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EFFECT OF INORGANIC & ORGANIC FERTILIZERS WITH FLY ASH ON MICROBIAL ACTIVITIES OF ACID SOIL UNDER RICE CROP

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ABSTRACT

Field studies were conducted during kharif season of 2014-15 at Ajirma village, Surajpur district(Chhattisgarh), to study the effect of different doses of inorganic & organic fertilizers with fly ash on microbial activities of acid soil under rice crop. The test crop was rice var. MTU-1010 The dehydrogenase activity (DHA) at tillering and harvesting stage of rice soil increased significantly. The highest DHA was recorded in 75% GRD + 40 t fly ash ha^{-1} + 5 t FYM ha^{-1} 29.63, 28.43μg TPF g^{-1} soil day^{-1}, while the lowest DHA was observed in control 22.89, 21.40 ug TPF g^{-1} soil day^{-1} at tillering and harvesting stage respectively. The similar pattern were observed in both total bacterial count (TBC) and soil microbial biomass carbon (SMBC), that the treatment 75% GRD + 40 t fly ash ha^{-1} + 5 t FYM ha^{-1} had maximum and the minimum in control, the total bacterial count was 5.60, 4.90 and 4.67, 4.00 x 10^7 CFU g^{-1} soil and soil microbial biomass carbon was 128.78, 98.06 and 102.99, 81.21 μg C g^{-1} dry soil at tillering and harvesting stage respectively.

INTRODUCTION

Fly ash is a by-product of the Thermal Power Station, where coal energy is converted into electrical energy. The Ministry of Power and Planning Commission estimates that the coal requirement and generation of fly ash during the year 2031-32 would be around 1800 million tonnes and 600 million tons respectively, the fly ash utilization in the country is estimated to be about 59% only (Kanungo, 2013). The demand for electrical energy is increasing day by day and in the absence of its utilization of the byproduct of thermal plant, it is been getting accumulated and for storing large area of arable land will be required which is therefore finding immediate use of fly ash for different purposes is very important material containing mineral nutrients as minor components which attracts the agriculture scientists for its utilization in improving crop and soil productivity. It is similar to soil in some of physical and chemical properties, as it contains major, secondary and trace elements, which are found in earth crust. Total major nutrients N and P were low *i.e.* 0.056 and 0.087 % respectively, but it contains sufficient by higher amount of total K (0.172%), CaO (1.60%), MgO (0.96%) and total trace elements *i.e.* Mn 3.98 ppm, Cu 3.60 ppm , Zn 1.30 ppm and Fe 3.81 ppm,respectively (Bhoyer,1998) . Application of fly ash increased the yield in various crops with improvement in the soil physical, chemical and biological properties and found beneficial for soil and crop (Kohli *et al*., 2010). It was found that the bacterial counts were enhanced due to presence of earthworm which bring about changes in the soil. In 5% amendment with earthworm, consecutive increase in the bacterial population was observed within 30 days of experiment. On the other hand a decrease in the count was observed in 10 and 15% amendment (Jabeen *et al*., 2010). Fly ash ameliorate and increase in the usability percent a well known biological modifier, recycling of wastes using earthworm has become an important component of substantial agriculture, which has a multidirectional impact in terms of safe disposal of wastes preventing environmental pollution besides providing nutrient rich material (Jabeen *et al*., 2012). Application of 10% and 20% FA treated soils showed a decreasing trend of soil MBC with time; and the decrease was significant throughout the period of incubation. The study concluded that application of FA up to 2.5 % can thus be safely used without affecting the soil biological activity and thereby improve nutrient cycling in agricultural soils (Nayak *et al*., 2014). The effect of fly ash on soil of Chhattisgarh in not studied therefore, present study deals with the effect of inorganic & organic fertilizers with fly ash on microbial activities of acid soil under rice crop.

