N. *Waste Management Resource* 22(6): 488-91. (Dec. 2004); ISSN: 0734-242X

Descriptors: animals/ biodegradation, environmental/ carbon: metabolism/ cattle/ conservation of natural resources: methods/ manure/ nitrates: analysis: metabolism/ nitrogen: analysis: metabolism/ oligochaeta: metabolism: microbiology/ particulate matter/ quaternary ammonium compounds: analysis: metabolism/ soil

Abstract: In view of environmental problems generated by large-scale production of fly ash, increasing attention is now being paid to the recycling fly ash as a source of plant nutrients in agriculture. However, the low amount of nitrogen in such materials forms a major constraint for such application. In the present study, the possibility of improving the N status in mixtures of fly ash and organic matter was investigated by adopting vermicomposting technology. Different combinations of fly ash and cow (*Bos taurus*) dung; namely fly ash alone, cow dung alone and fly ash + cow dung at 1:1, 1:3 and 3:1 ratios were incubated with and without epigeic earthworms (*Eisenia fetida*) for 50 days. The occurrence of N in different bio-available forms; namely easily mineralizable, NH₄⁺ and NO₃⁻ tended to increase considerably in the series treated with earthworms. This behaviour was attributed primarily to increased microbiological activity in the vermicomposted samples and also to a considerable rise in the concentration of nitrogen-fixing bacteria in this series. Among the three combinations of vermicomposted fly ash and cow dung, the 1:1 mixture appeared to exhibit the highest availability of nitrogen. This citation is from PubMed.

502. Translocation of metals from fly ash amended soil in the plant of *Sesbania cannabina* L. Ritiz: Effect on antioxidants.

Sarita Sinha and Gupta, A. K.

Chemosphere 61(8): 1204-1214. (2005)
NAL Call #: TD172 .C54; ISSN: 0045-6535

Descriptors: antioxidants/ ascorbic acid/ copper/ cysteine/ fly ash/ iron/ lead/ manganese/ metals/ nickel/ phytoremediation/ proline/ roots/ soil amendments/ soil pollution/ translocation/ zinc/ malondialdehyde/ Mn/ vitamin C

Abstract: The plants of *Sesbania cannabina* Ritz grown on different amendments of fly ash (FA), have shown a high accumulation of metals (Fe, Mn, Zn, Cu, Pb and Ni). The highest accumulation of Fe and the lowest level of Ni were recorded in these plants. The different amendments of fly ash with garden soil (GS) were extracted with DTPA and the levels of metals were found to be decreased with an increase in fly ash application ratio from 10% to 50% FA. The analysis of the results showed an increase in the level of malondialdehyde (MDA) content of the roots for all the exposure periods. The maximum increases of 136% (roots) and 120% (leaves) were observed in MDA content at 100% FA after 30 d of growth of the plant, compared to GS. The level of antioxidants was found to increase for all the exposure periods in the roots of the plants to combat metal stress. At 30 d, the maximum increase of 57% (ascorbic acid) and 78% (free proline) was observed in the roots of the plants grown on 100% and 10% FA, respectively, as compared to their respective GS. At 90 d, a maximum increase of 42% (cysteine) and 117% (NPSH) was recorded in the roots of the plants grown on 25% and 100% FA, respectively, as compared to their respective GS. In leaves, a significant increase in antioxidants i.e. cysteine, NPSH and free proline content was recorded after 30 d, whereas no such trend was observed for the rest of the exposure periods. The chlorophyll and carotenoid contents increased with an increase in the FA amendment ratio from 10% to 50% FA for all the exposure periods as compared to GS. In both roots and leaves, the level of protein content increased in all the amendments and 100% FA at 30 d as compared to GS. Thus, there is a balance in the level of MDA content and level of antioxidants in the plants at 90 d. In view of its tolerance, the plants may be used for phytoremediation of metals from fly ash contaminated sites and suitable species for plantation on fly ash land fills. Reproduced with permission from the CAB Abstracts database.

503. Transport and plant uptake of Zn in an oxyaquic haplustalf amended with coal ash and sewage sludge: A field study.

Khodke, U M; Tripathy, S; Panda, R K; Veeresh, H; and Sajwan, K S.

In: Coal Combustion Byproducts and Environmental Issues. Uppsala, Sweden.: Springer; pp. 159-170; 2006.
Notes: Meeting Information: 7th International Conference on Biogeochemistry of Trace Elements.; ISBN: 0387258655
Descriptors: biochemistry and molecular biophysics/ agronomy: agriculture/ soil science/ Leguminosae: angiosperms, dicots, plants, spermatophytes, vascular plants/ irrigation: applied and field techniques/ field experiment: applied and field techniques/ leaching/ sewage sludge/ coal ash/ loading rate/ root zone/ available soil water/ Oxyaquic Haplustalf/ maximum allowable depletion
Abstract: Field experiments were conducted to study the movement and uptake of Zn in an Oxyaquic Haplustalf (pH = 5.2) amended with coal ash (pH = 7.5) and sewage sludge (pH = 4.3) at low application rates. The plots received cumulative loadings of sludge (39.5 Mg ha⁻¹), ash (78 Mg ha⁻¹) and mixture of ash and sludge (1:2 i.e. 19.5:39 Mg ha⁻¹) over two years. Irrigated peanut (*Arachis hypogaea* L.) was the test crop. Irrigations were scheduled at two levels viz. 15% (I-1) and 50% (I-2) maximum allowable depletion (MAD) of available soil water (ASW) in the root zone. Soil samples were collected from 0-

15, 15-30, 30-45 and 45-60 cm depths during the experiment and analyzed for pH and water extractable concentration (WEC) of Zn. Pre and post experiment profile soil samples were also analyzed for total Zn concentration. The water extractable concentrations (WEC) of Zn were generally higher in sludge treated plots than the ones receiving mixture and ash. This is in accordance to the order of Zn loading by the amendments. Cyclic variation in WEC of Zn was perceptible within the top 15 cm layer of the soil compared to that at higher depths in all sampling periods across the treatments; but was more distinct in the case of plots treated with only sludge. The increase in WEC of Zn below 15 cm layer in sludge treated plots indicated the possibility of leaching. Noticeable increases in total Zn concentrations in the surface layers of sludge and mixture treated plots were observed. The total Zn concentration in the profile soil from sludge applied plots indicated significant movement of Zn within 15-30 cm and thereafter a marginal increase up to 45cm signifying the possibility of Zn movement at lower depths. Plant accumulation of Zn was the highest in sludge treated plots (150 mg kg⁻¹) followed by the ones treated with mixture (99 mg kg⁻¹) and coal ash (56 mg kg⁻¹) as compared to the control (25 mg kg⁻¹). On the other hand, the ratio of concentrations of Zn in the plant to its total in surface soil followed the order -: control < ash < mixture < sludge indicating that the plant accumulation is governed by its loading rates.
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504. Turf culture under declining volume and frequency of irrigation on a sandy soil amended with fly ash.

