ASSESSMENT OF SOIL ENZYMATIC ACTIVITIES AND NUTRIENT STATUS IN AN *INCEPTISOL* UNDER VARYING LEVELS OF FLY ASH WITH FYM

ABSTRACT

Background: A study was conducted to assess **"Assessment of soil enzymatic activities and nutrient status in an *Inceptisol* under varying levels of fly ash with FYM"** was carried out during *kharif* season of 2021. Field experiment was laid out in a randomized block design having 8 treatments which were randomized thrice viz. T1-Control; T2-100% RDF (100:60:40 N: P2O5:K2O kg ha^{-1}); T3 -75% RDF + 25t/ha Fly ash; T4-75% RDF + 25t/ha Fly ash + 5t/ha FYM; T5-75% RDF + 30t/ha Fly ash; T6-75% RDF + 30t/ha Fly ash + 5t/ha FYM; T7- 75% RDF + 45t/ha Fly ash; and T8 -75% RDF + 45t/ha Fly ash + 5t/ha FYM. The results showed that application of fly ash with fertilizer and FYM could be viable source for increasing the production of crops under degraded land conditions. The experiment resulted a significant effect on the soil enzymatic activity viz. dehydrogenase (47.21 µg TPF 24 hr-1g-1 soil), urease (38.65 µg NH4^{+}- N g^{-1} soil h^{-1}), acid phosphatase (27.41µg p-nitrophenol g-1 hr-1) and alkali phosphatase activity (69.54µg p-nitrophenol g^{-1}hr^{-1}) which were found highest with the 75% RDF + 45t/ha Fly ash + 5t/ha FYM. Overall result concluded that use of 75% RDF + 45t/ha Fly ash + 5t/ha FYM can save 25% of fertilizer (NPK) and increase the soil biological activity. N, P, K were significantly enhanced with the incorporation of fly ash with FYM whereas there was no effect on content of micronutrients (Fe, Mn, Zn,Cu) in soil.

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Key words: fly ash, farm yard manure, dehydrogenase, urease, acid and alkali phosphatase.

Introduction: Soil enzyme activities have been recognized as 14 useful measures of improvements in soil quality caused by various soil and crop management practices under various cropping systems. (Nannipieri *et al* 2011; Bandick and Dick 1999). Their activities have been used as indicators of soil fertility because they are a reflection of the effects of cultivation, soil properties, and pedological amendments. The number of enzymes in the soil system varies because each soil type has a varying amount of organic matter content the composition and behaviour of its living organisms, and the intensity of biological processes. Soil enzymes are very specific in terms of the types of reactions in which they participate. For example, the amount of available carbon has a large impact on soil microbial behaviour, which is reflected in dehydrogenase activity. Phosphatase, which is produced by root exudates and microorganisms, cleaves phosphate from organic substrate and participates in the phosphorus cycle in soil. Urease enzyme is carried out the hydrolysis reaction of urea fertilizer in the soil into NH_3 and CO_2 with the supplementary rise in soil pH (Byrnes and Amberger 1989).

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Being a vegetative fossil fuel fly ash consist of mineral matter which gets utilized by plants from the soil. It can act as a secondary source of fertilizer nutrients like P, K, Ca, Mg, S, Cu, Fe, Zn, Mn, Mo etc. (Totawat et al., 2002). Fly ash can be used for reclaiming the problematic soil and enhance the crop productivity depending upon the nature of fly ash.

Organic inputs, such as FYM, play a critical role in the productivity of many farming systems by supplying nutrients and a substrate for the synthesis of soil organic matter through decomposition (SOM). Soil organic matter has been found to increase crop yield and growth by delivering nutrients, or altering soil physical qualities.

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Material Method: The field experiment was carried out at Collage of Agriculture and Research Station, situated in Bemetara district of Chhattisgarh which is in the center of Mahanadi basin. Geographically, it is located between 21.6104^{0} N latitude and 81.2944^{0}'E, with an altitude of 278 meters above the mean sea level, covering an area of 2841.65 ha. The experiment was laid out in a randomized block design having 8 treatments which were randomized thrice viz. T1-Control; T2-100% RDF (100:60:40 N: P2O5:K2O kg ha^{-1}); T3 -75% RDF + 25t/ha Fly ash; T4-75% RDF + 25t/ha Fly ash + 5t/ha FYM; T5-75% RDF + 30t/ha Fly ash; T6-75% RDF + 30t/ha Fly ash + 5t/ha FYM; T7- 75% RDF + 45t/ha Fly ash; and T8 -75% RDF + 45t/ha Fly ash + 5t/ha FYM. The recommended dose of fertilizer (N, P_2O_5, K_2O) for rice was 100:60:40 kg/ha, resp. Urea, Diammonium Phosphate and Muriate of Potash were applied as fertilizer sources along with fly ash and FYM as an amendment. Characters of fly ash and FYM are given in (Table.1) The variety used for rice was DRR DHAN 42 transplanted on 22nd July and harvest on second week of November. To evaluate soil enzyme activities soil sample (0-15 cm depth) were taken by collecting 5 samples of soil from each plot, mixed, homogenized, and analyzed for soil enzyme activities viz. dehydrogenase, urease and acid alkali phosphatase. All major and micro nutrient were analyzed after harvest of crop.

