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EFFECT OF ZINC ENRICHED FARM YARD MANURE ON RICE IN TYPIC USTIFLUVENT SOIL

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Abstract

An experiment was conducted during *Rabi* 2017 to study the growth and yield of rice to zinc and zinc enriched FYM addition in Typic Ustifluvents soil. The experiment was conducted with eight treatments and three replications laid out in randomized block design(T_1 - Control (RDF) 100 %, T_2 - RDF + FYM @ 500 kg ha^{-1}, T_3 - RDF + Zinc @ 2.5 kg ha^{-1}, T_4 - RDF + Zinc @ 5.0 kg ha^{-1},T_5 - RDF + Zinc @ 7.5 kg ha^{-1}, T_6 - RDF + 2.5 kg Zn enriched FYM @ 500 kg ha^{-1},T_7 - RDF + 5.0 kg Zn enriched FYM @ 500 kg ha^{-1}, T_8 - RDF + 7.5 kg Zn enriched FYM @ 500 kg ha^{-1}). The result of experiment revealed that addition of zinc or zinc enriched farmyard manure favorably influenced the growth and yield of rice over control. Plant height, DMP and rice yield at all stage was highest with Zn-eFYM compared to zinc alone at all levels. Addition of RDF + 5.0 kg Zn enriched FYM @ 500 kg ha^{-1}registered the highest plant height, dry matter production and rice yield. The highest grain yield (7692 kg ha^{-1}) and straw yield (8942 kg ha^{-1}) was noticed with RDF + 5.0 kg Zn enriched FYM @ 500 kg ha^{-1}. This treatment on an average caused 56 per cent increase over control. Similarly in the plant height and DMP highest value was seen in RDF + 5.0 kg Zn enriched FYM @ 500 kg ha^{-1}.

Key words : Rice, Zinc, FYM.

Introduction

Rice (*Oryza sativa* L.) is one of the major stables, feeding more than half of the world population. It is grown in more than 100 countries, predominantly in Asia. Rice provides 21 % of energy and 15 % of protein requirement of human populations globally (Maclean *et al*., 2002; Depar *et al*., 2011). Among the rice growing countries India ranks first in area (43.8 million ha) and second in production (157.2 million tonnes), next only to China. However, the average productivity of rice in India is only 3.62 t ha^{-1} against the global average of 4.52 t ha^{-1} (FAO, 2014). Increasing productivity and production are essential to meet the food requirement of the burgeoning population. In order to attain the desired yield potential through agronomic manipulations and adopting appropriate management practices for raising not only the yield but also improvement of quality characteristics of rice is an area of research, which needs immediate attention. The productivity and quality of rice depends on environmental conditions and agronomic management practices of the area. In Tamil Nadu, rice cultivation spreads over an area of 21 lakh hectares with a total production of 93 lakh Mt (Anonymus, 2015). Among micronutrients, Zn deficiency is a widespread nutritional constraint throughout the world. Zinc is an essential micronutrient required for normal growth and development of living organisms including plant, animals and human beings (Kabata-Pendias, 2000). Zinc deficiency ranks 5th among the ten leading causes of diseases and illnesses in the developing countries of the world (WHO, 2002; IFA, 2007).

Zinc plays an important role in many biochemical functions within plants. *Viz.,* auxin production, preferential accumulation of chlorophyll, protein synthesis and starch metabolism Therefore, and deficiency of zinc in soil adversely affects the growth and development of plants (Rashid and Ryan, 2004). Rice crop requires high amount of Zn (Brady and Weil, 2007; Havlin *et al*., 2007), under deficient condition of Zn in soil, therefore Zn deficiency becomes in the rice plants, than plant growth is restricted