MATERIALS AND METHODS

The experiment was conducted in acid soil was carried out during season of 2014-15 at Farmer field, Ajirma village, Surajpur district, Chhattisgarh. The experiment design was randomized block design comprised of eight treatment combinations with three levels of fly ash (20, 40 and 60 t ha^{-1}) and two levels of FYM (0 and 5 t ha^{-1}). Fly ash and FYM applied as per the treatments before transplanting the rice. All the plots received the 75 percent of general recommended dose (GRD) of NPK fertilizers (100-60-40 kg ha^{-1}) except control and 100 percent GRD. The rice var. MTU-1010 was used as the test crop. The dehydrogenase activity in soil was determined by method given by Klein *et al.* (1971). Total bacterial count method was given by Wollum (1982) and is given below; serial dilution were prepared for plating of the soil within the laminar flow assembly. Soil microbial biomass carbon was determined by the fumigation extraction method as per the procedure of Jenkison and Powlson (1976).

RESULTS AND DISCUSSION

Dehydrogenase activity (DHA)

Dehydrogenase activity as influenced by different combinations of fly ash at tillering and harvesting stages in presented in Table 1. At tillering stage the treatments of fly ash with and without FYM showed significantly higher dehydrogenase activity as compared to 100% GRD and control. It ranged from 22.89- 29.63 ug TPF g^{-1} soil day^{-1}. The minimum dehydrogenase activity was recorded under control. The maximum dehydrogenase activity was obtained with 75% GRD + 40 t fly ash + 5 t FYM ha^{-1}. It was found statistically at par with 75% GRD + 20 t fly ash ha^{-1}, 75% GRD + 40 t fly ash ha^{-1}, 75% GRD + 20 t fly ash ha^{-1} + 5 t FYM ha^{-1} and 75% GRD + 60 t fly ash ha^{-1} + 5 t FYM ha^{-1}. At harvesting stage maximum dehydrogenase activity was observed in 75% GRD + 40 t fly ash + 5 t FYM ha^{-1} was found statistically at par with 75% GRD + 20 t fly ash ha^{-1} + 5 t FYM ha^{-1} and 75% GRD + 60 t fly ash ha^{-1} + 5 t FYM $ha^{-1}$and the minimum was obtained under control. It ranged from 21.40 to 28.43 μg TPF g^{-1} soil day^{-1}. The activity value decreased in harvesting stage, it may be due to depletion of moisture. Soil dehydrogenase activity was greatest at 10% level of fly ash amendment since fly ash amendment at moderate levels provides nutrients to the micro organism for carrying out various metabolic activities without any adverse effect has been documented (Kohli *et al.*, 2010). Jabben *et al.* (2011) also reported that the significant stimulation of soil respiration and microbial activities (dehydrogenase activity) 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 and soil organic matter becoming more susceptible to microbial attack and the contribution of cellular lysing from water-induced osmotic shock to an easily mineralizable C pool that is consumed by the surviving soil microbes.

Total bacterial count (TBC)

Total bacterial count data presented in (Table 2) revealed that total bacterial population at tillering and harvesting stages increased significantly by the application of different treatments. At tillering stage the TBC ranged from 4.67 to 5.60 x 10^7 CFU g^{-1} soil. The maximum bacterial population was recorded treatment 75% GRD + 40 t fly ash ha^{-1} + 5 t FYM ha^{-1}. The treatment 75% GRD + 40 t fly ash ha^{-1} + 5 t FYM ha^{-1} was found statistically at par with 75% GRD + 40 t fly ash ha^{-1}, 75% GRD + 20 t fly ash ha^{-1} + 5 t FYM ha^{-1} and 75% GRD + 60 t fly ash ha^{-1} + 5 t FYM ha^{-1}. The minimum bacterial population was recorded under control. At harvesting stage all treatments showed significantly higher TBC further different fly ash doses with and without FYM over control it ranged from 4.00 to 4.90 x 10^7 CFU g^{-1} soil. Keeping in view of estimated total bacteria population per gram of soil by dilution planting method 75% GRD + 40 t fly ash ha^{-1} + 5 t FYM ha^{-1} showed the highest. The treatment T_7(75% GRD + 40 t fly ash ha^{-1} + 5 t FYM ha^{-1}) was found significantly superior over than T_2 (100% GRD), T_5 (75% GRD + 60 t fly ash ha^{-1}) and T_1 (control), it was statistically at par with rest of the treatments. The minimum bacterial population was recorded under

