

## Effect of Fly Ash Combination with Inorganic Fertilizer and FYM on Micronutrient Availability and Heavy Metal Accumulation in *Entisol*

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Received 1 March 2016; Accepted 4 April 2016; Published online 20 April 2016

**Abstract** Field experiment were conducted in farmer field around National Thermal Power Corporation (NTPC) Tilda, Raipur (Chhattisgarh) during *kharif* season of 2013 to evaluate different doses of fly ash (20, 40, 60 t ha<sup>-1</sup>) combination with and without organic fertilizer on micronutrient (Zn, Cu, Mn, Fe) and heavy metal (Co, Pb, Ni, Cr) content in soil. Application of increasing doses fly ash with FYM was found to increase micronutrient availability and the highest recorded under application of 75% GRD +40 t ha<sup>-1</sup> fly ash + 5 t FYM ha<sup>-1</sup> and tended to marginal decrease micronutrient content 60 t fly ash ha<sup>-1</sup>. Increasing trend of micronutrients in soil due to application of fly ash were recorded, the permissible limits. Metal content in soil increased with increase application of ash that the concentrations of trace elements of crops. Higher soil heavy metal content of soil recorded in fly ash applied without organic fertilizer. Concentration of heavy metals in soils increased due to application of fly ash @ 60 t ha<sup>-1</sup>. However, the combined application of fly ash 20 t fly ash ha<sup>-1</sup> with FYM resulted in

lower concentration. The analysis of fly ash amendment soils and the produce rice grown, the concentration level of heavy metal element are well within the permissible and safe limit even after the application of fly ash at higher dose 40 t ha<sup>-1</sup> to the soil.

**Keywords** Fly ash, Inorganic fertilizer, FYM, Micronutrient, Heavy metal.

### Introduction

Coal is the prime source of energy for mankind all over the world which fulfills about 30% of its energy requirement. Coal plays the most vital role in the energy scenario of India. Fly ash is a product of Thermal Power Plant, which was produced during burning of coal for energy purpose, is a major concern. Recently, more than 175 mt of fly ash is generated in India from several thermal power plants and it is expected about 300 mt of fly ash will be generated in the year of 2016-17 [1]. Fly ash poses serious environmental problems as regards to its safe disposal. Fly ash is the portion of the combustion residue that enters the fluegas stream in power-generating facilities and consists of many small, glass-like particles ranging in size from 0.01 to 100  $\mu$ m. Chemically, fly ash contains oxides, hydroxides, carbonates, silicates, and sulfates of calcium (Ca), iron (Fe), aluminum (Al) and other metals as well as some noncombustible residues of the coal. Thermal Power Station has to manage minimal air and water pollution associated with it.

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However producer do not utilize major portion of ash. This material is used manufacturing of bricks, cement, ceiling and other civil construction activities, but its consumption is limited. It can also be used a soil additive that may improve physical, chemical and biological properties of the degraded soils and is a source of readily available plant micro and macro-nutrients. There is a need to evaluate the effect of fly ash soil environment and growth and yield of agriculture crops. In this context, ascertaining and providing the optimum nutritional requirement for rice in the most efficient manner with a view to maintain a high rate of growth ensuring maximum production within the prevailing set of environment appeared very essential for sustainable rice production. The response of fly ash addition in the soil on soil health and crop productivity is limited for soils of Chhattisgarh there is need to be evaluated on long term sustainable aspect. That's why this experiment had been formulated with an objective to find out the influence of integrated use of fly ash with inorganic fertilizer and FYM on soil health.

