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Effect of fly ash application with FYM on soil chemical properties of rice grown area in inceptisol

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Abstract
The field experiment entitled “Effect of fly ash application with FYM on soil chemical properties and rice yield in Inceptisol” was conducted during *Kharif* 2020 at college of agriculture and research station Bemetara (Chhattisgarh). “The treatments comprised of control, T_1 Control, T_2 100% RDF (100:60:40), T_3 75% RDF + 25t/ha Fly ash, T_4 75% RDF + 25t/ha Fly ash + 5t/ha FYM, T_5 75% RDF + 30t/ha Fly ash, T_6 75% RDF + 30T/ha Fly ash +5t/ha FYM, T_7 75% RDF + 45t/ha Fly ash, T_8 75% RDF + 45t/ha Fly ash + 5t/ha FYM. "The treatments were laid out in randomized block design (RBD) with three replications. The results showed that the application of fly ash with FYM, could be a viable option for enhancing the production of crops under slightly acidic soil conditions." The results indicated that soil organic carbon, available P, K and Fe was significantly increased with the application of fly ash with FYM.

Keywords: fly ash, FYM, soil physico-chemical properties

Introduction
Rice (*Oryza sativa*) is the most important crop in the world and the main food source for more than half of the world's population, especially in Asia. The phrase "rice is life" is particularly suitable for India because this crop plays a key role in our country's food security and provides a source of income for millions of people. More than 90% of the world's rice is grown and consumed in Asia, which has 60% of the world's population. In India, rice ranks first among all the crops occupying 43.79 million ha area and production of 116.40 million tones with an average productivity of 2659 kg/ha (GOI, 2018) [4]. Similarly, In Chhattisgarh rice grown area occupying 36.06 lakh hectares and production of 65.27 lakh tonnes with average productivity of 1810 kg/ha (GOI, 2018) [4] Chhattisgarh also known as the "Indian rice bowl".

Fly ash is the residue left after burning powdered bituminous coal or sub-bituminous coal (lignite) in the furnace of a thermal power plant. It contains the mineral elements of incompletely burned coal. In India, about 12.21 million tons of fly ash are produced every year, and one ton of fly ash requires 0.35 square meters of storage space. A large amount of fly ash is produced and disposed of at the ash treatment site, causing serious environmental problems. Some efforts have been made to use this large amount of solid industrial waste as an effective means to solve the problem of crop production and disposal. The high cost of chemical fertilizers and the low purchasing power of the country's smallholders and marginal farmers have restricted the use of expensive fertilizer inputs.

Some researchers have studied the impact of fly ash treatment on soil quality, hoping to use this industrial waste as an agronomic supplement. The physical and chemical quality of the modified fly ash soil depends on the initial quality of the soil and fly ash, but in most cases, it can be broadly generalized. When more than 10% fly ash is added to the soil, it can increase the yield of many crops by 20-25% and has high nutritional value. It has also been found to be beneficial to soil and crops (Yavarzadeh and Shamsadini, 2012) [13].

Materials and Methods
The present investigation “Effect of fly ash application with FYM on soil chemical properties and rice yield in Inceptisol” was conducted at the College of Agriculture and Research Station, Bemetara (C.G.). Soil pH was determined in 1:2.5 water-soil suspension (by Jackson, 1967)) [6] than samples were allow to settled down for recording electrical conductivity (Black, 1965) [3]. The organic carbon was determined by Walkley and Black rapid titration method (1934) [12].

Available nitrogen was estimate by alkaline potassium permanganate method (Subbiah and Asija. 1956) [11], available phosphorus by 0.5 M Sodium bicarbonate extractant method (Olsen *et al.,* 1954) [8] and available potassium was determined by neutral normal ammonium acetate extractant (Hanway and Heidel, 1952) [5]. The soil of the experimental field is locally known as Matasi and it comes under the order of Inceptisol. It is loam in texture, slightly acidic (6.50), low in organic carbon (0.38%), available N (213.0 kg ha^{-1}), medium in available P (15.2 kg ha^{-1}), available K (310.0 kg ha^{-1}) and sufficient in available micronutrients viz,. Fe, Mn, Cu and Zn.