Table 1: Effect of different treatment on dehydrogenase activity of soil

Treatments	Dehydrogenase activity (ì g TPF g^{-1} soil day^{-1}) Tillering	Harvesting
T_1 Control	22.89	21.40
T_2 100% GRD (100:60:40)	25.75	23.71
T_3 75% GRD + 20 t fly ash ha^{-1}	27.61	24.59
T_4 75% GRD + 40 t fly ash ha^{-1}	27.65	26.61
T_5 75% GRD + 60 t fly ash ha^{-1}	25.45	23.44
T_6 75% GRD + 20 t fly ash ha^{-1} + 5 t FYM ha^{-1}	28.59	27.65
T_7 75% GRD + 40 t fly ash ha^{-1} + 5 t FYM ha^{-1}	29.63	28.43
T_8 75% GRD + 60 t fly ash ha^{-1} + 5 t FYM ha^{-1}	28.44	27.05
SEm±	0.78	0.52
CD (P = 0.05)	2.35	1.58

Table 2: Effect of different treatment on total bacterial count of soil

Treatments	Total bacterial count Tillering	(CFU 10^7 g^{-1} soil) Harvesting
T_1 Control	4.67	4.00
T_2 100% GRD (100:60:40)	5.03	4.27
T_3 75% GRD + 20 t fly ash ha^{-1}	5.07	4.53
T_4 75% GRD + 40 t fly ash ha^{-1}	5.27	4.53
T_5 75% GRD + 60 t fly ash ha^{-1}	5.00	4.17
T_6 75% GRD + 20 t fly ash ha^{-1} + 5 t FYM ha^{-1}	5.40	4.83
T_7 75% GRD + 40 t fly ash ha^{-1} + 5 t FYM ha^{-1}	5.60	4.90
T_8 75% GRD + 60 t fly ash ha^{-1} + 5 t FYM ha^{-1}	5.30	4.77
SEm±	0.14	0.14
CD (P = 0.05)	0.43	0.43

Table 3: Effect of different treatment on soil microbial biomass carbon

Treatments	Soil Microbial Biomass Carbon	
	Tillering	Harvesting
T_1 Control	102.99	81.21
T_2 100% GRD (100:60:40)	109.88	85.41
T_3 75% GRD + 20 t fly ash ha^{-1}	119.62	91.00
T_4 75% GRD + 40 t fly ash ha^{-1}	120.08	93.20
T_5 75% GRD + 60 t fly ash ha^{-1}	122.65	94.96
T_6 75% GRD + 20 t fly ash ha^{-1} + 5 t FYM ha^{-1}	126.92	97.57
T_7 75% GRD + 40 t fly ash ha^{-1} + 5 t FYM ha^{-1}	128.78	98.06
T_8 75% GRD + 60 t fly ash ha^{-1} + 5 t FYM ha^{-1}	126.73	95.48
SEm ±	1.37	0.94
CD (P = 0.05)	4.15	2.85

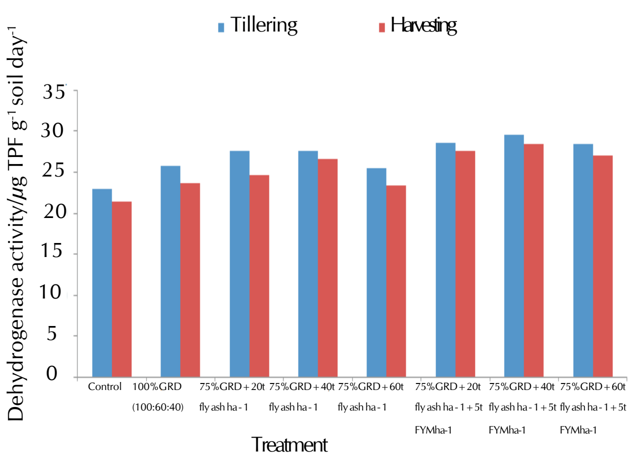

Figure 1: Influenced by integrated effect of inorganic and organic fertilizers with fly ash on the dehydrogenase activity