Pathan, S. M.; Aylmore, L. A. G.; and Colmer, T. D.

Plant and Soil 266(1/2): 355-369. (2004)

NAL Call #: 450 P696; ISSN: 0032-079X

Descriptors: application rates/ evaporation/ fly ash/ growth/ irrigation/ lawns and turf/ leaf water potential / plant water relations/ resistance to penetration/ sandy soils/ soil types/ soil water content/ water stress/ Bermuda grass/ lawns and sports turf/ watering

Abstract: The effects of four rates (0, 5, 10 and 20%, wt/wt) of fly ash amendment in a sandy soil (top 100-120 mm) on soil properties, turf (*Cynodon dactylon* (L.) Pers., cv. Wintergreen) water relations, growth and colour, were assessed during 84 days of irrigation treatments (irrigated daily, every 3rd day, or every 4th day) imposed during summer in a Mediterranean-type climate. In plots irrigated at 40% of net evaporation summed and applied every 3rd day: (i) soil water contents were 14-33% higher in the fly ash amended soil zone when compared to values in plots with non-amended soil; (ii) soil water content below the root zone (i.e., 1500 mm) during that period remained low (being only 1-2% above the permanent wilting point), indicating minimal, if any, deep drainage. Extractable soil P was 2.0- to 3.8-fold higher in the fly ash amended soil compared to non-amended soil. By contrast extractable P was 1.7- to 2.1-fold higher in the soil 100-500 mm below the surface in non-amended plots, compared with fly ash amended plots. Irrigation at 40% replacement of net evaporation summed and applied every 3rd day did not adversely impact on turf growth or colour, when compared to plots irrigated daily, irrespective of fly ash treatments. However, extending irrigations (at 40% of net evaporation) to every 4th day reduced turf growth and colour, but the turf recovered fully from the mild water stress within 21 days of being irrigated daily at 100% replacement of net

evaporation. Therefore, 40% replacement of net evaporation summed and applied every 3rd day was a suitable watering schedule for maintenance of turf, with minimal risks of deep drainage. Reproduced with permission from the CAB Abstracts database.

505. Upper profile changes over time in an Appalachian hayfield soil amended with coal combustion by-products.

Zhou, X.; Ritchey, K. D.; Clark, R. B.; Persaud, N.; and Belesky, D. P.

Communications in Soil Science and Plant Analysis 37(9-10): 1247-1267. (2006)

NAL Call #: S590.C63; ISSN: 0010-3624

Descriptors: agricultural soils/ soil amendments/ coal fly ash/ industrial byproducts/ gypsum/ soil chemical properties/ soil physical properties/ soil depth/ calcium/ magnesium/ land application/ dolomitic limestone/ exchangeable aluminum/ soil hydraulic properties/ soil density/ bulk density/ West Virginia/ hayfield soils/ flue gas desulfurization sludge/ fluidized bed combustion byproducts / calcitic dolomitic limestone

Abstract: Large amounts of flue gas desulfurization (FGD) and fluidized bed combustion (FBC) by-products from burning coal, consisting primarily of gypsum, are available for potential use as a soil amendment. However, information is limited on longer-term changes in chemical and physical properties induced over time and over small depth increments of the upper soil profile after applying these amendments. This study examined longer-term effects in an abandoned Appalachian pasture soil amended with various liming materials and coal combustion by-products (CCBPs). Soil chemical and physical properties were investigated over time and depths. The results indicated limited dissolution and movement of the calcium (Ca) and magnesium (Mg) applied with the chemical amendments, except for Ca and Mg associated with sulfate. However, sufficient dissolution occurred to cause significant increases in exchangeable Ca and Mg and decreases in exchangeable Al that were reflected in corresponding increases in soil pH. These beneficial effects persisted over time and were confined to the upper 0- to 15-cm depth of the profile. The greatest benefits appeared to be in the upper 0- to 5-cm surface layer. Both Ca and Mg applied as calcitic dolomitic limestone tended to be immobilized in the upper 0- to 5-cm layer of the soil profile; Ca more so than Mg. The presence of S applied in the FGD and FBC amendments appeared to enhance the mobility of Ca and Mg. The ratio of Ca/Mg in HCl extracts from the calcitic dolomitic treatment was close to that of applied calcitic dolomite, implying that the inactive component in soil might be the original calcitic dolomite particles. Soil physical properties measured over small depth increments showed that application of the amendments improved the saturated hydraulic conductivity only in the upper 0- to 5-cm depth and had little or no significant effect on the dry bulk density and plant-available water.

This citation is from AGRICOLA.

506. Use coal ash slags with fertilizers.

Pykhiteeva, M. A. and Rafal'skiy, S. V.

Kartofel' i Ovoshchi 8: 9-10. (2006); ISSN: 0022-9148

Descriptors: ash/ crop quality/ crop yield/ fertilizers/ mineral nutrition/ plant development/ plant disease control/ plant

diseases/ plant nutrition/ plant pathogenic fungi/ plant pathogens/ potatoes/ slags/ starch/ trace element fertilizers/ tubers/ micronutrient fertilizers/ Peronosporomycetes/ phytopathogens/ Pythiaceae

Abstract: Investigations were conducted in Russia during 2001-05 to study the effect of various doses of coal ash slags obtained from a brown coal-fired power station used as a chemical soil improver, as well as a combined effect of mineral fertilizers and ash slags on growth, development, yield and quality of potato cv. Nevskii. Ash slags were used at 40, 60 and 80 t/ha, and mineral fertilizers were used at N₄P₄₅K₄₅, N₆₀P₆₀K₆₀ and N₉₀P₉₀K₉₀. Effects of different doses of fertilizers and improvers on disease control, particularly *Phytophthora infestans*, yield and starch content are considered.

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507. Use of alkaline flyash-based products to amend acid soils: Extractability of selected elements and their uptake by plants.

Spark, K. M Swift R. S.

