EFFECT OF FLY ASH /POND ASH IN IRRIGATED VERTISOLS ON GRAIN YIELD AND MICRONUTRIENT CONTENT IN MAIZE AND SUNFLOWER

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SUMMARY

Application of fly ash / pond ash at maximum dose significantly increased the concentration of micronutrients in sunflower and maize grains. Further, combined application with FYM at 20 t/ha increased the micronutrient content due to increased solubility of metal ions by forming stable complexes with organic legends. The per cent increase in the concentration of micronutrients in sunflower seeds over control due to application of fly ash @ 40 t/ha varied from 0.7 to 20.8 per cent in Zn, 1.4 to 14.2 per cent in Mn, 0 to 4.3 per cent in Cu and 0.7 to 63.9 per cent in Fe. Similarly. in the succeeding maize grain, the same varied from 5.1 to 34.0 per cent in Zn, 0 to 3.4 per cent in Mn, 17.6 to 34. 7 per cent in Cu and 2.4 to 4.0 per cent in Fe.

Key words : Fly ash, Pond ash, Micronutrients, Maize, Sunflower.

The annual fly ash generation in India is expected to exceed 120 million tones by 2010 from the present generation of 80 to 100 million tones annually. At present, only small percentage (13-15%) of fly ash generated in India is being used in cement, ceramic, brick industries and also in asphalting of road, filling of low levels etc. and the remaining ash is dumped into large ponds near the thermal plants. Such a huge quantity of ash stored in ponds holds a potential threat to the environment if not controlled effectively.

In an attempt to find a solution for disposing of this huge quantity of fly ash scientists all over the world characterized the fly ash from different sources from agricultural point of view and reported that fly ash contained higher proportion of silt sized particle with high water holding capacity. The composition of fly ash is dominated by Si, AI, Ca and Fe followed by K, S and Mg. Abundance of most of the trace elements are comparable to earth's crust (Fisher *et al.,* 1976). The results of studies conducted world wide have clearly indicated that for most soils, addition of fly ash input would alter the mechanical composition towards increasing silt content, decrease bulk density, increase water holding capacity and improve nutrient availability (Chang, *et al.,* 1997; Campbell *et al.,* 1983; Martens, 1971), which resulted in higher crop yields. The present investigation was aimed at characterization of fly ash from RSTPS Shakthinagar, Raichur and to study the effect of bulk and long term fly ash /pond ash application on maize and sunflower yield and micronutrient content of their grains.

MATERIALS AND METHODS

Fly ash samples were collected from RSTPS, Shakthinagar, Raichur, (Karnataka) during 2004 to 2006. Both fly ash and pond ash were used in the study. Fly ash was collected directly from the hopper inside the plant and pond ash was collected from the ash pond at the lowest point. Both ashes were analyzed for various physico-chemical parameters like, particle size, water holding capacity, bulk density, pH, EC, organic carbon and available N, P and K contents by following standard procedure recommended for soil . The contents of micro nutrients such as Fe, Cu, Mn and Zn were extracted using 0.005 M DTPA and the concentration in the solution was determined using atomic absorption spectrophotometer. The total elemental concentration of Fe, Mn, Cu and Zn was determined after digesting the sample with HF + $HCIO_4$ acid mixture.

Field experiments were conducted to study the response of maize and sunflower to fly ash application to the irrigated vertisol. The treatment consisted of different levels of fly ash (@ 30 and 40 t/ha) applied individually or in combination with FYM at the rate of 20 t/ha. Crops were raised by following recommended package of practices. After harvesting at maturity the yield was recorded and expressed in q/ha. However, the results of only relevant treatments are presented and discussed.

RESULTS AND DISCUSSION

Effect of FA/PA on crop yield :

A worth noticing response for both the ashes at 30 and 40 t/ha over control has been observed in the grain and straw yields of sunflower and maize, as evidenced from the results obtained on grain yields (15-45% increase)

($p < 0.05\%$) of these crops . The effect of pond ash was observed to be more pronounced than fly ash, but there was no significant difference between them. The repeat application of both the ashes was observed *at par* with one time application. One time application of both the ashes @ 40 t/ha at the time of cultivation of first crop (sunflower) with appreciable yield has also shown significant residual effect in the grain yield of succeeding crops grown in rotation *i.e.* sunflower – maize-sunflower. Thus, both the ashes were suitable for cultivation of sunflower and maize. This observation on the beneficial effects of FA application in respect of significant increase in yield of crops over control is also corroborated from investigation made by Wong and Wong (1990).