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and quality of rice grain deteriorate and human health is also adversely affected (Pathak *et al*., 2008; Singh, 2010). To ameliorate zinc deficiency in the zinc deficient soils, the zinc fertilizers are being used but the zinc availability is less to the plants due to very high zinc fixation in soil. Organic manures provide major as well as minor nutrients and improve soil health by improving physical condition of soil. The combined use of inorganic fertilizers with organic manures namely, farmyard manure (FYM), green manure, poultry manure, pig manure increased the rice yield, nitrogen, phosphorus and potassium uptake, use efficiency of nutrients and available nutrient status of soil (Laxminarayana, 2006; Laxminarayana and Patiram, 2006). The recovery of micronutrients is very poor in crop that necessitates the adoption of improved techniques like use of micronutrients synthetic chelates. Since it is a costly technology, therefore enrichment of soil with organic manures and micronutrients, which acts as natural chelates in the soil, seems to be economically viable. Zinc application in the enriched form with organic manure, enhances the fertilizer use efficiency and increases the rice yield. The enrichment of micronutrients with organic manures not only enhances the rate of decomposition but also improves the nutrient status and health of soil. Application of FYM with $ZnSO_4$ increased the DTPA-Zn content in soils (Meena *et al*., 2016). The zinc deficiency in soil may be mitigated by applying inorganic salt or organic manures. However the application of zinc enriched organic manures ensures supply of zinc besides savings 50 per cent of zinc application (Jadhav *et al*., 2003). The effect of combined application of FYM and zinc on soil parameters and plant factors was well documented (Ram Sakal, 2001). However, information on the response of rice to zinc enriched FYM on growth and yield of rice is limited. Hence, the present investigation was carried out to study the influence of zinc and zinc enriched FYM plant height, DMP and rice yield.

Materials and Methods

With a view to study the response of growth and yield of rice to zinc and zinc enriched FYM in Typic Ustifluvents soil, the field experiment was carried out during *Rabi* 2017 at experimental farm, Faculty of Agriculture, Annamalai University. The experimental soil was sandy 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 experiment consisted of eight treatments viz., T_1 - Control (RDF) 100 %, T_2 - RDF + FYM @ 500 kg ha^{-1}, T_3 - RDF + Zinc @ 2.5 kg ha^{-1}, T_4 - RDF + Zinc @ 5.0 kg ha^{-1}, T_5 - RDF + Zinc @ 7.5 kg ha^{-1}, T_6 - RDF + 2.5 kg Zn enriched FYM @ 500 kg ha^{-1}, T_7 - RDF + 5.0 kg Zn enriched FYM @ 500 kg ha^{-1}, T_8 - RDF + 7.5 kg Zn enriched FYM @ 500 kg ha^{-1}. The recommended dose of 120:38:38 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 applied basally as per the treatment

Table 1: Effect of zinc and Zn-eFYM application on plant height (cm) of rice crop.

Treatments	Tillering stage	Panicle initiation stage	Harvest stage
T_1 - Control (RDF)	33.0	58.1	73.3
T_2 - RDF + FYM @ 500 kg ha^{-1}	37.5	64.1	80.2
T_3 - RDF + Zinc @ 2.5 kg ha^{-1}	41.4	69.7	86.4
T_4 - RDF + Zinc @ 5.0 kg ha^{-1}	45.8	75.9	92.6
T_5 - RDF + Zinc @ 7.5 kg ha^{-1}	45.0	74.7	91.6
T_6 - RDF + 2.5 kg Zn enriched FYM @ 500 kg ha^{-1}	50.0	82.0	99.3
T_7 - RDF + 5.0 kg Zn enriched FYM @ 500 kg ha^{-1}	54.0	88.2	106.7
T_8 - RDF + 7.5 kg Zn enriched FYM @ 500 kg ha^{-1}	53.1	86.7	105.1
SEd	1.02	0.94	1.13
CD (P = 0.05)	2.14	2.02	2.43

Table 2: Effect of zinc and Zn-eFYM application on DMP (kg ha^{-1}) of rice crop.

Treatments	Tillering stage	Panicle initiation stage
T_1 - Control (RDF)	1641	3656
T_2 - RDF + FYM @ 500 kg ha^{-1}	1910	4104
T_3 - RDF + Zinc @ 2.5 kg ha^{-1}	2169	4525
T_4 - RDF + Zinc @ 5.0 kg ha^{-1}	2396	4931
T_5 - RDF + Zinc @ 7.5 kg ha^{-1}	2329	4825
T_6 - RDF + 2.5 kg Zn enriched FYM @ 500 kg ha^{-1}	2628	5329
T_7 - RDF + 5.0 kg Zn enriched FYM @ 500 kg ha^{-1}	2868	5720
T_8 - RDF + 7.5 kg Zn enriched FYM @ 500 kg ha^{-1}	2749	5618
SEd	56.07	62.87
CD (P = 0.05)	120.0	134.84

schedule. The test crop rice CO 51. The zinc was applied through analytical grade zinc sulphate ($ZnSO_4.7H_2O$). The zinc sulphate contains 21 per cent Zn. Calculated quantities of zinc, FYM and Zn Enriched FYM(Zn-eFYM) were applied as per the treatment schedule in soil. At different stages of crop growth plant height and DMP and harvest stage grain and straw yield were recorded.