Australian Journal of Soil Research 46(7): 585-599. (2008)
NAL Call #: 56.8 Au7; ISSN: 0004-9573

Descriptors: fly ash/ soil pH/ soil amendments/ acetic acid extract / plant uptake/ contaminants/ Internet resource

Abstract: In addition to promoting plant growth, the incorporation of flyash material into soil also has the potential to affect the solubility and plant availability of some elements. This paper reports on the effect of 2 flyash products (FAP) on the extractability and plant uptake as a function of pH of selected elements of concern in the environment: As, B, Cd, Co, Cu, Cr, Mn, Pb, Ni, and Zn. The results for the growth response of maize plants (*Zea mays* L.) in the FAP-amended soils have been reported in a companion paper. The addition of the FAP to the soils used in this study at rates up to 5% w/w resulted in increased levels of Cu, Mn, Ni, As, and Co in an acetic acid extract. The levels of Cr, Mn, Ni, Pb, Zn, As, and Co in these extracts all showed a dependency on pH for some soils. Maize plants grown in the amended soils exhibited an increase in the plant uptake of Cu, Mn, and Ni in some soils. However, none of the elements studied increased the plant uptake to levels which would generally be considered toxic to plants or cause problems in the food chain. The presence of the FAP decreased the plant availability of Ni at low pH and levels of Mn and Cd in the acetic acid extract were decreased, most likely due to sorption of these elements by the FAP. There is no evidence that either the flyash alone, or the 2 FAP used in this study would pose a threat to plants or the environment when used at levels of up to 5% w/w. Possible beneficial effects for the environment were observed as the incorporation of FAP into soils has the capacity to reduce the uptake and potential toxicity of Cd, Ni, or Mn in some soils. This citation is from AGRICOLA.

508. Use of coal ash generated at Minn-Dak for soil stabilization at a sugarbeet piling site.

Carlson, J. L.; Jensen, P. W.; Groneman, J.; Thilmony, P. J.; Niday, M. G.; and Scharf, J.

In: Proceedings from the 31st Biennial Meeting Operations of the American Society of Sugar Beet Technologists. Vancouver, BC, Canada.; pp. 211-218; 2001.

Descriptors: clay soils/ construction/ environmental impact/ fly ash/ processing/ sampling/ soil amendments/ soil analysis/ soil compaction/ soil stabilization/ soil strength/ sugarbeet/ test procedure/ environmental effects/ sampling techniques/ smectite/ United States of America

Abstract: Results of a study on the use of different tests (ash leach testing, beneficial use testing and finished piling site leachate testing) to assess the potential application of fly ash or a mixture of fly and bottom ash for soil stabilization at a sugarbeet piling site for the Minn-Dak Farmer's Cooperative near Galchutt in the Red River Valley of North Dakota, USA during March 2000 are discussed. The addition of ash from the low sodium-high calcium coals used in the Minn-Dak facility to the smectite clay soils of the Red River Valley stabilized the soil by reducing the shrink-swell potential and reacting with water and soil to produce cementitious properties which provided additional strength to a weak subgrade during construction of the pad and aided soil compaction. Sampling of the amended soils and subsequent chemical analysis suggested that potential environmental impacts that might result from the soil amendment were minimal.

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509. Use of coal combustion products (fly ash) for reducing mud problems in heavy use areas for dairy cattle.

Pennington, J. A.; VanDevender, K. W.; Andrews, M. C.; and Griffin, D. J.

In: Annual Meeting of the American Dairy Science Association/American Society of Animal Science/Canadian Society of Animal Science. Cincinnati, OH, USA.; Vol. 88(Suppl. 1); pp. 21; 2005.

NAL Call #: 44.8 J822

Descriptors: Biochemistry and Molecular Biophysics/ Animal Husbandry: Agriculture/ Bovidae: Animals, Artiodactyls, Chordates, Mammals, Nonhuman Vertebrates, Nonhuman Mammals, Vertebrates/ Rainfall/ Mud/ Feeding Area/ Talcum Powder/ Soil Ash Mixture/ Heavy Use Area © Thomson Reuters

510. The use of coal fly ash in sodic soil reclamation.

Kumar, D. and Singh, B.

Land Degradation and Development 14(3): 285-299. (2003)
NAL Call #: S622.L26; ISSN: 1085-3278

Descriptors: adsorption/ aluminium/ boron/ bulk density/ calcium/ cobalt/ electrical conductivity/ fly ash/ gypsum/ iron/ lead/ magnesium/ manganese/ molybdenum/ nickel/ nitrogen/ phosphorus/ potassium/ reclamation/ saturated hydraulic conductivity/ sodic soils/ sodium/ soil chemical properties/ soil ph/ soil physical properties/ soil types/ soil water/ sulfur/ wheat/ zinc/ aluminum/ chemical properties of soil/ elemental sulphur/ Indian Punjab/ Mn/ Mo/ physical properties of soil/ soil moisture / sulphur

Abstract: An experiment was conducted for two years in northwest India to explore the feasibility of using coal fly ash for reclamation of waterlogged sodic soils and its resultant effects on plant growth in padi-wheat rotation. The initial pH, electrical conductivity, exchangeable sodium percentage and sodium adsorption ratio of the experimental soil were 9.07, 3.87 dS m⁻¹, 26.0 and 4.77 (me l)^{-1/2}, respectively. The fly ash obtained from electrostatic

precipitators of thermal power plant had a pH of 5.89 and electrical conductivity of 0.88 dS m⁻¹. The treatments comprised of fly ash levels of 0.0, 1.5, 3.0, 4.5, 6.0 and 7.5 per cent, used alone as well as in combination with 100, 80, 60, 40, 20 and 10 per cent gypsum requirement of the soil, respectively. There was a slight reduction in soil pH while electrical conductivity of the soil decreased significantly with fly ash as measured after padi and wheat crops. The sodium adsorption ratio of the soil decreased with increasing fly ash levels, while gypsum treatments considerably added to its favourable effects. Fly ash application increased the available elemental status of N, K, Ca, Mg, S, Fe, Mn, B, Mo, Al, Pb, Ni, Co, but decreased Na, P and Zn in the soil. An application of fly ash to the soil also increased the concentrations of above elements except Na, P and Zn in the seeds and straw of padi and wheat crops. The available as well as elemental concentrations in the plants was maximum in the 0 per cent fly ash+100 per cent gypsum requirement treatment except Na and heavy elements like Ni, Co, Cr. The treatment effects were greater in the fly ash+gypsum requirement combinations as compared to fly ash alone. Saturated hydraulic conductivity and soil water retention generally improved with the addition of fly ash while bulk density decreased. Application of fly ash up to 4.5 per cent level increased the straw and grain yield of padi and wheat crops significantly in both years. The results indicated that for reclaiming sodic soils of the southwest Punjab, gypsum could possibly be substituted up to 40 per cent of the gypsum requirement with 3.0 per cent acidic fly ash. Reproduced with permission from the CAB Abstracts database.