Furthermore, since FA contains, other than nitrogen and humus, the entire essential plant nutrients (Cu, Zn, Mn, Fe, B, Mo, etc.), and their addition to the soil improves the fertility of the soils via enrichment with these elements (Ashokan *et al.*, 1995 and Reddy *et al.*, 1995). The proportionate increase in the crop yield was due mainly to the uptake of these essential plant nutrients in available form. Fly ash additionally helps in the retention of most of essential plant nutrients in the soil system for longer durations due to its high surface area and adsorption properties.

Effect of fly ash and pond ash on concentration of micronutrients in grain :

Fly ash :

The concentration of micro nutrients in sunflower seeds and maize grains in vertisol grown with RDF (control) averaged 79.10 and 50.07 ppm Zn, 45.70 and 67.85 ppm Mn, 9.0 and 7.62 ppm Cu and 74.2 and 95.86 ppm Fe, respectively (Fig. 1).

Application of fly ash @ 30 t/ha along with FYM @ 20 t/ha significantly increased the concentration of Zn, Cu and Fe in sunflower seeds and maize grains. While, the effect of above treatment remained non-significant in the concentration of Mn in sunflower seed and maize grain. The per cent increase in the concentration of micronutrients in sunflower seeds over control was from 1.2 to 14.7 in Zn, 1.8 to 29.4 in Mn, 4.2 to 18.8 in Cu and 0.7 to 33.9 in Fe. Similarly, the same in the concentration of maize grain varied from 32.8 to 43.2 per cent in Zn, 1.9 to 4.5 per cent in Mn, 25.4 to 46.9 per cent in Cu and 9.7 to 20.5 per cent in Fe. Baskar and Jayanti (1999) recorded increased uptake of secondary and micronutrients by groundnut due to application of graded levels of fly ash.

The concentration of micro nutrients in sunflower seeds and maize grains in vertisol grown with RDF (control) averaged 79.10 and 50.07 ppm Zn, 45.70 and 67.85 ppm Mn, 9.0 and 7.62 ppm Cu and 74.2 and 95.86 ppm Fe, respectively (Fig. 2). Similar results were reported in the concentration of Fe and Mn in barley and spinach (Read and Sidrak., 1956). Application of fly ash @ 40 t/ha in black soil under irrigated condition was able to enhance the concentration of micronutrients in both the crops during the first year only. Mishra and Sukla (1986) have reported that fly ash application markedly increased the concentration of copper and zinc in maize.

The per cent increase in the concentration of micronutrients in sunflower seeds over control ranged from 0.7 to 5.2 per cent in Zn, 1.8 to 31.5 per cent in Mn, 1.3 to 2.4 per cent in Cu and 0.2 to 32.6 in Fe. Similarly, in maize grains, it varied between 0.3 and 45.0 per cent in Zn, 0.7 and 2.4 per cent in Mn, 4.9 and 37.3 per cent in Cu and 3.4 and 8.6 per cent in Fe.

Pond ash :

The concentration of micro nutrients in sunflower seeds and maize grains in vertisol grown with RDF (control) averaged 79.10 and 50.07 ppm Zn, 45.70 and 67.85 ppm Mn, 9.0 and 7.62 ppm Cu and 74.2 and 95.86

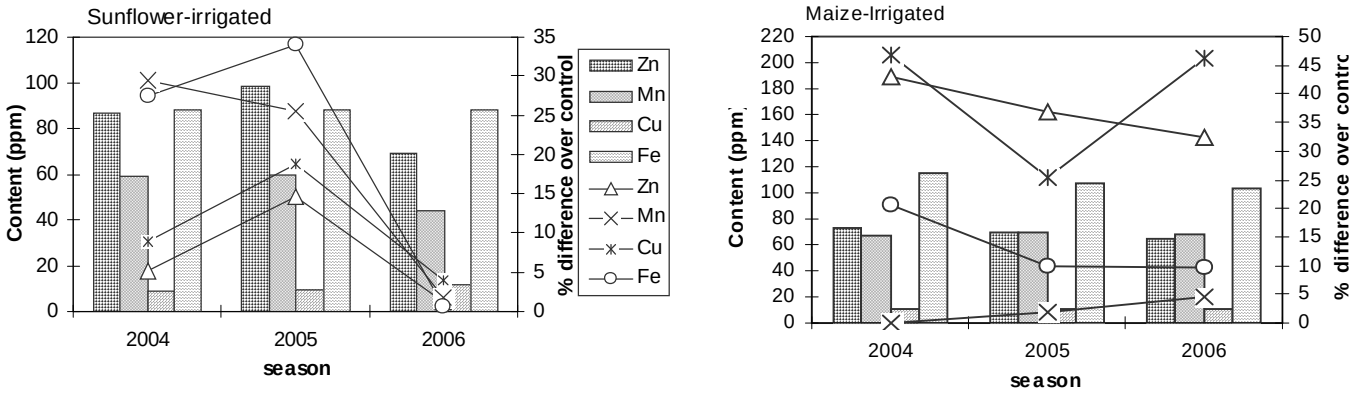

Fig 1: Effect of fly ash (max.yield) on the micronutrients (ppm) in grain in irrigated vertisols.

