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Effects of Fertility Management on Soil Enzymatic Activities under Different Agro Climatic Zones of Andhra Pradesh and Telangana

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ABSTRACT
Among the different Agro Climatic zones, urease activity was highest in Northern Telangana Zone followed by Southern Telangana Zone and Godavari Zone with 56.2, 55.8 and 46.2 µg of NH_4^+-N g^{-1} soil $2h^{-1}$, respectively. Dehydrogenase activity is highest in Godavari Zone with 596.3, 500.5 and 488.2 µg of TPF g^{-1} soil day^{-1}. Higher activity of alkaline phosphatase (µg of p-nitrophenol g^{-1} soil h^{-1}) was recorded under rice-rice system at Southern Telangana Zone (149.7) followed by Godavari Zone (144.9). The treatment receiving inorganic fertilizers along with organic manures resulted higher activity of enzymes in all the zones. The enzyme activity of soils, which is governed by microbial population is also significantly higher in INM treatments in all the four zones. Soil enzyme activities can be used as potential indicators of nutrient cycling processes and fertility management, particularly in long-term organic and conventional farming systems.
Key words: *Agro climatic zones, urease, dehydrogenase, phosphatase and integrated nutrient management*

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INTRODUCTION

Enzymes are biological catalysts possessing extraordinary efficiency and specificity. All biological reactions are catalyzed by the enzymes which are proteins with catalytic properties towards specific substance (Quastel, 1946). The activity of soil enzymes are influenced by the nature, age of crop and addition of fertilizers and manures. The enzyme activity is considered as an index of biological activity. Interest in soil enzyme activity has been increased recently since their activities are believed to reflect the potential capacity of a soil to perform nutrient transformations. Soil enzyme activities are sensors of soil degradation since they combine information about microbial status and soil physicochemical conditions (Aon and Colaneri, 2001). Soil enzymes play an essential role in soil processes such as nutrient cycling and energy transformation by catalysing numerous chemical, physiological and biological reactions (Shi *et al.,* 2008). The enzymes are constantly synthesized, accumulated, inactivated or decomposed in soil and play an important role in agriculture (Tabatabai, 1994). Hydrolytic enzymes make the nutrients available to plants by acting on a wide range of complex substances. Soil enzyme activities are influenced by system of agriculture, inputs (fertilizers,
organic manures and pesticides) and depth. The effect of cultivation induced significant changes in quality, chemical composition and molecular size of organic matter which inturn influenced the C, N and P cycles and enzyme activity. The effects of different treatments were evaluated in terms of soil enzyme activity *viz.,* urease, dehydrogenase and acid and alkaline phosphatase.

MATERIALS AND METHODS

The long-term fertilizer experiments are being conducted in Andhra Pradesh and Telangana under four different agro climatic zones, *viz.,* Southern Telangana zone [Rice – Rice (27 years) and Maize - Onion (13 years) cropping systems at All India Co-ordinated Research Project on Integrated Farming Systems, Rajedranagar], Northern Telangana zone [Rice – Rice (14 years) cropping system at Regional Agricultural Research Station, Jagtial], Godavari zone [Rice – Rice (26 years) cropping system at Andhra Pradesh Rice

Research Institute, Maruteru] and Scarce Rainfall Zone [Groundnut - fallow (30 years) cropping system at All India Co-ordinated Research Project on Dryland Agricultural Research Station, Ananthapur]. The present study was carried out during *kharif* and *rabi* seasons of 2013-2014.

Soil sample analysis: Urease activity was assayed by quantifying the rate of release of NH_4^+ from the hydrolysis of urea as described by Tabatabai and Bremner (1972). Dehydrogenase activity in the soil was determined by the procedure given by Casida *et al.* (1964). The method involved spectrophotometric determination of the Tri Phenyl Formazon (TPF) produced when soil is treated with Triphenyl Tetrazolium Chloride (TTC). The acid and alkaline phosphatase activity was assayed by quantifying the amount of p-nitrophenol released and expressed as µg of p-nitrophenol released g^{-1} soil h^{-1} as described by Tabatabai and Bremner (1969).

RESULTS AND DISCUSSION

We tried to compare the effects of Agro Climatic zones and the influence of long-term fertilizer management treatments on the soil enzymatic activities in order to arrive at suitable conclusions. While comparing the effects of management practices on enzyme activities, the treatments control (without fertilizers and manure application), 100 % inorganic fertilizer, 100% organic form and an optimum combination of organic, inorganic sources were taken into considerations. The soil enzyme activity was significantly influenced by diversified crop management practices and long-term application of integrated nutrient management treatments are presented in tables 1 to 4.

Urease activity

The data set out on rice-rice system, urease activity indicated highest in Northern Telangana Zone followed by Southern Telangana Zone and Godavari Zone with 56.2, 55.8 and 46.2 µg of NH_4^+-N g^{-1} soil $2h^{-1}$, respectively, while the lowest was recorded in Scarce Rainfall Zone (15.0 µg of NH_4^+-N g^{-1} soil $2h^{-1}$). The per cent increase in treatment receiving 100% Inorganic + FYM @ 5-10 t ha^{-1} over control was nearly 99 and 44 % under Godavari Zone and Northern Telangana Zone, respectively. Treatment receiving 50% organics + 50% inorganic over control was nearly 135, 72 and 66 %, in Scarce Rainfall Zone and Southern Telangana Zone (rice-rice and maize-onion), respectively (Table 1).