511. Use of fly ash in increasing the efficiency of gypsum and fertilizer treatments for revegetation of sodic soil.

Jha, M. N.; Sharma, S. D.; and Gupta, M. K.

Annals of Forestry 13(1): 9-16. (2005); ISSN: 0971-4022

Descriptors: afforestation/ fly ash/ growth/ gypsum/ multipurpose trees/ plant height/ potassium fertilizers/ reclamation/ revegetation/ sodic soils/ soil types/ superphosphates/ survival/ trees/ urea/ use efficiency/ waste utilization/ water management/ woody plants/ potash fertilizers/ reforestation/ reforestation/ water resource management

Abstract: An experiment was conducted near Phulpur NTP plant in Allahabad District, Uttar Pradesh, India to explore the possibilities of using fly ash as an ameliorant in sodic soil for improving its bioproductive potential. Eight treatments consisting of fly ash, fertilizer (urea, single superphosphate and muriate of potash) and gypsum were applied to *Albizia procera* in four replications. Results showed that the survival of *A. procera* was higher and it attained greater height when planted in pits containing 1:1 mixture of fly ash and soil. Maximum survival and height were achieved by planting *A. procera* in pits treated with fly ash, fertilizer and gypsum. The efficiency of gypsum and fertilizer, in promoting the growth performance of *A. procera*, increased by adding fly ash. The experiment therefore, confirmed that fly ash, a byproduct of coal combustion process, could be a potential soil amendment for increasing tree cover in sodic areas.

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512. Use of flyash and biogas slurry for improving wheat yield and physical properties of soil.

Garg, R. N.; Pathak, H.; Das, D. K.; and Tomar, R. K. *Environmental Monitoring and Assessment* 107(1/3): 1-9. (2005)

NAL Call #: TD194.E5; ISSN: 0167-6369

Descriptors: biogas slurry/ bulk density/ crop yield/ fly ash/ leaf area/ leaf area index/ roots/ saturated hydraulic conductivity/ soil amendments/ soil density/ soil physical properties/ soil water content/ soil water retention/ wheat/ LAI/ New Delhi/ physical properties of soil

Abstract: This study explores the potential use of byproducts of energy production, i.e., fly ash from coal-powered electricity generation, and biogas slurry from agricultural waste treatment, as nutrient sources in agriculture. These residues are available in large amounts and their disposal is a major concern for the environment. As both residues contain considerable amounts of plant nutrients, their use as soil amendment may offer a promising win-win opportunity to improve crop production and, at the same time, preventing adverse environmental impacts of waste disposal. The effect of fly ash and biogas slurry on soil physical properties and growth and yield of wheat (*Triticum aestivum*) was studied in a field experiment in New Delhi, India. Leaf area index, root length density and grain yield of wheat were higher in plots amended with fly ash or biogas slurry compared to unamended plots. Both types of amendments reduced bulk density, and increased saturated hydraulic conductivity and moisture retention capacity of soil. The study showed that fly ash and biogas slurry should be used as soil amendments for obtaining short-term and long-term benefits in terms of production increments and soil amelioration.

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513. Use of flyash as environmental and agronomic amendments.

Zhang, G. Y.; Dou, Z.; Toth, J. D.; and Ferguson, J. *Environmental Geochemistry and Health* 26(2): 129-134. (2004)

NAL Call #: TD195.M5 M54; ISSN: 0269-4042

Descriptors: animal manures/ dairy wastes/ desulfurization/ fluidized bed wastes/ fly ash/ pig manure/ poultry manure/ soil amendments/ soil management/ water quality/ desulphurization/ poultry litter/ water composition and quality

Abstract: Coal combustion power plant flyash materials have been reported as useful soil amendments with agronomic and environmental benefits. This paper reports the efficacy of fluidized bed combustion (FBC) and flue gas desulfurization (FGD) byproducts, when amended with dairy, swine, and broiler litter manures, in reducing phosphorus (P) solubility and potential impact on water quality. At a rate of 400 g/kg, FBC reduced water soluble P by 60% for dairy and swine and 50% for broiler litter, as compared to un-treated control samples. Byproduct FGD had little effect when amended into dairy manure, but reduced water soluble P by nearly 80% when amended into swine and broiler manure at a rate of 250 g/kg. The amount of Ca added in the amendments together with pH of the mixture is the major contributing factor in soluble P reduction. Sequential extraction results showed that the flyash treatments shifted water soluble P into mainly bicarbonate extractable P. The latter is still considered

available for crop uptake but less vulnerable for environmental losses. Coal combustion byproducts, when amended into manure and used properly, can provide a useful and viable option for improving nutrient management on animal farms.

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514. The use of polymers and coal combustion by-products for amelioration of crusting in disturbed soils.

Stoddard, Albert Augustus III
Athens, GA, United States : University of Georgia, 1998.

Descriptors: ash/ biodiversity/ coal/ combustion/ erosion/ fertilizers/ gypsum/ infiltration/ polyacrylamide/ polymers/ rainfall/ runoff/

sedimentary rocks/ sedimentation/ simulation/ soils/ stabilization/ sulfates/ surface water/ testing

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515. Use of resistant varieties and organic nutrients to manage yellow stem borer in rice.