### Materials and Methods

A field experiment was conducted during *kharif* season of 2013-14 at Gaitara, Raipur. The soil of the experimental plot having pH 6.81, Gaitara is located at Raipur district lies at 21°55' N latitude and 81°78' E longitudes. It has an average elevation of 278.89 m. The experiment was planned with is 8 treatment, viz., T<sub>1</sub> – (Control), T<sub>2</sub> – general recommended dose (GRD) of fertilizer (N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O), T<sub>3</sub> – (75% GRD + 20 t Fly ash ha<sup>-1</sup>), T<sub>4</sub> – (75% GRD + 40 t Fly ash ha<sup>-1</sup>), T<sub>5</sub> – (75% GRD + 60 t Fly ash ha<sup>-1</sup>), T<sub>6</sub> – (75% GRD + 20 t Fly ash ha<sup>-1</sup> + 5 t FYM ha<sup>-1</sup>), T<sub>7</sub> – (75% GRD + 40 t Fly ash ha<sup>-1</sup> + 5 t FYM ha<sup>-1</sup>) and T<sub>8</sub> – (75% GRD + 60 t Fly ash ha<sup>-1</sup> + 5 t FYM ha<sup>-1</sup>) with three replication in randomized block design. The general recommended dose of fertilizer (N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O) for rice was 100, 60 and 40 kg ha<sup>-1</sup>, respectively. Urea, diammonium phosphate and muriate of potash were taken as fertilizer sources for N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O. Fly ash and FYM used as soil amendment and the nutrient content (N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O) of Fly ash and FYM was 0.14%, 0.078%, 0.029% and 0.60%, 0.41%, 0.53%, respectively. The variety used for rice was MTU- 1010. The rice was transplanted in second week of August 2013 and harvested on sec-

ond week of November. The mean rainfall received during the cropping season was 1250 mm. The soil samples were air dried, grinded, sieved (2 mm sieve) and used for analysis for various soil properties by standard procedure.

### Results and Discussion

#### Available micronutrient

The data pertaining soil properties have been summarized and presented in (Table 1). The beneficial effect of fly ash on improvement of soil health in respect of nutritional status. A positive effect on the Zn, Cu, Mn, Fe content of increase doses of fly ash in all the treatment except control. Table 1 showed soil properties maximum Zn content in soil found there 75% GRD + 40 t Fly ash ha<sup>-1</sup> + 5 t FYM ha<sup>-1</sup> while minimum in T<sub>1</sub> (control). 75% GRD + 40 ton Fly ash ha<sup>-1</sup> + 5 ton FYM ha<sup>-1</sup> and 75% GRD + 60 ton Fly ash ha<sup>-1</sup> + 5 ton FYM ha<sup>-1</sup> significantly increased available Zn as compare to GRD. Accumulation of Zn in rice was increased in fly ash treatment [2]. All the treatment combination showed in increase available Cu as compare to control. Highest Cu content in soil found there 75% GRD + 40 t Fly ash ha<sup>-1</sup> + 5 t FYM ha<sup>-1</sup> while minimum in T<sub>1</sub> (control). Available Mn were significantly increased with application of 75% GRD + 40 ton Fly ash ha<sup>-1</sup> + 5 ton FYM ha<sup>-1</sup> over control. The highest Fe contained was found in soil in 75% GRD +

**Table 1.** Effect of different treatments on micronutrient (Mn, Cu, Zn and Fe) status of soil.

Treatments	Available micronutrient (mg kg <sup>-1</sup> )			
	Zn	Cu	Mn	Fe
T <sub>1</sub> Control	0.35	1.21	27.83	38.58
T <sub>2</sub> GRD (100:60:40)	0.39	1.35	28.29	41.74
T <sub>3</sub> 75% GRD+20 t Fly ash ha <sup>-1</sup>	0.52	1.43	31.37	47.22
T <sub>4</sub> 75% GRD+40 t Fly ash ha <sup>-1</sup>	0.49	1.4	31.48	47.99
T <sub>5</sub> 75% GRD+60 t Fly ash ha <sup>-1</sup>	0.48	1.39	30.99	45.21
T <sub>6</sub> 75% GRD+20 t Fly ash ha <sup>-1</sup> +5 t FYM ha <sup>-1</sup>	0.6	1.47	31.9	44.77
T <sub>7</sub> 75% GRD+40 t Fly ash ha <sup>-1</sup> +5 t FYM ha <sup>-1</sup>	0.69	1.6	32.64	48.57
T <sub>8</sub> 75% GRD+60 t Fly ash ha <sup>-1</sup> +5 t FYM ha <sup>-1</sup>	0.63	1.56	32.01	47.37
SEm ±	0.03	0.03	.70	0.60
CD (p = 0.05)	0.09	0.10	2.13	1.8