A close perusal at the data indicated that soil enzyme activity under submergence in rice-rice cropping system and rice based cropping systems increased over the long-term application of fertilizers and manures. The submergence of soil sets in motion a series of physico-chemical and microbiological processes which have a profound influence on nutrient transformation and availability (Ponnaperuma, 1972). Thus submergence may bring about enzyme synthesis and the addition of organic manures / organic fertilizers could bring about changes in activity of proliferating microorganisms resulting in alteration of enzyme activities. It may be ascribed to the fact that organic matter when applied to rice soil with water more than saturation capacity enhanced microbial fermentation of organic manures producing substances which are subjected to oxidation and reduction. Kanchikerimatha and Singh (2001) observed that urease activity increased with balanced application of inorganic fertilizers. Vandana *et al.* (2012) also reported that balanced application of NPK fertilizer causes an increase in substrate through the decomposition of stubbles resulting in an abaundance of soil microorganisms and enzyme activity.

Dehydrogenase activity

The results related to dehydrogenase activity revealed that highest activity was observed under rice- rice cropping system, in Godavari Zone followed by Northern Telangana Zone and Southern Telangana Zone with 596.3, 500.5 and 488.2 µg of TPF g^{-1} soil day^{-1}, respectively. The lowest was recorded in Scarce Rainfall Zone (63.2 µg of TPF g^{-1} soil day^{-1}). Among the treatments, treatment receiving 100% Inorganic + FYM @ 5-10 t ha^{-1} followed by 50% organics + 50% inorganic, 100% organic and 100 % inorganic treated plots. The per cent increase in treatment receiving 50% organics + 50% inorganic over control was nearly 167.3, 123, 68, and 67 %, in Scarce Rainfall Zone, Southern Telangana Zone (maize-onion and rice-rice) and Godavari Zone, respectively (Table 2). It might be due to addition of organic matter through FYM which increased the microbial activity and microbial biomass.

The increase in dehydrogenase activity under rice based cropping systems could be due to submergence which resulted an increased population of anaerobic microorganisms. There was shift in soil microflora from predominantly aerobic to facultative and obligate anaerobic microorganisms when once the soil was flooded. This shift from aerobic to anaerobic microorganisms was found to cause an increase in dehydrogenase activity. Similar results were reported by several workers Vandana *et al.* (2012) and Srilatha (2014).

Phosphatase activity

Phosphatases are broad group of enzymes that are capable of catalyzing hydrolysis of esters and anhydrides of phosphoric acids. In soil ecosystems these enzymes were believed to play a vital role in P-cycles (Speir and Ross, 1978). The activity of phosphatases followed the same trends as that of urease and

dehydrogenase. Under rice- rice cropping system, higher acid phosphatase activity (Table 3) was observed in Godavari Zone followed by Southern Telangana Zone and Northern Telangana Zone with 87.9, 79.4 and 79.2 µg of p-nitrophenol g^{-1} soil h^{-1}, respectively. The lowest was recorded in Scarce Rainfall Zone (34.8 µg of p-nitrophenol g^{-1} soil h^{-1}). Acid phosphatase per cent increase in treatment receiving 50% organics + 50% inorganic over control was nearly 117, 106, 88, and 34 %, in Scarce Rainfall Zone, Southern Telangana Zone (maize-onion and rice-rice) and Godavari Zone, respectively.

Higher activity of alkaline phosphatase (µg of p-nitrophenol g^{-1} soil h^{-1}) was recorded under rice-rice system at Southern Telangana Zone (149.7) followed by Godavari Zone (144.9). The per cent increase of alkaline phosphatase activity was higher under treatment receiving 100% Inorganic + FYM @ 5-10 t ha^{-1} followed by 50% organics + 50% inorganic over control, 100% organic and 100% inorganic treated plots (Table 4).

The acid phosphatase increased in treatment receiving organic + inorganic as compared to 100 % inorganic fertilizers alone. This might be due to added quantity of organic matter which inturn increased the organic carbon and nitrogen (Kadlag *et al.*, 2008). Temporal sequence in the activity of enzyme was attributed to the different production rate which may be influenced by the physiological age of different groups of microorganisms present in the soil (Srinivas *et al.*, 2003, Vandana *et al.*, 2012 and Srilatha 2014).