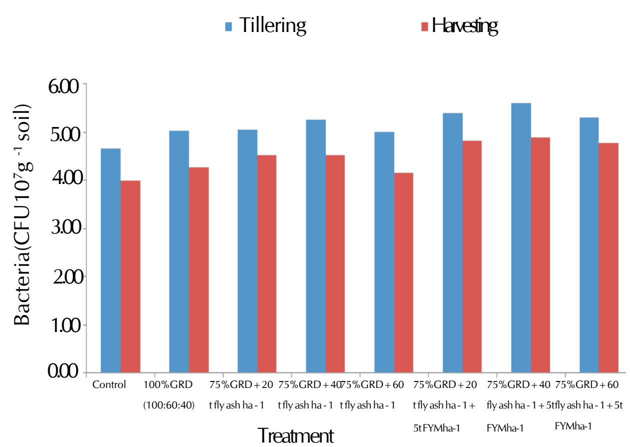

Figure 2: Influenced by integrated effect of inorganic and organic fertilizers with fly ash on total bacterial count

control. Application of fly ash along with recommended dose of NPK fertilizers increased the population of bacteria but when applied higher doses was mainly attributed to pozzolonic effect of fly ash which reduced the air capacity of the soil and reduced bacterial population this have been documented by Yeledhalli *et al*. (2007). Similar results are also found by Jabeen *et al*. (2011), the bacterial population showed a gradual rise reaching to maximum on 90th day at a time interval of 15 days, in 5% FA amendment in the presence of earthworms and decrease with doses increased.

Soil microbial biomass carbon (SMBC)

The data presented in Table 3 revealed that the SMBC is significantly increased at tillering stage with different treatments. It ranged from 102.99 to 128.78 µg C g^{-1} dry soil. The maximum SMBC was obtained in treatment 75% GRD + 40 t fly ash + 5 t FYM ha^{-1}. The minimum value was recorded at control. The treatments 75% GRD + 40 t fly ash ha-1 + 5 t FYM ha^{-1} was at par with75% GRD + 20 t fly ash ha^{-1} + 5 t FYM ha^{-1} and 75% GRD + 60 t fly ash ha^{-1} + 5 t FYM ha^{-1}. At harvesting stage, SMBC ranged from 81.21to 98.06 µg C g^{-1} dry soil. The maximum SMBC was recorded in treatment 75% GRD + 40 t fly ash ha-1 + 5 t FYM ha^{-1}, it was found statistically at par with 75% GRD + 20 t fly ash ha^{-1} + 5 t FYM ha^{-1} and 75% GRD + 60 t fly ash ha^{-1} + 5 t FYM ha^{-1}. All the treatments showed significantly higher SMBC as compared to 100% GRD and control. The minimum value was recorded at control. Keeping in the view of above results the soil microbial biomass carbon increased when application of fly ash with FYM combination in soil. This showed that FYM helped to maintain SMBC content in the root zone. It is a sound indicator of soil health since it regulates nutrient cycling and acts as a highly labile source of plant available nutrients. The nutrients content of fly ash with FYM provides nutrients to the micro-organism for

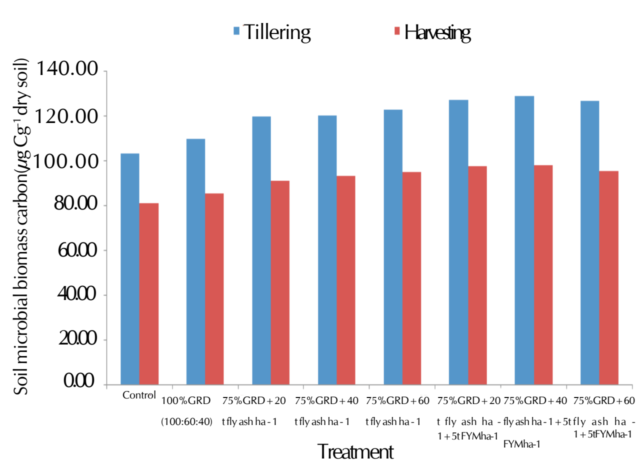

Figure 3: Influenced by integrated effect of inorganic and organic fertilizers with fly ash on soil microbial biomass carbon

carrying out various metabolic activities without any adverse effect. Nayak *et al*. (2014), Kohli and Goyal (2010) also reported the increased soil microbial activity with the integrated application of fly ash and FYM. Similar result observed by Bharat *et al*. (2015) and Meshwar *et al*. (2016).

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