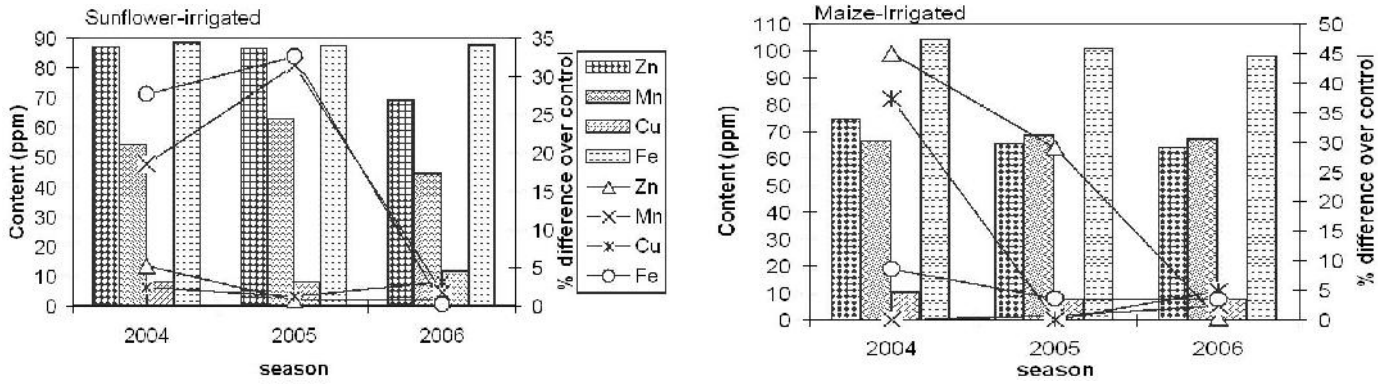

Fig. 2 : Effect of fly ash (max.dose) on the micronutrients (ppm) in grain in irrigated vertisols.

ppm Fe, respectively (Fig 3)

Application of pond ash @ 30 t/ha along with FYM @ 20 t/ha, in general, significantly increased the concentration of Zn, Cu and Fe in sunflower seeds and maize grains during most of the seasons, while concentration of Mn remained non-significant. Increase in the concentration of micronutrients over control in sunflower seeds was from 1.6 to 9.80 per cent in Zn, 2.5 to 23.0 per cent in Mn, 1.6 to 4.9 per cent in Cu and 0.5 to 32.4 per cent in Fe. While in maize grain, it was from 13.6 to 34.0 per cent in Zn, 0.1 to 3.7 per cent in Mn, 26.6 to 35.9 per cent in Cu and 7.0 to 11.6 per cent in Fe. The concentration of micro nutrients in sunflower seeds and maize grains in black soil grown with RDF (control) averaged 79.10 and 50.07 ppm in Zn, 45.70 and 67.85 ppm in Mn, 9.0 and 7.62 ppm in Cu and 74.2 and 95.86 ppm in Fe, respectively (Fig 4). The results are in corroborate with the findings of Hussain Sahib (1993) in groundnut. Application of fly ash @ 40 t/ha significantly increased the concentration of Zn in sunflower seeds and maize grains in most of the seasons. In contrast, the concentration of Mn, Cu, and Fe did not vary much as compared to control. The DTPA extractable micronutrients in fly ash were 1.4 ppm Zn, 12.8 ppm Mn, 0.5 ppm Cu and 12.0 ppm Fe. The corresponding values in pond ash were 1.3 ppm Zn, 10.2 ppm Mn, 0.4 ppm Cu and 10.6 ppm Fe. As stated earlier, the lower content of micronutrients in pond ash than that in fly ash was due to loss of nutrients during lagooning.

In general, application of fly ash @ 40 t/ha or 30 t/ha significantly increased the concentration of micronutrients in sunflower - maize grains. Similarly, the application of pond ash at the corresponding level increased the concentration of micronutrients in both the crops. It was ascribed due to direct supplement of micronutrient elements by fly ash or pond ash application and improvement in physical condition of soil. It was further observed that combined application of either fly ash or pond ash @ 40 t/ha and FYM @ 20 t/ha significantly increased the concentration of micronutrients in sunflower seeds. It was because of the release of micronutrient elements from the above sources upon degradation. It is