Rani, B. U.; Rajendran, R.; and Suresh, K. *International Rice Research Notes* 31(2): 39-41. (2006)
NAL Call #: SB191.R5I6; ISSN: 0117-4185

Descriptors: botanical insecticides/ cultivars/ cultural control/ farmyard manure/ fly ash/ insect control/ insect pests/ neem seed cake/ non wood forest products/ organic amendments/ pest control/ pest resistance/ phosphate solubilizing bacteria/ plant pests/ rice/ silica/ biofertilizers/ cultivated varieties/ FYM/ Madras / minor forest products/ neem seed oilmeal/ non timber forest products/ paddy

Abstract: An experiment was conducted from October 2004 to January 2005 at Agricultural College and Research Institute in Tamil Nadu, India to determine the impact of using resistant cultivars (TKM6, IR36 and a control MDU5) and organic nutrients (farmyard manure (FYM), biofertilizers (Azospirillum+phosphobacterium+silica solubilizing bacteria (SSB)), lignite fly ash, neem seed cake) to manage yellow stem borer [*Scirpophaga incertulas*] in rice. The percent deadhearts recorded at 30 and 45 days after transplanting (DAT) and the percent whiteheads at 70 DAT were significantly different. Deadhearts ranged from 0.51% to 12.04% at 30 DAT. TKM6 treated with FYM, Azospirillum, phosphobacterium, SSB, lignite fly ash and neem seed cake recorded significantly less deadheart incidence (0.51%) with a corresponding reduction of 95.8% and 83.8% over MDU5+NPK (inorganic) and TKM6+NPK (inorganic), respectively. The same trend was observed at 45 DAT. TKM6 given organic nutrients recorded the lowest whitehead incidence (0.97%) against that of MDU5+NPK (inorganic) (6.9%).

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516. Using low calcium ash of brown coal from the azeiskoe deposit as a combined amendment for gray forest soil.

Kulikova, N. N.; Sutorin, A. N.; Tanicheva, I. V.; Antonenko, A. M.; Paradina, A. F.; Boiko, S. M.; and Kochnev, N. K. *Agrokhimiya* 0(6): 21-27. (1999); ISSN: 0002-1881

Descriptors: soil science/ Gramineae: angiosperms, monocots, plants, spermatophytes, vascular plants/ Leguminosae: angiosperms, dicots, plants, spermatophytes, vascular plants/ gray forest soil

Abstract: The positive effect of brown coal low-calcium ash on the complex of the physicochemical properties was studied in gray forest gleyey medium loamy soil. The biological activity of the soil was investigated as was the productivity of potatoes, pea-oat mixture, and maize. The effect of the ash on the trace element composition of the soil and plants was considered. The ash was produced by coal from Azeiskoe deposits in Russia.

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517. Utilisation of lignite flyash as source of plant nutrient for rice.

Jeyabal, A.; Arivazhagan, K.; and Thanunathan, K.

Fertiliser News 45(7): 55-58. (2000)

NAL Call #: 57.8 F4123; ISSN: 0015-0266

Descriptors: alkaline soils/ application rates/ dry matter accumulation/ field experimentation/ filter cake/ fly ash/ plant nutrition/ pollution/ rice/ soil amendments/ sugarcane byproducts/ yield components/ yields/ clarification mud/ environmental pollution/ Madras/ paddy

Abstract: In field studies on alkaline soils at the Annamalai University Experimental Farm, Tamil Nadu, India, 10 or 20 t sugarcane pressmud [filter cake]/ha and/or 1 or 2 t lignite fly ash (LFA)/ha were incorporated into the soil before transplanting rice cv. ADT 37. Combined application of pressmud and LFA increased tiller numbers, dry matter production, panicle numbers and grain and straw yields. Grain yields with combined application were 6.33 t/ha compared with 5 t/ha in the control. Addition of LFA at 2 t/ha to 10 t pressmud/ha gave yields 9.2% higher than with pressmud alone. The combined application of both LFA and pressmud was recommended for increased rice yields. Also, utilization of sugar industry waste (pressmud) in agriculture reduces pollution risks.

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518. Utility of flyash in agriculture: A review.

Suwalka, R. L.

Agricultural Reviews 24(3): 197-203. (2003); ISSN: 0253-1496

Descriptors: acid soils/ alkaline soils/ fly ash/ growth/ nutrient content/ nutrient uptake/ reviews/ seed germination/ soil amendments/ soil chemical properties/ soil physical properties/ soil types/ sustainability/ chemical properties of soil/ physical properties of soil

Abstract: Characterization of fly ash has widely shown about its usefulness in improving soil physico-chemical properties and crop growth, as its disposal needs large area of land. The research conducted on the use of fly ash in agriculture indicates that main constituents of flyash are silicates of iron and aluminium. It contains fairly high available major nutrients like P, K and S and micronutrients such as Zn, Cu, Fe, Mn and B with high bioavailable heavy metals. Depending upon its source of availability it may be acidic or alkaline in reaction and therefore, it can be used as ameliorant to reclaim acidic and alkali soils. Fly ash also acts as a soil modifier to upgrade the physical properties of clay as well as sandy soil. Fly ash not only enhance germination of seed but also helps in development of plant due to increased nutrient content and uptake by plants in terms of sustainable economic production. Further, the work done in India is very scanty on the use fullness of fly ash in agriculture like as build up of heavy metals as well as

toxic levels of nutrients, its use in combination with fertilizer and compost and its effect on the soil microbes responsible for nitrification. Hence an attempt has been made to summarize the work done in recent past on the use of fly ash in crop production in this review article.

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519. Utilization of coal fly ash; a solid waste from thermal power stations; in agriculture and its effect on soil properties and crop yields.

Srivastava, P. C.; Prashant Srivastava; Singh, S. K.; and Gangwar, M. S.

Reutilization of Industrial Effluents and Waste: 123-131. (2001)

Descriptors: agricultural soils/ agriculture/ biochemistry/ chemical composition/ coal/ crop yield/ fly ash / microbiology/ nutrient content/ organic wastes/ plant nutrition/ power stations/ soil chemical properties/ soil conditioners/ soil fertility/ soil physical properties/ soil types/ solid wastes/ thermal energy/ trace element fertilizers/ chemical properties of soil/ micronutrient fertilizers/ physical properties of soil

Abstract: Coal fly ash, a solid waste from thermal power stations, can be used in agriculture as a soil conditioner and micronutrient source. Some physical and chemical properties of coal fly ashes, including those derived from Indian coals, are reviewed. Indian coal fly ashes are deficient in N, medium to high in P, high in K, Ca, Mg, S, B and micronutrient cations. The effects of coal fly ash application on soil physical, chemical, microbiological and biochemical properties of soil are discussed. Application of coal fly ash to soil affects both macro- and micronutrient content as well as yields of growing plants depending upon application rate, stage of weathering, composition of fly ash and the nature of crop. The combined use of coal fly ash at tolerable levels of toxic elements and organic manure is beneficial for obtaining higher yields.

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520. Utilization of coal fly ash as a slow-release granular medium for soil improvement.

