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Research Article

EFFECT OF ZINC FERTILIZATION ON SOIL ENZYMES ACTIVITY

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ABSTRACT

An field experiment was conducted in zinc deficient soil belonging to Padugai series (Typic Ustifluevents) at the farmer's holding during the Navarai season of year 2017.The treatments consists of viz., T_1 - Absolute control , T_2 - NPK (RDF), T_3 - RDF + $ZnSO_4$ @ 25 kg ha^{-1} , T_4 - RDF + Nano zinc (Granules @ 10 kg ha^{-1}),T_5 - RDF + Nano zinc (Granules @ 15 kg ha^{-1}),T_6 - RDF + Bio zinc (Granules @ 10 kg ha^{-1}),T_7 - RDF + Bio zinc (Granules @ 15 kg ha^{-1}),T_8 - RDF + Foliar spray of 0.5 % as $ZnSO_4$ at T.S and P.I.,T_9-RDF + Foliar spray of 1 ml L^{-1} as nano zinc at T.S and P.I. and T_{10}- RDF + Foliar spray of 1.5 ml L^{-1} as bio zinc at T.S and P.I.. The test crop was rice var.CO 51. The results revealed that enzymes activity was significantly enhanced on addition of different sources of zinc over control. The enzymatic activity increased with the age of the crop and the highest activity was seen at panicle emergence stage and decreased at harvest. Among all the treatments RDF + soil application of bio zinc @ 30kg ha^{-1} and RDF + soil application of Zn SO_4 @ 25 kg ha^{-1} recorded the highest urease activity and was on par with each other at all stages. Similarly dehydrogenase, acid and alkaline phosphatise activity highest was observed in the treatment receiving and RDF + Soil application of Bio zinc @ 30kg ha^{-1}.

INTRODUCTION

Zinc is an essential micronutrient for plant development and growth (Kashem *et al*. 2010) and it acts as cofactor of more than 300 proteins. It is present in all six classes of enzymes (Gupta *et al*. 2016). Zinc belongs to metals in particular active in soil and thus can be phytotoxic in high concentrations. Its toxicity is dependent on the plant development stage, soil properties, and plant species. Cereals belong to the plants which are most sensitive to zinc excess in the soil. They give a lower yield in such conditions (Baran 2013). The biological activity of the soil is evaluated mainly on the basis of the activity of four enzymes: dehydrogenase, phosphatase, urease, and protease (Dec 2014). Often, only dehydrogenase activity is used for this purpose (Kaczyński *et al*. 2016). The heavy metals inhibit enzymatic and microbiological activity in the soil due to changes in microflora composition and activity of individual enzymes which decreases organic matter decomposition. The investigation of soil enzymatic activity is useful for assessment of its chemical degradation. The aim of the studies was determination of enzymatic activity (dehydrogenase, acid and alkaline phosphatase, urease) of zinc deficient soil.

MATERIALS AND METHODS

With a view to study the effect of zinc fertilization on soil enzymes activity, the field experiment was conducted in zinc deficient soil belonging to Padugai series (Vertic Ustropept) at the farmer's holding during the Navarai season of year 2017. The experimental soil was clay loam in texture with pH 7.78, EC 0.84 dS m^{-1}, organic carbon 3.9 g kg^{-1} (low), low in $KMnO_4$-N 275 kg ha^{-1}, low in Olsen-P 10.4 kg ha^{-1}, high in NH_4OAc-K 294 kg ha^{-1} and low in available DTPA-Zn 0.68 mg kg^{-1}.The experiment was laid out in randomized block design. The treatments consists of eight treatments viz., T_1 - Absolute control , T_2 - NPK (RDF), T_3 - RDF + $ZnSO_4$ @ 25 kg ha^{-1} , T_4 - RDF + Nano zinc (Granules @ 10 kg ha^{-1}),T_5 - RDF + Nano zinc (Granules @ 15 kg ha^{-1}),T_6 - RDF + Bio zinc (Granules @ 10 kg ha^{-1}),T_7 - RDF + Bio zinc (Granules @ 15 kg ha^{-1}),T_8 - RDF + Foliar spray of 0.5 % as $ZnSO_4$ at T.S and P.I.,T_9-RDF + Foliar spray of 1 ml L^{-1} as nano zinc at T.S and P.I. and T_{10}- RDF + Foliar spray of 1.5 ml L^{-1} as bio zinc at T.S and P.I. The recommended dose of 150:50:50 N, P_2O_5, K_2O ha^1 through urea, superphosphate and muriate of potash was added uniformly to all the plots. Nitrogen was applied in three split doses i.e., 50% as basal, 25% each at active tillering and 25% panicle initiation stages. The entire dose of P_2O_5 and K_2O were

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applied basally as per the treatment schedule. The test crop rice CO 51. The zinc was applied through bio and nano zinc formulations. At different stages of crop growth assay of enzyme activity in soil by the standard method Dehydrogenase (Casida Jr *et al*., 1964), Acid phosphatase (Tabatabai and Bremner, 1969) , Urease activity (Tabatabai and Bremner, 1972).