Comment [DE6]: Materials and Methods

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Result & discussion: The highest (47.21 µg TPF 24 hr-1g-1 soil) dehydrogenase activity was observed in treatment T8 (75%RDF+45t/ha fly ash + 5t/ha FYM) followed by T6 (75%RDF+30t/ha fly ash + 5t/ha FYM) and T4(75%RDF+25t/ha fly ash + 5t/ha FYM).The rest other treatments were found at par with each other except control .The lowest (23.68 µg TPF 24 hr-1g-1 soil) dehydrogenase activity was observed under T1 (control).The treatment (T2,T3,T5 & T7) without FYM caused significant decline in the dehydrogenase activity.

Comment [DE8]: Results and Discussion

The increase in dehydrogenase activity with integrated application of fly ash FYM and inorganic source of fertilizer may be due to increasing microbial population which may be due to increase in substrate availability through FYM. Jala and Goel (2010) also discovered enzymatic activity to be best when fly ash was used as an amendment along with manure

It was recorded that there was significant change (Table.2) in urease activity due to application of different doses of fly ash, fertilizer and FYM.The highest (38.65 µg $NH4^{+}$- N g^{-1} soil h^{-1}) urease activity was recorded in treatment T8 (75%RDF+45t/ha fly ash + 5t/ha FYM) followed by T6 (75%RDF+30t/ha fly ash + 5t/ha FYM) and T2(100%RDF). The rest other treatments were found at par with each other except control. The lowest (24.78 µg $NH4^{+}$- N g^{-1} soil h^{-1}) enzyme activity was observed under T1 (control). Urea added as a fertilizer acted as a substrate for the urease activity along with the complimentary effect of FYM and fly ash which could provide a better environment for enzyme activity. Sahu *et.al* (2018) supported that FA added to soil boosts urease activity.

The highest (27.41µg p-nitrophenol g-1 hr-1) acid phosphatase activity was observed in treatment T8 (75%RDF+45t/ha fly ash + 5t/ha FYM) followed by T4(75%RDF+25t/ha fly ash + 5t/ha FYM), T5(75%RDF+30t/ha fly ash) and T6 (75%RDF+30t/ha fly ash + 5t/ha FYM).The rest other treatments were found at par with each other except control .The lowest (9.36 µg p-nitrophenol g-1 hr-1) enzyme activity was observed under T1 (control). The findings corroborate those of Roy *et.al* (2011) who found that soil blended with farmyard manure and amended with fly ash increased phosphatase activity.

Significant variation in available N (Table.3) due to combined application of fertilizer, FYM, and FA were recorded. The data varied from 102.30kg/ha to 159.60kg/ha. Significantly higher available nitrogen (159.60kg/ha) was recorded under application of treatment T8(75%RDF + 45t/ha fly ash + 5t/ha FYM) which was found at par with rest other treatments except T1(control) and T3.The lowest(102.30kg/ha) available nitrogen was seen under T1 (control).The incorporation of different doses of fly ash along with chemical fertilizers and FYM improved the nitrogen supply due to the mineralization of organic nitrogen from FYM, which is a slow process occurring during the crop growth and resulted in increased soil N status under different treatments as supported by Sikka & Kansal (1995),and Kuchanwar *et.al.*(1997).

The analysis of available phosphorous revealed significant variation. The data varied from 9.42kg/ha to 21.09kg/ha. Significantly higher available phosphorous (21.09kg/ha) was recorded under T8(75%RDF + 45t/ha fly ash + 5t/ha FYM) followed by T6(75%RDF + 30t/ha fly ash + 5t/ha FYM) (20.76kg/ha) and T4(75%RDF + 25t/ha fly ash + 5t/ha FYM) (19.29kg/ha), which were statistically at par. The lowest (9.42kg/ha) was found under T1 (control). Increase in available phosphorous content due to graded dose of fly ash incorporation with FYM may be due to P content of fly ash and FYM also due to its impact on improved soil biotic activity which aided in P release in soil pool. Yadav *et.al* (2006), Yellidhalli *et.al* (2007), Deshmukh *et.al* (2000) and Gupta & Chaudhary (1995) also supported that incorporation of fly ash and FYM improved P mobility.

The data on available potassium varied from 335.62kg/ha to 373.35kg/ha. Significantly higher available potassium (373.35kg/ha) was recorded under T8(75%RDF + 45t/ha fly ash + 5t/ha FYM) followed by T6(75%RDF + 30t/ha fly ash + 5t/ha FYM) (370.33kg/ha) and T4(75%RDF + 25t/ha fly ash + 5t/ha FYM) (368.00kg/ha) which was statistically at par. Availability of K in soil was significantly increased due to addition of different doses of fly ash with fertilizer and FYM in an *Inceptisol* that may be attributed to higher content of exchangeable K in fly ash which led to the rise of available & exchangeable potassium upon incorporation. Reddy *et.al* (2010), &Yeledhalli *et.al* (2007) also had similar suggestions regarding increase in available K.

