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Impact of Flyash Pollutant on Growth Performance of Selected Herbaceous Flora of Southern Rajasthan

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ABSTRACT: Fly ash is a coal combustion product. It is part of a set of products that makes up the most abundant waste materials worldwide.^[1] If not collected, this waste material is blown out with the flue gas in a coal fired power plant. Fly ash exists after combustion because ash adheres to coal, making up between 1-15% of its weight. About 90% of the ash is fly ash, while 10% is bottom ash.^[2] Fly ash is composed of tiny, airborne particles and is thus considered to be a type of particulate matter or particle pollution.^[3] Below is a comparison of fly ash and bottom ash, to show the size difference of the particles and the difference in texture. Fly ash, a result of coal burning in thermal power plants, is sustainably used in agriculture and has been regarded as a problematic solid waste worldwide. The presence of some desired nutrients (macro and micro) and its porosity makes it a marvelous soil amendment for plant growth and development. The higher doses, i.e., 40% and 50% of fly ash showed a negative effect and reduced the growth, chlorophyll, carotenoid, biochemical content, proline, and yield in pumpkin crop. We concluded that the lower level of fly ash (up to 30%) could be used as fertilizer in agricultural fields for the improvement of vegetable as well as other food crops in a sustainable manner but the higher level of fly ash (40 and 50%) is toxic to the plant.

I. INTRODUCTION

Though a large percentage of the total area is desert and even though there is little forest cover, Rajasthan has a rich and varied flora and fauna. The natural vegetation is classed as Northern Desert Thorn Forest. These occur in small clumps scattered in a more or less open forms. Density and size of patches increase from west to east following the increase in rainfall. The Northwestern thorn scrub forests lie in a band around the Thar Desert, between the desert and the Aravallis.

The Aravalli and the south-eastern region is home to the dry deciduous forests, with tropical dry broadleaf forests that include teak, Acacia, and other trees. The hilly 'Vagad' region lies in southernmost Rajasthan, on the border with Gujarat. With the exception of Mount Abu, Vagad is the wettest region in Rajasthan, and the most heavily forested. North of 'Vagad' lies the Mewar region, home to the cities of Udaipur and Chittaurgarh. The Hadoti region lies to the southeast, on the border with Madhya Pradesh. North of 'Hadoti' and 'Mewar' lies the 'Dhundhar' region, home to the state capital of Jaipur. Mewar, the easternmost region of Rajasthan, borders Haryana and Uttar Pradesh. All these regions have varied flora and fauna distinct to the region.

Plant Biodiversity IN SOUTH RAJASTHAN

ANGIOSPERMS

Wild Species.....1714

Agro-horticultural Species.....320

Total2034

GYMNOSPERMS: Wild Species.....01

CRYPTOGAMS

Liverworts & Hornworts37



Mosses.....42

Ferns.....60

Plants of special interest

- Red data Species02
- Orchids.....14
- Terrestrial 08
- Epiphytic 06

Parasitic Species..... 10

Carnivorous Species 05

Endemic Species19

Medicinal Plant Species 157+

Fly Ash (FA)-a coal combustion residue of thermal power plants has been regarded as a problematic solid waste all over the world. Disposal of high amount of fly-ash from thermal power plants absorbs huge amount of water, energy and land area by ash ponds. Therefore, fly-ash management would remain a great concern of the century. However, several studies proposed that FA can be used as a soil ameliorate that may improve physical, chemical and biological properties of the degraded soils and is a source of readily available plant micro-and macro-nutrients. Practical value of FA in agriculture as an eco-friendly and economic fertilizer or soil amendments can be established after repeated field experiments for each type of soil to confirm its quality and safety. Fly-ash has great potentiality in agriculture due to its efficacy in modification of soil health and crop performance. The high concentration of elements (K, Na, Zn, Ca, Mg and Fe) in fly-ash increases the yield of many agricultural crops. But the use of fly-ash in agriculture is limited compare to other sector. An exhaustive review of numerous studies of last four decades took place in this study, which systematically covers the importance, scope and apprehension regarding utilization of fly-ash in agriculture. This study also identified some areas, like soil fertility and its response on cereal oil seed and vegetable crops. Agricultural lime application contributes to global warming as Intergovernmental Panel on Climate Change (IPCC) assumes that all the carbon in agricultural lime is finally released as CO₂ to the atmosphere. It is expected that use of fly-ash instead of lime in agriculture can reduce net CO₂ emission and also reduce global warming.