Table 1. Long-term effects of INM treatments on urease activity (µg of NH_4^+-N g^{-1} soil $2h^{-1}$) of the soils under different agro climatic zones

Treatments	Southern Telangana Zone (Rajendranagar)		Northern Telangana Zone (Jagtial)	Godavari Zone (Maruteru)	Scarce Rainfall Zone (Ananthapur)
	Rice-Rice	Maize-Onion	Rice-Rice	Rice-Rice	Groundnut-fallow
Control	32.5	30.3	39.2	23.3	6.4
100% Inorganic	49.7 (53 %)	39.3 (29.8%)	50.2 (28.2%)	28.4 (21.8%)	10.5 (64.6%)
100% Organic	-	46.2 (52.7%)	53.5 (36.5%)	40.3 (73.1%)	13.3 (107.7 %)
50% Inorganic + 50% Organic	55.8 (71.5%)	50.1 (65.5 %)	-	43.6 (87.2%)	15.0 (135.1 %)
100% Inorganic + FYM @ 5 t ha^{-1}	-	-	-	46.2 (98.6 %)	-
100% Inorganic + FYM @ 10 t ha^{-1}	-	-	56.2 (43.4 %)	-	-

Table 2 . Long-term effects of INM treatments on dehydrogenase activity (µg of TPF g^{-1} soil day^{-1}) of the soils under different agro climatic zones

Treatments	Southern Telangana Zone (Rajendranagar)		Northern Telangana Zone (Jagtial)	Godavari Zone (Maruteru)	Scarce Rainfall Zone (Ananthapur)
	Rice-Rice	Maize-Onion	Rice-Rice	Rice-Rice	Groundnut-fallow
Control	290.1	35.4	336.2	284.5	23.6
100% Inorganic	359.0 (23.8%)	48.9 (38.3%)	366.9 (9.1 %)	344.6 (21.1%)	47.5 (101.1%)
100% Organic	-	66.6 (88.3 %)	446.6 (32.8%)	565.4 (98.7%)	58.7 (148.1 %)
50% Inorganic + 50% Organic	488.2 (68.2 %)	78.8 (122.7 %)	-	475.8 (67.2%)	63.2 (167.3%)
100% Inorganic + FYM @ 5 t ha^{-1}	-	-	-	596.3 (109.5%)	-
100% Inorganic + FYM @ 10 t ha^{-1}	-	-	500.5 (48.9%)	-	-

Table 3. Long-term effects of INM treatments on acid phosphatase activity (µg p-nitrophenol g^{-1} soil h^{-1}) of the soils under different agro climatic zones

Treatments	Southern Telangana Zone (Rajendranagar)		Northern Telangana Zone (Jagtial)	Godavari Zone (Maruteru)	Scarce Rainfall Zone (Ananthapur)
	Rice-Rice	Maize-Onion	Rice-Rice	Rice-Rice	Groundnut-fallow
Control	38.6	41.7	44.5	44.0	16.1
100% Inorganic	44.4 (15.2%)	49.0 (17.5 %)	61.4 (38.0 %)	66.4 (50.7 %)	24.2 (50 .0 %)
100% Organic	-	50.9 (22.2 %)	72.0 (61.8 %)	71.8 (63.1 %)	29.8 (84.8 %)
50% Inorganic + 50% Organic	79.3 (105.6%)	55.8 (33.8%)	-	82.9 (88.1%)	34.9 (116.6%)
100% Inorganic + FYM @ 5 t ha^{-1}	-	-	-	87.9 (99.6 %)	-
100% Inorganic + FYM @ 10 t ha^{-1}	-	-	79.4 (78.4%)	-	-

Table 4. Long-term effects of INM treatments on alkaline phosphatase activity (µg p-nitrophenol g^{-1} soil h^{-1}) of the soils under different agro climatic zones

Treatments	Southern Telangana Zone (Rajendranagar)		Northern Telangana Zone (Jagtial)	Godavari Zone (Maruteru)	Scarce Rainfall Zone (Ananthapur)
	Rice-Rice	Maize-Onion	Rice-Rice	Rice-Rice	Groundnut-fallow
Control	98.2	65.4	96.4	102.9	33.4
100% Inorganic	108.5 (104.9 %)	86.1 (31.6 %)	108.9 (12.9 %)	109.3 (6.2 %)	46.6 (39.5 %)
100% Organic	-	93.3 (42.7 %)	120.6 (25.1 %)	126.9 (23.3 %)	59.5 (78.3 %)
50% Inorganic + 50% Organic	149.7 (52.4%)	106.9(63.6%)	-	141.5 (37.5%)	64.4 (92.8%)
100% Inorganic + FYM @ 5 t ha^{-1}	-	-	-	144.9 (40.8 %)	-
100% Inorganic + FYM @ 10 t ha^{-1}	-	-	130.3 (35.2%)	-	-

CONCLUSIONS

The results revealed that Northern Telangana Zone (56.2) was recorded higher urease activity (µg of NH_4^+-N g^{-1} soil $2h^{-1}$) followed by Southern Telangana Zone (55.8 and 50.1) whereas lowest was recorded under Scarce Rainfall Zone (6.4). The treatments receiving inorganic fertilizers along with organic manures resulted in higher activity of enzymes in all the zones. However, percent increase of dehydrogenase activity (µg of TPF g^{-1} soil day^{-1}) was highest in groundnut cropping system (167) followed by Maize-Onion cropping system (123). Among the treatments 50% organic + 50 % inorganic treated plots showed higher sequestration rate than 100% organic and 100 % inorganic treated plots. This indicates that combined application of organic and inorganic fertilizers helps in improving the soil enzymatic activity.

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