RESULTS AND DISCUSSION

Urease Activity

Effect of various sources of zinc on the activity of soil urease (µg NH_4^+ released g^{-1} soil 2 hr^{-1}) at different growth stages are depicted in fig. 1. The urease activity showed an increasing trend with the age of the crop. It increased from tillering stage to panicle emergence stage, exhibited highest activity at panicle emergence stage and there after the activity decreased at harvest stage. At both stages of crop growth, combined application of RDF + soil application of bio zinc @ 30 kg ha^{-1} (T_7) registered the highest urease activity(390.1, 416.4 and 324.0 µg NH_4^+ released g^{-1} soil 2 hr^{-1}) at tillering stage and panicle initiation stage, respectively. Which was on par with RDF + soil application of $ZnSO_4$ @ 25 kg ha^{-1} (T_3).It was followed by RDF + foliar spray of 0.5 % $ZnSO_4$ (T_8), RDF + foliar spray of 1 ml l^{-1} as nano zinc (T_9) which were on par with each other. At harvest there was a decrease in urease activity among all the treatments and the highest value was seen in RDF + soil application of $ZnSO_4$ @ 25 kg ha^{-1} T_3 (372.2 µg NH_4^+ released g^{-1} soil 2 hr^{-1}). These treatments were followed by RDF + soil application of bio zinc @ 30 kg ha^{-1} T_7 (324.0 µg NH_4^+ released g^{-1} soil 2 hr^{-1}), RDF + soil application of bio zinc @ 15 kg ha^{-1} T_6 (313.1 µg NH_4^+ released g^{-1} soil 2 hr^{-1}). The lowest urease activity was recorded in the treatment absolute control (T_1). Soil urease plays a major role in catalysis of the hydrolysis of urea to ammonical form, which will be subsequently oxidized by nitrifiers to nitrate form, which increase the utilization rate of nitrogen fertilizer. Effect of various sources of zinc on the activity of soil urease (µg NH_4^+ released g^{-1} soil 2 hr^{-1}) at different growth stages are depicted in fig.1. Similar results were also reported by Ramalakshmi (2011) at different growth stages of rice.

Acid and Alkaline phosphatase Activity

Impact of various sources of zinc on the acid and alkaline phosphatase activity (µg of p – nitrophenol g^{-1} soil hr^{-1}) at different growth stages are depicted in fig. 2 . The acid and alkaline phosphatase activity showed an increasing trend with the age of the crop. It increased from tillering stage to panicle emergence stage, exhibited highest activity at panicle emergence stage and there after the activity decreased at harvest stage. At all stages of crop growth, combined application of RDF + soil application of bio zinc @ 30 kg ha^{-1} (T_7) registered the highest acid and alkaline phosphatase activity(128.4, 160.2 and 116.3 µg of p – nitrophenol g^{-1} soil hr^{-1}) and (202.4, 238.1 and 184.4 µg of p– nitrophenol g^{-1} soil hr^{-1}) at tillering stage , panicle initiation stage and harvest stage, respectively. Which was on par with RDF + soil application of $ZnSO_4$ @ 25 kg ha^{-1} (T_3). These treatments were followed by RDF + foliar spray of 0.5 % $ZnSO_4$ (T_8), RDF + foliar spray of 1 ml l^{-1} as nano zinc (T_9) which were on par with each other. The lowest acid and alkaline phosphatase activity was recorded in the treatment absolute control (T_1). Phosphatases are broad groups of enzymes that are caple of catalyzing hydrolysis of esters and anhydrides of phosphoric acid. In soil ecosystems, these enzymes are believed to play critical roles in P cycles (Speir and Ross, 1978) as evidence shows that they are correlated to P stress and plant growth. Phosphatases is an enzymes present in all the microorganisms and increase in its activity is mainly due to increase in bacterial biomass. Temporal sequence in activity of this enzymes may be due to the differential production rates which may be influenced by the physiological age of different groups of microorganisms present in the soil (Srinivas *et al.,* 2003).

Dehydrogenase Activity

Effect of various sources of zinc on the dehydrogenase activity (µg TPF produced g^{-1} soil d^{-1}) at different growth stages are depicted in fig.3.The dehydrogenase activity showed an increasing trend with the age of the crop.

It increased from tillering stage to panicle emergence stage, exhibited highest activity at panicle emergence stage and there after the activity decreased at harvest stage.