II. DISCUSSION

Fly-ash application to sandy soil could permanently alter soil texture, increase microporosity and improve the water-holding capacity . Fly-ash addition at 70 t ha⁻¹ has been reported to alter the texture of sandy and clayey soil to loamy .Addition of fly-ash at 200 t acre⁻¹ improved the physical properties of soil and shifted the USDA textural class of the refuge from sandy loam to silt loam . The particle size range of fly-ash is similar to silt and changes the bulk density of soil. It was observed that among five soil types, Reyes silty clay showed an increase in bulk density from 0.89 to 1.01 g cc⁻¹ and a marked decrease in soils having bulk density varying between 1.25 and 1.60 g cc⁻¹ when the corresponding rates of flyash amendment increased from 0 to 100%. Application of fly-ash at 0, 5, 10 and 15% by weight in clay soil significantly reduced the bulk density and improved the soil structure, which in turn improves porosity, workability, root penetration and moisture-retention capacity of the soil . Hence concluded that addition of fly-ash up to 46% reduced the dry density of the soil in the order of 15-20% due to the low specific gravity and unit weight of soil. A gradual increase in fly-ash concentration in the normal field soil (0, 10, 20 up to 100% v/v) was reported to increase the porosity and water-holding capacity (Khan and Khan, 1996). This improvement in water-holding capacity is beneficial for the growth of plants