No significant effect of fly ash and FYM additions on soil micronutrients (Fe, Mn, Zn,Cu) (Table.4)was seen under different treatments as there were no additional source of micronutrient provided to soil. Similar findings were also reported by Khandkar *et.al* (1996), and Rani & Kalpana (2010).

Conclusion: The application of 75% RDF + 45t/ha fly ash and 5t/ha FYM have been recorded significant effect on enzyme activity viz. dehydrogenase, urease, and acid alkali phosphatase along with the nutrient status of soil. Fly-ash has great potentiality in agriculture due to its efficacy in modification of soil health and crop performance and shows improved impact when incorporated along with manures or organic amendments. Results of the present study therefore support the concept of fly ash incorporation along with FYM under recommended dose of fertilizers.

Table .1 Chemical properties of FYM and Fly ash used in the experimental site.

Particulars	FYM	Fly ash
pH	8.1	7.7
EC dS/m	0.20	0.29
OC (%)	2.21	0.24
N%	0.98	0.070
P%	0.18	0.041
K%	0.81	0.32
Total Fe (mg.kg^{-1})	1084.00	3340.0
Total Mn (mg.kg^{-1})	254.00	320.00
Total Zn (mg.kg^{-1})	161.7	33
Total Cu (mg.kg^{-1})	35.00	11.0

Table.2 Effect of fly ash and FYM incorporation on soil enzymatic activity in an *Inceptisol*

Treatment	Dehydrogenase activity	Urease activity (µg	Acid Phosphatase activity	Alkali Phosphatase activity

	(µg TPF 24 $hr^{-1}g^{-1}$ soil)	NH4^{+}- N g^{-1} soil h^{-1})	(µg p-nitrophenol g^{-1} hr^{-1})	(µg p-nitrophenol g^{-1} hr^{-1})
T1 - Control	23.68	24.78	9.36	34.05
T2 -100% RDF (100:60:40)	35.11	35.21	16.14	47.42
T3 -75% RDF + 25t/ha Fly ash	35.20	32.08	21.33	44.35
T4 -75% RDF + 25t/ha Fly ash + 5t/ha FYM	41.60	33.91	23.22	64.64
T5 -75% RDF + 30t/ha Fly ash	33.86	30.99	24.60	48.21
T6 -75% RDF + 30t/ha Fly ash + 5t/ha FYM	46.42	36.12	25.46	67.89
T7 -75% RDF + 45t/ha Fly ash	32.15	32.57	18.17	49.88
T8 -75% RDF + 45t/ha Fly ash + 5t/ha FYM	47.21	38.65	27.41	69.54
SEm±	**1.57**	**1.09**	**1.58**	**1.99**
CD (p=0.05)	**4.75**	**3.32**	**4.80**	**6.03**

Table .3 Effect of fly ash and FYM incorporation on Available macronutrients (N, P, K) (kg/ha) in an *Inceptisol*

Treatment	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
T1 - Control	102.30	9.42	335.62
T2 -100% RDF (100:60:40)	145.79	14.96	366.83
T3 -75% RDF + 25t/ha Fly ash	144.43	12.99	359.76
T4 -75% RDF + 25t/ha Fly ash + 5t/ha FYM	146.48	19.29	368.00
T5 -75% RDF + 30t/ha Fly ash	147.30	14.26	365.00
T6 -75% RDF + 30t/ha Fly ash + 5t/ha FYM	150.02	20.76	370.33
T7 -75% RDF + 45t/ha Fly ash	155.17	15.74	368.81
T8 -75% RDF + 45t/ha Fly ash + 5t/ha FYM	159.60	21.09	373.35
SEm±	**4.52**	**1.31**	**2.33**
CD (p=0.05)	**13.70**	**3.98**	**7.07**

Table .4 Effect of fly ash and FYM incorporation on available micronutrient (mg/kg) in an *Inceptisol*

Treatment	Av. Fe (mg/kg)	Av. Mn (mg/kg)	Av. Zn (mg/kg)	Av. Cu (mg/kg)

T1 - Control	46.10	33.77	0.66	0.51
T2 -100% RDF (100:60:40)	49.96	37.99	0.76	0.69
T3 -75% RDF + 25t/ha Fly ash	40.93	31.21	0.70	0.66
T4 -75% RDF + 25t/ha Fly ash + 5t/ha FYM	41.73	36.28	0.74	0.60
T5 -75% RDF + 30t/ha Fly ash	47.50	35.49	0.75	0.63
T6 -75% RDF + 30t/ha Fly ash + 5t/ha FYM	49.20	33.24	0.75	0.58
T7 -75% RDF + 45t/ha Fly ash	42.03	37.98	0.76	0.58
T8 -75% RDF + 45t/ha Fly ash + 5t/ha FYM	43.84	32.60	0.77	0.51
SEm±	**2.44**	**3.35**	**0.04**	**0.06**
CD (p=0.05)	**NS**	**NS**	**NS**	**NS**

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