Yoo JeongGun and Jo YoungMin

Journal of the Air and Waste Management Association 53(1): 77-83. (2003); ISSN: 1047-3289

Descriptors: coal/ fly ash/ granules/ leaching/ potassium/ potassium fertilizers/ potassium hydroxide/ slow release fertilizers/ soil amendments/ waste management/ waste utilization/ potash fertilizers

Abstract: This work proposes a new potential application of waste coal fly ash as a K fertilizer support. Fly ash was reacted with KOH to facilitate the impregnation of K as well as to enhance the bonding force. In particular, the applied process resulted in a significant slow-releasing characteristic of fertilizer elements. To examine the effect of K impregnation, a few detailed leaching tests were carried out in terms of process variables such as reaction time and temperature, sintering time and temperature, and KOH concentration. The current experiment presented an optimum preparation condition that is competitive with conventional commercial fertilizers. The manufactured ash fertilizers inhibited release of the K elements. It was also

found through the continuous leaching test with pure water that the ash fertilizer had excellent moisture absorbability. Reproduced with permission from the CAB Abstracts database.

521. Utilization of coal fly ash for the production of artificial aggregates as a crop growth medium with acidic "Kunigami Mahji" soils in Okinawa, Japan.

Jayasinghe, G. Y. and Tokashiki, Y. 32(1): 1-9. (2006); ISSN: 10881697

Descriptors: 'Kunigami Mahji' soils/ Aggregate stability/ Aggregate strength/ Coal fly ash/ Synthetic light weight aggregates (SLWA)/ Agriculture/ Coal ash/ Industrial waste disposal/ Land fill/ Soil conditioners/ Coal fly ash/ Crop production/ Synthetic light weight aggregates (SLWA)/ Industrial wastes/ Brassica/ Brassica rapa/ Brassica rapa subsp rapa/ Spinacia oleracea

Abstract: The escalating world wide production of coal fly ash and its respective costs of disposing create an urgent need to find potential utilization methods in order to avoid disposal as land fillings. Development of synthetic light weight aggregates (SLWA) with coal fly ash and used paper can be regarded as an unconventional method for ash utilization which is being not much addressed. This study examined the properties of SLWA developed by coal fly ash, used paper and starch as a binder and their utilization as a soil amendment to improve the crop production in acidic, low productive 'Kunigami Mahji' soils in sub tropical Okinawa, Japan. Produced aggregates showed high levels of stability, strength and water holding capacities. Moreover heavy metal contents in aggregates were analyzed and found to remain well below the permissible level. SLWA, which had the highest aggregate stability and strength (i.e. produced at 20% level of starch application) were used as an amendment to improve the crop production in 'Kunigami Mahji' soils. Aggregates were mixed in 6 proportions with 'Kunigami Mahji' soils at the percentages of 0 % (100 % soil), 10%, 25%, 50%, 75% and 100% (100% SLWA) in a pot experiment. Komatsuna, which is called Japanese mustard spinach (*Brassica rapa* Var. *Pervidis*), was used in the experiment. It is evident that aggregate mixing percentage up to 25% with 'Kunigami Mahji' soils, was the best mixing percentage which gave the maximum yield. Moreover SLWA addition as a soil amendment significantly enhanced physical and chemical properties of 'Kunigami Mahji' soils. Therefore, this study demonstrates that coal fly ash together with used paper can be used to produce synthetic light weight aggregates, which can be utilized to improve the crop production in low productive 'Kunigami Mahji' soil as a soil amendment. Moreover this SLWA production can be recommended as an effective alternative method for fly ash disposal.

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522. Utilization of ingredients from fuel ashes for fertilization of triticale plants: Wykorzystanie skadnikow popiou weglowego do nawozenia roslin pszenzyta.

Murkowski, A. and Stankowski, S.

Folia Universitatis Agriculturae Stetinensis, Agricultura 91: 87-91. (2002); ISSN: 1506-1973.

Notes: Language: Polish.

Descriptors: fertilizers/ fly ash/ photosynthesis/ seedlings/

triticale/ vigour/ carbon assimilation/ carbon dioxide fixation/ vigor

Abstract: The effects of solutions from stone ash produced by a "Dolan Odra" power plant (Poland) on two-week-old seedlings of triticale cv. Bogo were studied under laboratory conditions. The results showed that the water fraction from the ashes was not phytotoxic. The water fraction from ashes supplemented with fertilizers had a positive effect on the light phase of photosynthesis and on the vitality index of plants.

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523. Utilization of the gypsum from a wet limestone flue gas desulfurization process.

Chou, M.-I. M.; Patel, V.; Lytle, J. M.; Chou, S. J.; and Carty, R. H.

In: Proceedings of the International Conference on Solid Waste Technology and Management.

Philadelphia, PA, USA: Widener University School of Engineering; pp. 754-760; 1999.

Notes: Chapter Number: Chester, PA, United States.;

ISBN: 10918043

Descriptors: calcium compounds/ cost benefit analysis/ desulfurization/ fertilizers/ flue gases/ gypsum/ limestone/ soil mechanics/ wet limestone flue gas desulfurization process/ effluent treatment

Abstract: The authors have been developing a process which converts FGD-gypsum to ammonium sulfate fertilizer with precipitated calcium carbonate as a by-product during the conversion. Preliminary cost estimates suggest that the process is economically feasible when ammonium sulfate crystals are produced in a granular size (1.2 to 3.3 mm), instead of a powder form. However, if additional revenue from the sale of the PCC for higher-value commercial application is applicable, this could further improve the economics of the process. Ammonium sulfate is known to be an excellent source of nitrogen and sulfur in fertilizer for corn and wheat production. It was not known what impurities might co-exist in ammonium sulfate derived from scrubber gypsum. Before the product could be recommended for use on farm land, the impurities and their impact on soil productivity had to be assessed. The objectives of this phase of the study were to evaluate the chemical properties of ammonium sulfate made from the FGD-gypsum, to estimate its effects on soil productivity, and to survey the marketability of the two products. The results of this phase of the study indicated that the impurities in the ammonium sulfate produced would not impose any practical limitations on its use at application levels used by farmers. The market survey showed that the sale price of solid ammonium sulfate fertilizer increased significantly from 1974 at \$110/ton to 1998 at \$187/ton. Utilities currently pay \$16 to \$20/ton for the calcium carbonate they use in their flue gas scrubber system. The industries making animal-feed grade calcium supplement pay \$30/ton to \$67/m-ton for their source of calcium carbonate. Paper, paint, and plastic industries pay as much as \$200 to \$300/ton for their calcium carbonate fillers. The increased sale price of solid ammonium sulfate fertilizer and the possible additional revenue from the sale of the PCC by-product could further improve the economics of producing ammonium sulfate from FGD-gypsum.