Results and Discussion

Physico-chemical properties of fly ash and FYM

The pH, EC, and organic carbon of fly ash was 8.3, 0.37 dSm^{-1} and 0.19% organic carbon, respectively (Table 4.1). Total nitrogen, phosphorus, and potassium content of fly ash was 0.12, 0.079 and 0.75%, respectively (Table 4.1). Major elements in fly ash during the current experiment was reported in the following order K> N> P. Total iron, manganese, zinc and copper content recorded in fly ash was 3340, 320, 33, and 11.0 mg kg^{-1} respectively. Micro-nutrients present in fly ash was in the following order Fe>Mn> Zn> Cu.

Similarly, pH, EC, and organic carbon in FYM was found 8.1, 0.20 dSm^{-1} and 2.21%, respectively. Total nitrogen, phosphorus, and potassium contents in FYM was 0.98, 0.18 and 0.81%, respectively. Total iron, manganese, copper and zinc content of FYM was 1084.0, 254.0, 161.7, and 35.0 mg kg-1, respectively.

Table 1: Chemical characteristic of fly ash and FYM

Particulars	Fly ash	FYM
Soil reaction (pH)	38.388	8.1
Electrical conductivity (dSm^{-1})	0.37	0.20
Organic carbon (%)	0.19	2.21
Total N (%)	0.12	0.98
Total P (%)	0.079	0.18
Total K (%)	0.75	0.81
Total Fe (mg kg^{-1})	3340	1084.00
Total Mn (mg kg^{-1})	320	254.00
Total Zn (mg kg^{-1})	33	161.7
Total Cu (mg kg^{-1})	11	35.00

Soil Reaction

"Table 2 shows that soil pH was non significantly enhanced from value due to addition of fly ash with and without FYM in an Inceptisol. The pH value varied from 6.43 to 6.77. The highest pH (6.73) was found in treatment T_7 (75% RDF + 45t/ha Fly ash), followed by T_8 (75% RDF + 45t/ha Fly ash + 5t/ha FYM) and T_5 (75% RDF + 30t/ha Fly ash). While minimum (6.43) in T_1 (control). The application of different doses of fly ash either with or without FYM had no significant influenced on soil reaction was also observed by Rautaray *et al*., (2003) [9] and Sikka and Kansal (1995) [10].

Electrical conductivity EC (dSm^{-1})

Table 2 showed that soil EC (dSm^{-1}) was non-significantly enhanced due to addition of fly ash with and without FYM in an Inceptisol. The EC value ranged from 0.23 to 0.26. The highest EC (0.26) (dSm^{-1}) was found in treatment T_7 (75% RDF + 45t/ha Fly ash) and T_8 (75% RDF + 45t/ha Fly ash + 5t/ha FYM) followed by T_6 (75% RDF + 30t/ha Fly ash + 5t/ha FYM) and T_5 (75% RDF + 30t/ha Fly ash). While minimum (0.23) (dSm^{-1}) in T_1 (control).

Organic carbon (%)

"Table 2 showed that soil OC (%) was significantly enhanced due to addition of fly ash with and without FYM in an Inceptisol**.** The OC value varied from 0.37 to 0.44%. The highest organic carbon (0.44%) was found in treatment T_8 (75% RDF + 45t/ha Fly ash + 5t/ha FYM) followed by T_6 (75% RDF + 30t/ha Fly ash + 5t/ha FYM), T_4 (75% RDF + 25t/ha Fly ash + 5t/ha FYM) (0.38%), while minimum (0.37%) in T_1 (control).