especially under rainfed agriculture. Amendment with fly-ash up to 40% also increased soil porosity from 43 to 53% and water-holding capacity from 39 to 55%. Fly-ash had been shown to increase the amount of plant available water in sandy soils. The Ca in fly-ash readily replaces Na at clay exchange sites and thereby enhances flocculation of soil clay particles, keeps the soils friable, enhances water penetration and allows roots to penetrate compact soil layers. Water-holding capacities of fly-ashes from different thermal power plants in Eastern India were compared and the effect of size fractionation on the water-holding capacity was determined in an investigation by a scientist. Agricultural utilization of fly ash has been proposed because of its considerable content of K, Ca, Mg, S and P. Fly ash addition generally increases plant growth and nutrient uptake. It was reported that fly ash increased crop yield of alfalfa (*Medicago sativa*), aloe (*Aloe vera*), Bermuda grass (*Cynodon dactylon*) and white clover (*Trifolium repens*). Addition of unweathered western US fly ash up to 8% (w/w) to either calcareous or acidic soils resulted in higher yield of several agronomic crops (Page *et al.*, 1979) mainly due to increased availability of S to plants. Furr *et al.* (1977) demonstrated that alfalfa, sorghum (*Sorghum bicolor*), field corn (*Zea mays*), millet (*Echinochloa crusgalli*), carrots (*Daucus carota*), onion (*Allium cepa*), beans (*Phaseolus vulgaris*), cabbage (*Brassica oleracea*), potatoes (*Solanum tuberosum*) and tomatoes (*Lycopersicon esculentum*), babool, kikar, cactus and other plants of Rajasthan in South could be grown on a slightly acidic soil (pH 6.0) treated with 125 mt ha⁻¹ of unweathered fly ash. These plants exhibited higher contents of As, B, Mg and Se. Also winter wheat (*Triticum aestivum*) grown on a deep bed of fly ash produced grains containing higher Se. Greenhouse experiments conducted by Sikka and Kansal who showed that application of 2-4% fly ash significantly increased N, S, Ca, Na and Fe content of rice (*oryza sativa*) plants. The foliar application of fly ash also enhances growth and metabolic rates, as well as increasing the photosynthetic pigments of crops like maize and .They did not find any residual effect of fly ash application on the following wheat crop except for a slight increase in Fe content of the soil. The post harvest soil samples from rice and wheat also did not show any change in the nutrient content and pH. The iron content of the soil however, increased to 18 from 12%. The application at 40% fly ash can increase the yield of tomato by 81% and market value (mean fruit weight). Increased selenium accumulation in plant tissues with increased fly ash application warrants close monitoring and use of appropriate quantity of weathered fly ash depending upon the end use of the produced biomass. Application of 5-20% fly ash on w/w basis in the plough layer (0-15 cm) increased both grain and straw yield of pearl millet (*Pennisetum sp.*) followed by wheat (Grewal *et al.*, 2001). Lau and Wong (2001) reported that weathered coal fly ash at 5% resulted in higher seed germination rate and root length of lettuce (*Lactuca sativa*). The amino acid content in soybean (*Glycine max*) was found to show an increase when grown in fly ash amended soils in pot cultures (Goyal *et al.*, 2002). High yield of aromatic grasses particularly palmarosa (*Cymbopogon martini*) and citronella (*Cymbopogon nardus*), in presence of different fly ash-soil combinations, was attributed to increased availability of major plant nutrients. Fly ash applied at 25% showed higher yield of brinjal (*Solanum melongena*), tomato and cabbage. Oil seed crops such as sunflower (*Helianthus sp.*) and groundnut (*Arachis hypogaea*) also responded favorably to fly ash amendment. Medicinal plants such as cornmint (*Mentha arvensis*) and vetiver (*Vetiver zizanoides*) were successfully planted in fly ash used in conjunction with 20% farmyard manure (FYM) and mycorrhiza. The level of 40% fly ash was found to have nematocidal effect and was suggested for the management of root knot disease in tomato caused by *Meloidogyne sp.* and providing nutrients. Tomato cultivars grown on fly ash amended soils had higher tolerance to wilt fungus *Fusarium oxysporum*.

III. CONCLUSION

Saving of chemical fertilizers use of fly-ash along with chemical fertilizers and organic materials in an integrated way can save chemical fertilizer as well as increase the fertilizer use efficiency (FUE). Accordingly, integrated use of fly-ash, organic and inorganic fertilizers saved N, P and K fertilizers to the range of 45.8, 33.5 and 69.6%, respectively and gave higher FUE than chemical fertilizers alone or combined use of organic and chemical fertilizers in a rice-groundnut cropping system. FA can be used as a potential nutrient supplement for degraded soils thereby solving the solid waste disposal problem to some extent. However, the bioaccumulation of toxic heavy metals and their critical levels for human health in plant parts and soil should be investigated. An ultimate goal would be to utilize FA in degraded/marginal soils to such an extent as to achieve enhanced fertility without affecting the soil



quality and minimizing the accumulation of toxic metals in plants below critical levels for human health. There are several potential beneficial and few harmful effects of FA application in soil.

Beneficial Effects

(1) Improves soil texture; (2) reduces bulk density of soil; (3) improves water holding capacity; (4) optimizes pH value; (5) increases soil buffering capacity; (6) improves soil aeration, percolation and water retention in the treated zone (due to dominance of silt-size particles in FA; (7) reduces crust formation; (8) provides micro-nutrients like Fe, Zn, Cu, Mo, B etc.; (9) provides macro-nutrients like K, P, Ca, etc.; (10) reduces the consumption of soil ameliorants (fertilizers, lime); (11) FA can also be used as insecticidal purposes and (12) decreases the metal mobility and availability in soil.

Harmful Effects

(1) Reduction in bioavailability of some nutrients due to high pH (generally from 8 to 12); (2) high salinity and (3) high content of phytotoxic elements, especially boron.

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