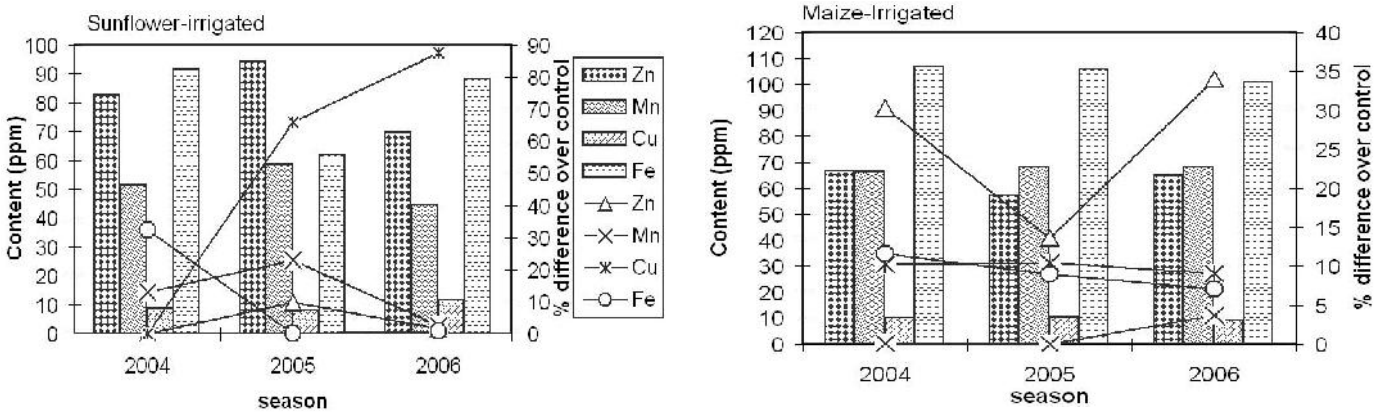

Fig. 3 : Effect of pond ash (max.yield) on the micronutrients (ppm) in grain in irrigated vertisols.

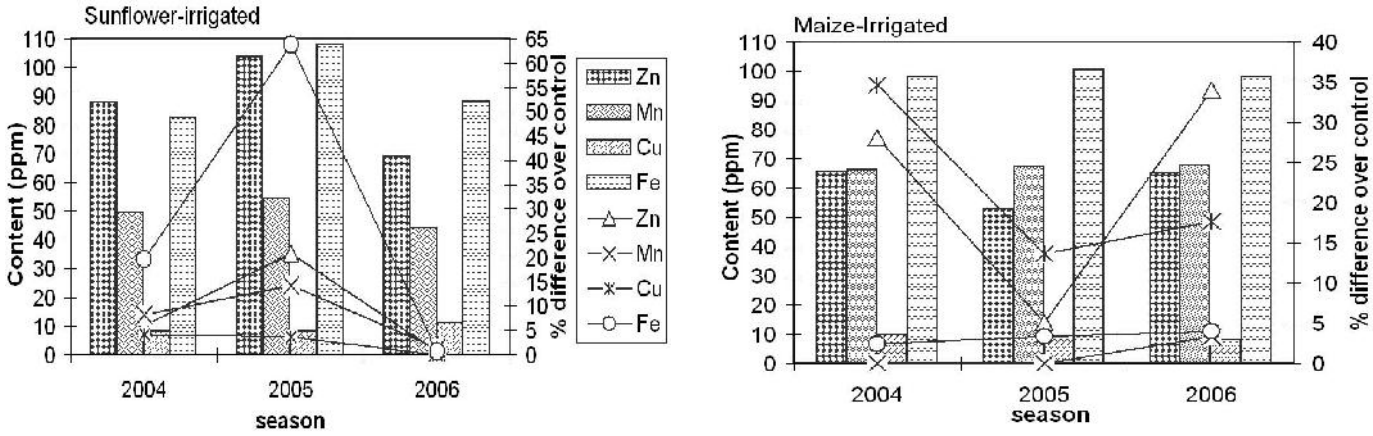

Fig. 4 : Effect of pond ash (max.dose) on the micronutrients(ppm) in grain of the crops grown in irrigated vertisols.

therefore suggested to use pond ash and FYM conjunctively at the recommended dosage to attain optimum concentration of micronutrients in edible plant parts, particularly in alkaline calcareous soil and to increase the yield. These findings were in agreement with those reported by Sims *et al*., (1995).

Application of fly ash/pond ash at maximum significantly increased the concentration of micronutrients in sunflower and maize seeds. It was ascribed to direct supplement of micronutrient elements by fly ash/pond ash and improvement in physical condition of soil. The combined application of fly ash/pond ash and FYM @ 20 t/ha significantly increased the concentration of micronutrients in sunflower and maize seeds. It is therefore suggested to use fly ash/pond ash and FYM conjunctively at the recommended dosage to attain optimum concentration of micronutrients in edible plant parts.

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