Table 2: Effect of fly ash application with and without FYM on chemical properties of soil (pH, EC, OC)

S. No.	Treatment	pH	EC (dSm^{-1})	OC (%)
1	Control	6.43	0.23	0.37b
2	100% RDF (100:60:40)	6.60	0.24	0.37b
3	75% RDF + 25t/ha Fly ash	6.57	0.23	0.36b
4	75% RDF + 25t/ha Fly ash + 5t/ha FYM	6.50	0.23	0.42ab
5	75% RDF + 30t/ha Fly ash	6.60	0.24	0.36b
6	75% RDF + 30t/ha Fly ash + 5t/ha FYM	6.57	0.25	0.43a
7	75% RDF + 45t/ha Fly ash	6.77	0.26	0.38ab
8	75% RDF + 45t/ha Fly ash + 5t/ha FYM	6.73	0.26	0.44a
	SEm±	0.123	0.010	0.019
	CD (p=0.05)	NS	NS	0.058
	Control			

Available Nitrogen

"Table 3 showed that soil available nitrogen in soil was non-significantly enhanced due to addition of fly ash with and without FYM in an Inceptisol. The available nitrogen value varied from 210.33 to 217.33 (kg ha^{-1}). The highest available nitrogen (217.33) was found under the treatment T_5 (75% RDF + 30t/ha Fly ash) followed by T_8 (75% RDF + 45t/ha Fly ash + 5t/ha FYM), T_6 (75% RDF + 30t/ha Fly ash + 5t/ha FYM), while minimum (210.33) in T_1 (control).

Available Phosphorus

Table 3 showed that soil available phosphorus in soil was significantly enhanced due to addition of fly ash with and without FYM in an Inceptisol. The available phosphorus value varies from 19.44 to 25.79 kg/ha. The highest available phosphorus (25.79 kg/ha) was found in the treatment T_8 (75% RDF + 45t/ha Fly ash + 5t/ha FYM) followed by T_6 (75% RDF + 30t/ha Fly ash + 5t/ha FYM) (25.44), T_7 (75% RDF + 45t/ha Fly ash) (24.16), while minimum (19.44 kg/ha) in T_1 (control).

Fly ash addition to soil considerably reduced the acid phosphate activity in soil and thereby increased available phosphorus content of the soil. The favorable effect of fly ash on P availability was also reported by. Lee *et al.* (2007) [7].

Available Potassium

"Table 3 showed that potassium value range from 315.76 to 343.06 (kg ha^{-1}) Maximum available K in soil 343.06 (kg ha^{-1}) was recorded in treatment of T_7 (75% RDF + 45t/ha Fly ash) which was at par with all other treatment except control and GRD. While, the minimum value under T_1 (control) 315.76 (kg ha^{-1}).

Application of fly ash combination with 75% NPK with and without FYM resulted in improved soil available potassium could be due to K content of fly ash and FYM. Similar effect of fly ash on soil available K were also reported by Bhople *et al.* (2011) [1] and Bhoyar (1998) [2].

Table 3: Effect of fly ash application with and without FYM on available macronutrients (NPK) in Inceptisol at harvested stage

S. No.	Treatment	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
1	Control	210.33	19.44[a]	315.76[b]
2	100% RDF (100:60:40)	211.67	22.86[ab]	317.25[bc]
3	75% RDF + 25t/ha Fly ash	212.67	23.47[a]	336.16[abc]
4	75% RDF + 25t/ha Fly ash + 5t/ha FYM	213.33	24.05[a]	337.47[ab]
5	75% RDF + 30t/ha Fly ash	217.33	24.48[a]	341.20[a]
6	75% RDF + 30t/ha Fly ash + 5t/ha FYM	216.67	25.44[a]	339.85[a]
7	75% RDF + 45t/ha Fly ash	213.33	24.16[a]	343.06[a]
8	75% RDF + 45t/ha Fly ash + 5t/ha FYM	217.00	25.79[a]	342.49[a]
	SEm±	7.496	1.33	6.5
	CD (p=0.05)	NS	4.04	19.6

Conclusion

In conclusion, found that application of fly-ash with and without FYM application showed non-significant effect on soil pH, EC, O.C., available N, DTPA-extractable Mn, Cu and Zn but showed significant effect on available P, available K and DTPA-extractable Fe. Overall result showed that use of 75% RDF + 45t/ha Fly ash + 5t/ha FYM increase available P, K and Fe in soil.

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