**Table 2.** Effect of different treatment on heavy metal (Ni, Co, Cr, Pb) status of soil.

Treatments	Heavy metal (mg kg <sup>-1</sup> )			
	Co	Pb	Ni	Cr
T <sub>1</sub> Control	0.69	6.03	0.48	5.94
T <sub>2</sub> GRD (100:60:40)	0.90	6.16	0.57	6.18
T <sub>3</sub> 75% GRD+20 t Fly ash ha <sup>-1</sup>	1.09	6.55	0.60	6.89
T <sub>4</sub> 75% GRD+40 t Fly ash ha <sup>-1</sup>	1.18	6.96	0.70	7.49
T <sub>5</sub> 75% GRD+60 t Fly ash ha <sup>-1</sup>	1.26	7.09	0.81	7.46
T <sub>6</sub> 75% GRD+20 t Fly ash ha <sup>-1</sup> +5 t FYM ha <sup>-1</sup>	0.98	6.47	0.56	6.92
T <sub>7</sub> 75% GRD+40 t Fly ash ha <sup>-1</sup> +5 t FYM ha <sup>-1</sup>	1.15	6.71	0.67	7.15
T <sub>8</sub> 75% GRD+60 t Fly ash ha <sup>-1</sup> +5 t FYM ha <sup>-1</sup>	1.09	6.98	0.76	7.32
SEm ±	0.04	0.31	0.03	0.33
CD ( <i>p</i> = 0.05)	0.14	0.95	0.09	1.01

40 t Fly ash ha<sup>-1</sup> + 5 t FYM ha<sup>-1</sup> while minimum in T<sub>1</sub> (control). With different integrated nutrient management practices highest nutrient content found 75% GRD + 40 t Fly ash ha<sup>-1</sup> + 5 t FYM ha<sup>-1</sup> and lowest nutrient content was found T<sub>1</sub> (control). Availability of the micronutrients in soil increased with increasing doses of fly ash and its combination with FYM. The increase of micronutrient content due to higher concentration of DTPA extractable micronutrient with fly ash Fe, Zn, Cu and Mn incorporation with FYM [3]. Macro and micronutrient also increased correspondingly with increasing level of fly ash application [4, 5]. Organic material like FYM are commonly used for enrichment of soil. Zn content was increased due to combined use of fly ash with FYM and chemical fertilizer [6]. The high concentration of elements like Zn, Mn and Fe in fly ash increases the yield of agricultural crops [7].

#### Available heavy metal

The data pertaining available heavy metal have been summarized and presented in (Table 2). The available Co significantly affected by different treatment. The maximum available Co content in soil was recorded under treatment 75% GRD + 60 t Fly ash ha<sup>-1</sup> and minimum in T<sub>1</sub> (control). The maximum available Pb content in soil was recorded under treatment 75% GRD + 60 t Fly ash ha<sup>-1</sup> and minimum in T<sub>1</sub> (control).

Increase of Pb content in soil with increasing application of fly ash [8]. The available Cr significantly affected by different treatment. Highest Cr content in soil found there 75% GRD+ 40 t Fly ash ha<sup>-1</sup> while minimum in T<sub>1</sub> (control). The highest Ni content was noted in 75% GRD + 40 ton Fly ash ha<sup>-1</sup> treated plants as compared to other treatment. Fly-ash contains essential macronutrients and micronutrients some are rich in heavy metals such as Cd and Ni [9]. The finding indicate that the significant increase in Co, Cr, Pb and Ni content in soil amendment with fly ash however, there is a tendency of higher accumulation at increasing dose of fly ash due to high concentration of toxic heavy metal contain in fly ash [10, 11]. The concentration of heavy metal element reduced due to combined application of fly ash with FYM [12].

#### Conclusion

It may be concluded that there is considerable scope for proper utilization of fly ash in conjunction with FYM and chemical fertilizer improving soil productivity. The analysis of fly ash amendment soils and the produce rice grown has shown the concentration level of heavy metal element are well within the permissible and safe limit even after the application of fly ash at higher dose 40 t ha<sup>-1</sup> to the soil. However, its effect on soil to be evaluated in entisol. The modification in soil properties with fly ash incorporation. The increased cost of disposing fly ash in term of abating environmental pollution creates an urgent need to find its potential uses by which the maximum amount of fly ash can be utilized. Results need confirmation on long term basis looking into sustainability issues associated with fly ash conditioning in differential soil. Therefore application of chemical fertilizer, industrial wastes and agricultural animal wastes in an integrated manner may bring changes in the decomposition process of organic material and hence are likely to alter the nutrient release pattern of the soil.

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