Results and Discussion

Plant height

Analysis of variance on plant height furnished in table 1 showed that application of different levels of zinc and Zn-eFYM caused significant improvement on plant height at all stages over control. Plant height ranged from 33 to 54 cm at tillering stage, 58.10 to 88.20 cm at panicle initiation stage and 73.30 to 106.7 cm at harvest stage respectively. Plant height at all stage was highest with Zn-eFYM compared to zinc alone at all levels. Plant height increased up to 5.0 kg Zn ha^{-1} and decreased at 7.5 kg Zn ha^{-1} whether applied as zinc alone or as zinc enriched FYM. Among the treatments, tallest plant (54, 88.2 and 106.7 cm) at tillering, panicle initiation and harvest stage was noticed with combined application of RDF + 5.0 kg Zn-eFYM @ 500 kg ha^{-1} (T_7) and was on par with T_8 and significantly superior to rest of the treatments. However absence of zinc and Zn-eFYM (T_1) reduced the plant height at all stages. The beneficial effect of zinc-enriched FYM clearly noticed over straight zinc application in rice. The significant effect of zinc-enriched FYM due to the fact that the zinc availability expected to be enhanced through complexation or chelation and thereby inhibited zinc fixation in soil (Latha et al., 2001; Venkatasheshagiri *et al.*, 1994) besides FYM supplying other nutrients as well. The results corroborate with the findings of Osman *et al.,* (2000). FYM recorded higher

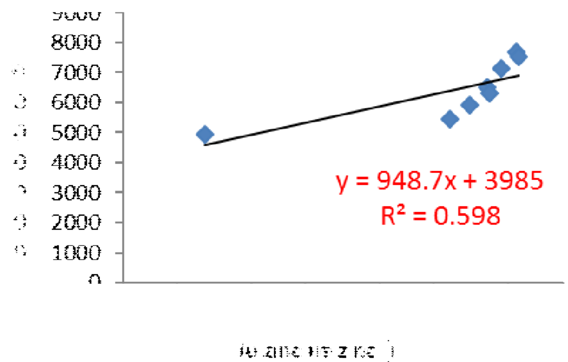

Fig. 1: Linear relationship between grain yield with available Zn.

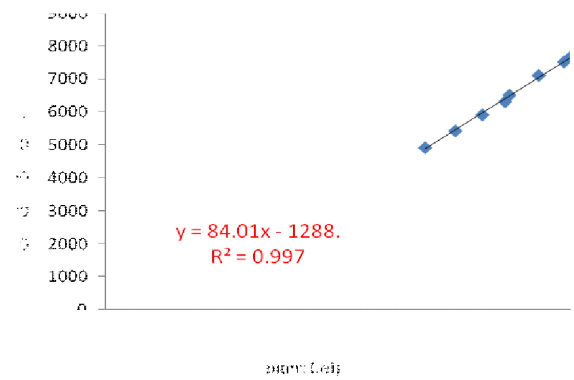

Fig. 2: Linear relationship between grain yield with plant height (Harvest stage).

plant height compared to other organics because FYM is an excellent organic fertilizer, as it contains higher nitrogen, phosphorus, potassium and other essential nutrients (Garg and Bahla, 2008). Ghosh and Sharma (1999) reported application of organic manures increased the plant height of rice plant.

Dry matter production (DMP)

Addition of Zn or Zn-eFYM at different levels caused significant effect on dry matter production at all stages of crop growth over NPK alone Table 2. DMP at all stage was highest with Zn-eFYM compared to zinc alone at all levels. The DMP ranged from 1641 to 2868 kg ha^{-1} at tillering stage and 3656 to 5720 kg ha^{-1} at panicle initiation stages respectively. The highest DMP was noticed with combined application of RDF + 5.0 kg Zn-eFYM @ 500 kg ha^{-1} (T_7) at tillering stage (2868 kg ha^{-1}) and panicle initiation stage (5720 kg ha^{-1}) respectively. It was comparable with T_8 and significantly superior to rest of the treatments. Increase in DMP due to zinc and organic manures might be due to intermediates / metabolites of decomposing

Table 3: Effect of zinc and Zn-eFYM application on grain and straw yield of rice.