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524. Variability of inorganic and organic constituents in lime spray dryer ash.

Taerakul, P.; Sun, P.; Walker, H.; Weavers, L.; Golightly, D.; and Butalia, T. 84(14-15): 1820-1829. (2005); ISSN: 00162361 [FUELA].

Notes: doi: 10.1016/j.fuel.2005.03.015.

Descriptors: Lime spray dryer ash/ Re-use/ Variability/ Byproducts/ Coal combustion/ Desulfurization/ Electrostatic separators/ Flue gases/ Hazardous materials/ Leachate treatment/ Leaching / Molecular weight/ Polycyclic aromatic hydrocarbons/ Power plants/ Pyrolysis/ Available lime index (ALI)/ Lime spray dryer (LSD) ash/ Re-use/ Variability/ Coal ash

Abstract: Flue gas desulfurization (FGD) by-products, including lime spray dryer (LSD) ash, have many demonstrated uses. However, concern about the temporal variability in the chemical properties of this material has limited widespread utilization. To determine the variability in inorganic and representative model organic constituents, this study measured elemental composition, leaching properties, polycyclic aromatic hydrocarbon (PAH) concentrations, available lime index (ALI), calcium carbonate equivalent (CCE), and total neutralization potential (TNP) for a representative LSD ash. All parameters investigated showed little variability over different time periods (e.g., daily to yearly) and little variability between samples collected from different particle collection hoppers. Metal concentrations including As, Se, and Hg in LSD ash and in the leachate did not surpass limits for land application (EPA 503 Rule) or limits for the determination of hazardous waste as specified in the Resource Conservative and Recovery Act (RCRA). While a number of PAHs were detected, including naphthalene and phenanthrene, the levels were low and in the range of natural soils. The low variability in ALI, CCE, TNP, and inorganic and organic composition suggests that LSD ash is a consistent and environmentally benign material for agricultural and other engineering applications. _ 2005 Elsevier Ltd. All rights reserved.

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525. Vase life of cut roses grown in coal bottom ash-amended media: A correlation with tissue calcium.

Cross, Marlene; Bearce, Bradford; and Arora, Rajeev. In: 97th Annual International Conference of the American Society for Horticultural Science. Lake Buena Vista, Florida, USA.; Vol. 35(3).; pp. 405; 2000.

NAL Call #: SB1.H6

Descriptors: Horticulture: Agriculture/ Rosaceae: Angiosperms, Dicots, Plants, Spermatophytes, Vascular Plants/ Coal Bottom Ash Amended Media/ Vase Life/ Meeting Abstract/ Meeting Poster

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526. Weed flora mediated mycorrhizal infective potential preservation benefit for succeeding crops in fly ash.

Goswami, A.; Panja, B. N.; and Chaudhuri, S.

Journal of Interacademia 11(2): 244-246. (2007); ISSN: 0971-9016

Descriptors: cowpeas/ dry matter accumulation/ farmyard manure/ fly ash/ growth/ inoculum/ maize/ mycorrhizas/ plant colonization/ plant height/ rhizosphere/ roots/ weeds/

Bermuda grass/ black eyed peas/ corn/ FYM/ southern peas

Abstract: This study was conducted to investigate whether the roots of five mycorrhizal weeds (viz., *Cynodon dactylon*, *Urochloa mutica*, *Eleusine indica*, *Colocasia esculenta* and *Borreria hispida*) grown on fly ash could be used as inoculum source, and to determine whether mycorrhizal potential preserved by them would be helpful for the growth and nutritional improvement of the succeeding crops grown on fly ash. The roots and rhizosphere ash sample of five weed species with intensity of 59.3-77.6% mycorrhizal colonization were collected in bulk from 0-2 m zone from the borderline of the fly ash pond of Bandel Thermal Power Station in West Bengal, India. Fly ash was amended with sterilized farmyard manure. The growth responses of cowpea, maize and jowar (sorghum) grown in fly ash under inoculated and non-inoculated mycorrhizal conditions revealed that mycorrhizal plants exhibited higher growth response in terms of plant height, dry matter accumulation in root and shoot than non-mycorrhizal control plants. Percent increment of plant height and total dry matter accumulation over non-mycorrhizal one was higher in maize and jowar respectively, followed by other crops. Total dry matter gained by the crops due to mycorrhization ranged from 40.2-73.3%. Based on these results, the inoculum prepared by mixing the roots of mycorrhizal weed species could be used as source for inoculating mycorrhiza-susceptible crops.

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527. Western Australian fly ash on sandy soils for clover production.

Summers, R.; Clarke, M.; Pope, T.; and O'Dea, T. *Communications in Soil Science and Plant Analysis* 29(17/18): 2757-2767. (1998)

NAL Call #: S590.C63; ISSN: 0010-3624

Descriptors: analysis / cadmium/ dry matter/ fertilizers/ fly ash/ foliar diagnosis/ growth/ mercury/ pastures/ phosphorus/ phosphorus fertilizers/ potassium/ potassium fertilizers/ retention/ sandy soils/ soil/ variation/ foliage diagnosis/ grazing lands/ phosphate fertilizers/ potash fertilizers/ tissue analysis

Abstract: An experiment was conducted to determine the value of fly ash in Western Australia as an amendment for sandy soils and as a replacement for phosphorus or potassium fertilizers. The results showed large increases in clover (*Trifolium subterraneum*) dry matter production (49% to 278%), attributed to improvements in nutrient and water retention from the fly ash. The fly ash provided a substantial amount of the phosphorus needed by the clover, although application of phosphorus fertilizer further increased dry matter production in the presence of fly ash. No evidence was obtained from plant growth or tissue analysis that the fly ash provided potassium to the pasture. The maximum yield was achieved when 50 t fly ash/ha was applied to the soil. However, only 10 to 40 t/ha was required to achieve 75 to 90% of the maximum production. Although a statistically significant increase in cadmium and mercury concentration could be attributed to fly ash, the increase was small and within the range of natural variation of levels found at the sites.

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528. Yield and nutrition of rice and wheat in a fly ash-amended soil.

Benipal, D. S.; Manchanda, J. S.; Kansal, B. D.; Arora, C. L.; and Thind, H. S.