At all stages of crop growth, combined application of RDF + soil application of biozinc @ 30 kg ha^{-1} (T_7) registered the highest Dehydrogenase activity (83.4,140.2 and 79.6 µg µg TPF produced g^{-1} soil d^{-1}) at tillering stage , panicle initiation stage and harvest stage, respectively. Which was on par with RDF + soil application of $ZnSO_4$ @ 25 kg ha^{-1} (T_3). These treatments were followed by RDF + foliar spray of 0.5 % $ZnSO_4$ (T_8), RDF + foliar spray of 1 ml l^{-1} as nano zinc (T_9) which were on par with each other. The lowest Dehydrogenase activity was recorded in the treatment absolute control (T_1).Dehydrogenase is considered as an indicator of overall microbial activity because it has interacellular activity in all living microbial cells and it is linked with microbial respiratory process. The dehydrogenase activity is commonly used as an indicator of biological activity in soils (Burns and Bolton 1978). Dehydrogenase enzymes is known to oxidize soil organic matter by transferring protons and electrons from substrates to acceptors. These processes are part of respiration pathways of soil microorganisms and closely related to the type of soil. The activity of dehydrogenase enzyme in the soil systems is very important as it gives indications of the potential of the soil to support biochemical processes which are essential for maintaining soil fertility (Joachim *et al.,* 2008). Similar results were also reported by Rai and Yadav (2011). The increase in dehydrogenase activity was attributed due to increase in population of anaerobic microorganism in submerged soils. There was a shift in soil micro flora from aerobic of facultative and obligatory anerobic ones after the soil is flooded. The shift from aerobic to increase the dehyrogenase activity.

CONCLUSION

The present investigation find out among all the treatments RDF + soil application of bio zinc @ 30 kg ha^{-1} recorded the highest enzymes activity .

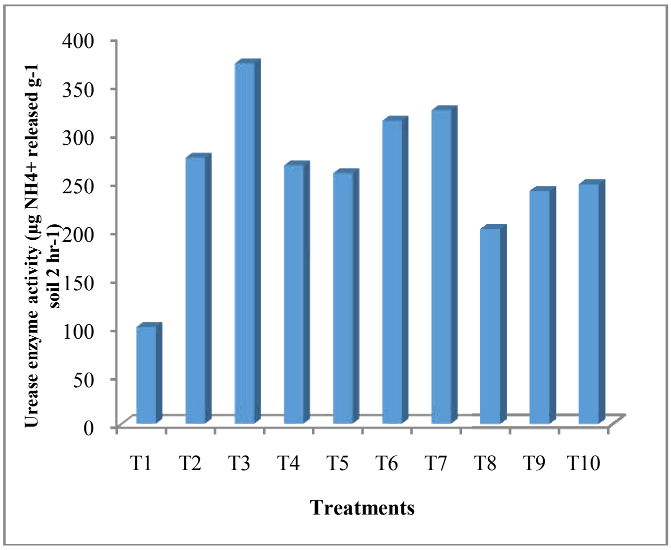

Fig 1 Effect of zinc sources on urease enzyme (µg NH_4^+ released g^{-1} soil 2 hr^{-1}) activity.

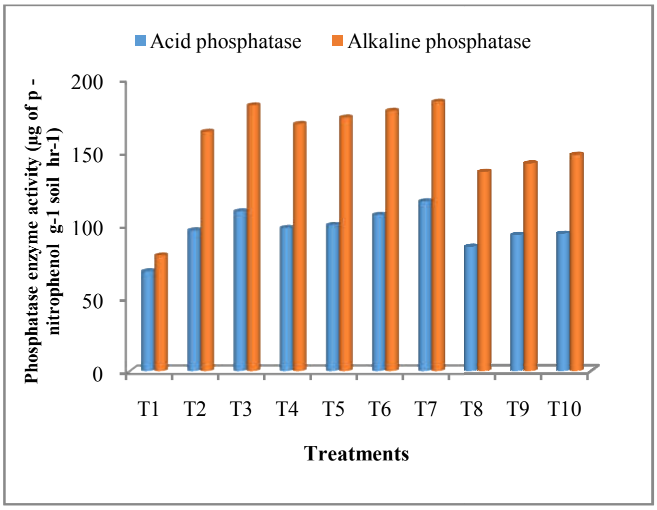

Fig 2 Effect of zinc sources on phosphatase enzyme (µg of p - nitrophenol g^{-1} soil hr^{-1}) activity

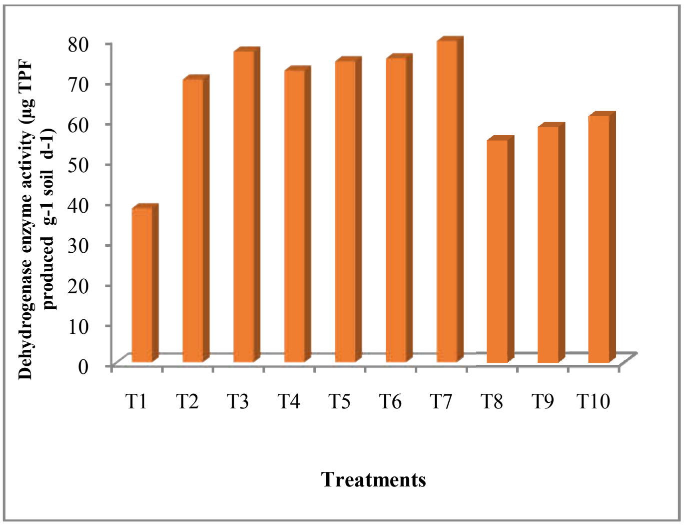

Fig 3 Effect of zinc sources on dehydrogenase enzyme (µg TPF produced g^{-1} soil d^{-1}) activity.

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