Treatments	Grain Yield (kg ha^{-1})	Panicle (kg ha^{-1})
T_1 - Control (RDF)	4926	5964
T_2 - RDF + FYM @ 500 kg ha^{-1}	5436	6500
T_3 - RDF + Zinc @ 2.5 kg ha^{-1}	5918	7014
T_4 - RDF + Zinc @ 5.0 kg ha^{-1}	6522	7668
T_5 - RDF + Zinc @ 7.5 kg ha^{-1}	6323	7468
T_6 - RDF + 2.5 kg Zn enriched FYM @ 500 kg ha^{-1}	7114	8327
T_7 - RDF + 5.0 kg Zn enriched FYM @ 500 kg ha^{-1}	7692	8942
T_8 - RDF + 7.5 kg Zn enriched FYM @ 500 kg ha^{-1}	7532	8784
SEd	134.86	158.9
CD (P = 0.05)	289.29	340.10

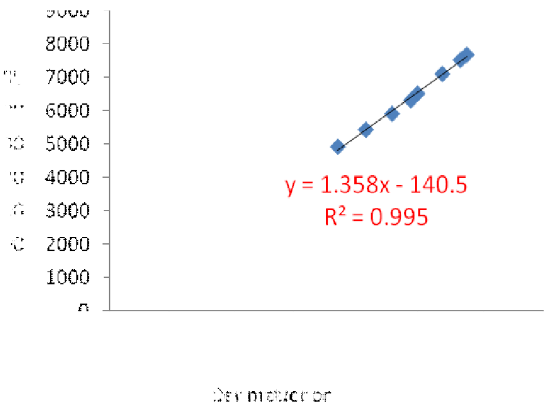

Fig. 3: Linear relationship between grain yield with DMP (P.I. stage).

organic manures that hold zinc in the form available to plant or release of Zn mobilizing compounds such as phytosiderophores from roots and induction of polypeptide involved in Zn uptake and translocation to shoot (Cakmak and Braun, 2004; Ahmed *et al.,* 2012). It could also be due to integrated use of both these amendments that have favourable effect on soil property by forming soluble complexes with zinc which ultimately increased nutrient availability to plant resulting in higher dry biomass.

Rice Yield

A significant increase in grain and straw yield of rice was noticed due to application of different levels of zinc and Zn-eFYM over control table 3. However, the response was more evident in the treatments of Zn-eFYM as compared to Zn application as ($ZnSO_4.7H_2O$) at all levels.. Grain and straw yield ranged from 4926 to 7692 kg ha^{-1} and 5964 to 8942 kg ha^{-1}. The highest grain and straw yield was obtained with combined application of RDF + 5.0 kg Zn-eFYM @ 500 kg ha^{-1} T_7 (7692 and 8942 kg ha^{-1}). It was on par with T_8 (7532 and 8784 kg ha^{-1}) and significantly superior to rest of the treatments. The yield increase due to zinc enriched FYM was 24 per cent over straight application of zinc. The lowest grain yield (4926 kg ha^{-1}) was observed in the absence of Zn and Zn-eFYM (T_1). Increase rice yield to elevated zinc was expected because the available zinc in soil was below the crucial limit. Response of rice crop was noticed from growth stage onwards and its effect was culminated in increasing the rice yield. Enhanced grain and straw yield could be due to supply of nutrients especially macro and micronutrients which induced cell division, expansion of cell wall, meristematic activity, photosynthetic efficiency, regulation of water to cells, conducive physical environment, facilitating to better aeration, root activity and nutrient absorption leading to higher rice yield (Singh and Sharma 2014). In the present study, RDF + 5.0 kg Zn-eFYM @ 500 kg ha^{-1} amended soil showing maximum nutrients. This was ably confirmed by significant positive correlation between grain yield with available Zn (r = 0.592**), plant height (r= 0.997**) and DMP (r= 0.995**). Higher rice yield due to combined application of organics and zinc could be due to the fact that micronutrient availability was expected to enhance through complexation or chelation thereby prevent fixation in soil (Mani *et al.,* 2001; Latha *et al.,* 2001).

Conclusion

In conclusion, zinc application to zinc deficient soil significantly increased plant height, DMP and grain yield of rice. Application of zinc enriched FYM proved better over application of alone zinc sulphate ($ZnSO_4$) indicating the positive role of organic matter in increasing plant height, DMP and grain yield on soils affected with zinc deficient.

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