Environment and Ecology 24S(Special 4): 1145-1149. (2006)

NAL Call #: TD172.E5; ISSN: 0970-0420

Descriptors: aluminium/ application rates/ bulk density/ cadmium/ calcium/ chemical composition/ copper/ crop yield/ fly ash/ iron/ lead/ magnesium/ manganese/ nickel/ nutrient availability/ nutrient content/ phosphorus/ plant composition/ potassium/ radionuclides/ rice/ seeds/ sequential cropping/ soil density/ soil organic matter/ soil pH/ sulfur/ waste utilization/ wheat/ zinc/ aluminum/ chemical constituents of plants/ elemental sulphur/ Mn/ organic matter in soil/ paddy/ radioactive isotopes/ radioactive nuclides/ radioisotopes/ sulphur

Abstract: A field experiment was conducted in Ropar, Punjab, India, during 1999-2000 to study the effects of fly ash (0, 10, 20 and 40 t/ha) on soil properties, yield, and nutrition of crops in a rice-wheat system. Soil pH and bulk density decreased, while organic matter increased with the application of 40 t fly ash/ha. The availability of P, S and Cu in soil decreased, while that of K, Ca, Mg, Zn, Fe and Mn increased with graded levels of applied fly ash. The grain yield of rice increased by 4.5 and 2.3 quintal/ha over the control with the application of 10 and 20 t fly ash/ha, respectively. The levels of Al, Cd, Ni and Pb in soil and grains of wheat and rice, and the concentration of radionuclides (40K, 226Ra and 228Ac) in wheat grain was within the permissible limits. [1.0 quintal=100.0 kg]. Reproduced with permission from the CAB Abstracts database.

529. Yield and trace metal levels in rice (*Oryza sativa*) as influenced by flyash, fertilizer and farmyard manure application.

Arvind Kumar; Sarkar, A K; Singh, R P; and Sharma, V N
Indian Journal of Agricultural Sciences 68(9): 590-592. (1998)

NAL Call #: 22 AG831; ISSN: 0019-5022

Descriptors: cereal grains/ cobalt/ contamination/ copper/ crop yield/ farmyard manure/ fly ash/ grain/ heavy metals / iron/ lead/ manganese/ manures/ mineral nutrition/ mineral uptake/ nickel/ NPK fertilizers/ plant nutrition/ rice/ soil amendments/ trace elements/ yields/ zinc/ FYM/ microelements/ Mn/ paddy

Abstract: In a field experiment in 1994 in Bihar, rice (*Oryza sativa*) was amended with 4 or 8% fly ash with NPK fertilizer and/or farmyard manure (FYM). The application of 8% fly ash + the recommended NPK rate produced the highest grain yield of 4.85 t/ha which was not significantly different from 4.63 t obtained with 4% fly ash + 10 t FYM + 50% of the recommended NPK rate. Nickel content of rice grain was higher with 8 than 4% fly ash alone (7.6 vs. 4.4 mg/kg), but the uptake of other trace elements (Fe, Mn, Cu, Co, Pb and Zn) were not significantly different. Fly ash did not significantly influence the availability of trace metals in soil.

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530. Yield and trace metals of vegetable crops as influenced by fly ash.

Arvind Kumar; Rajesh Kumar; Singh, R. P.; and Sarkar, A. K.

Journal of Research, Birsa Agricultural University 17(2): 155-160. (2005); ISSN: 0971-1724

Descriptors: cobalt/ copper/ crop yield/ fly ash/ iron/ lead/ manganese/ nickel/ nutritive value/ okras/ potatoes/ tomatoes/ zinc/ Mn/ nutritional value/ quality for nutrition

Abstract: Field experiments conducted during 1997/98 and 1998/99, in Ranchi, Bihar, India, revealed that the yield of okra, tomato, colocasia and potato increased significantly due to the incorporation of fly ash (0, 4, 8 and 16%) in soil. Per cent increase in yield of all crops was maximum under the treatment with 16% fly ash. Content of trace metals (Zn, Cu, Fe, Mn, Pb, Ni and Co) in edible parts increased when the crops were grown in fly ash-treated soil. The study highlighted the need to monitor the trace metal levels, especially heavy metals (Pb, Ni and Co) which increased from 4.15 to 31.40, 5.33 to 26.67 and 4.39 to 43.30 mg kg⁻¹, respectively, when plants were grown in and around fly ash dumps. Higher content of heavy metals in short duration crops is a potential health hazard which prohibits its application in soil as a plant nutrient source or as a soil conditioner.

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531. Yield, NPK concentration and their uptake by sunflower and cotton as influenced by fly ash with and without FYM and fertilizers.

Malewar, G. U.; Badole, S. B.; Mali, C. V.; and Siddiqui, M. B.

Journal of Soils and Crops 9(1): 18-22. (1999); ISSN: 0971-2836

Descriptors: cotton/ crop yield/ farmyard manure/ fertilizers/ fly ash/ mineral uptake/ NPK fertilizers/ nutrient uptake/ sunflowers/ uptake/ vertisols/ FYM

Abstract: In field experiments on Vertisols at Parbhani, Maharashtra, India, sunflowers cv. MFSH-8 and cotton cv. NHH-44 were given different combinations of NPK fertilizers, FYM and 0-20 t fly ash/ha. Sunflower seed and seed cotton yields were significantly increased due to combined application of FYM (10 t/ha) + full recommended doses of 60:30:30 and 80:40:40 kg NPK/ha, respectively. The optimum rate of fly ash was 10 t/ha for both crops. Data on NPK concentrations and uptake are tabulated, and follow a similar pattern to crop yields.

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532. Zeolite synthesis from pre-treated coal fly ash in presence of soil as a tool for soil remediation.

Terzano, R.; Spagnuolo, M.; Medici, L.; Tateo, F.; and Ruggiero, P.

Applied Clay Science 29(2): 99-110. (Apr. 2005)

NAL Call #: TA455.C55; ISSN: 0169-1317.

Notes: References: 50; illus. incl. 2 tables. DOI: 10.1016/j.clay.2004.12.006.

Coal Combustion Byproducts

Descriptors: ash/ chemical properties/ chemical ratios/ clay mineralogy/ degradation/ faujasite/ framework silicates/ geochemistry/ heavy metals/ pollution/ remediation/ silicates/ soil pollution/ soil treatment/ soils/ synthesis/ zeolite group/ Environmental geology/ Geochemistry of rocks, soils, and sediments/ Sedimentary petrology
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