

Original Research Article

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Effect of Zinc and Iron Enriched Organic Manures on Growth and Yield of Rice under Sodic Soil Conditions

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ABSTRACT

The field study was conducted at Anbil Dharmalingam Agricultural College and Research Institute, Thiruchirappalli during late samba season of 2019-2020 to evaluate the effect of enriched organic manures with different levels of zinc and iron on growth and yield of rice under sodic soil condition. The experiment was laid out in randomized block design with three replications. Three levels of zinc and iron were enriched with three different organic manures. The treatments consisted of recommended dose of fertilizers with enriched poultry manure, vermicompost and farmyard manure each of 500 kg per hectare with 100% Zn & Fe (37.5 and 30 kg /ha), 75% Zn & Fe (28 and 22 kg /ha) and 50% Zn & Fe (18.7 kg and 15 kg /ha) and control i.e. Application of Zn (37.5 kg /ha)+ Fe (30 kg /ha) alone were taken. The enriched organic manures were applied at the time of transplanting of rice. The applied enriched organic manures showed significant impact on the growth and yield parameters of rice. Readings taken at harvest showed that the highest plant height(159.01cm), number of tillers(604 no/m²), root length (25.18cm), dry matter production(12188 kg ha⁻¹), panicles/m² (479 no/m²), filled grain per panicle(479 no/m²), grain and straw yield (4535 kg ha⁻¹and7259 kg ha⁻¹) were recorded with the application of poultry manure enriched with 100% zinc and iron along with recommend dose of fertilizers over control. This was on par with vermicompost enrichment with 100% zinc and iron. The lowest growth and yield parameters were observed with the control.

Keywords

Enriched organic manures, Zinc, Iron, Poultry manure, Vermicompost and FYM

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Introduction

Rice (*Oryza sativa* L.) encompasses all the aspect of livelihood and acts as the major staple food crops in the world as well as India, feeding 60 % of the world population. It bestows 21% of human per capita energy and 15% of protein of human nutrient

requirements (Deepar *et al.*, 2011). In India, nearly 43.7 m ha area is under rice cultivation and the production accounts to 112.7 m t with an average productivity of 2.57 t ha⁻¹. In Tamilnadu, it is grown in an area of 1.8 m ha with an annual production of 6.6 m t and the average productivity is about 3.6 t ha⁻¹

Among all abiotic stresses soil salinity is the acute one. Presence of high concentration of soluble salts, Na domination on cation exchange complex and low organic content of the soil are the main problem in saline and sodic soils (Newell and Nicole, 2013). Crops grown on these soils suffer from specific ionic toxicities (Na, Cl) and deficiencies (Ca, K, Fe and Zn) causing substantial yield decline (Yadav *et al.*, 2011).

Zinc play an important role in enzyme activation, protein synthesis, carbohydrate and lipids metabolism, auxins synthesis and chlorophyll biosynthesis which greatly influence the plant growth and yield (Graham *et al.*, 2000; Mousavi, 2013). Iron is required to maintain proper metabolic and physiological processes in plants. The high soil pH and bicarbonate content reduces the solubility of iron and zinc in the soil solution and plants growing in alkaline soils often exhibit distinct symptoms of Fe deficiency (Kakei *et al.*, 2012; Qadar, 2002).

Addition of organic amendments to soil, decrease the bulk density, pH, EC and ESP while it increase the CEC, water holding capacity and organic carbon content of the soil which have a diluting effect on alkali soil (Wang *et al.*, 2014). Though ZnSO₄ and FeSO₄ are the widely used fertilizers for its solubility, low cost availability in the market, fixation of nutrients is the major problem in the sodic soil. In that case augmented methods like use of synthetic chelates can be endorsed to increase the insubstantial uptake of micronutrients. Beside using synthetic chelates like Zn-EDTA, Zn- DTPA and EDDHA-Fe which is costly, making use of organic manures that act as natural chelates for enrichment sounds to be economically viable. When the micronutrients are enriched with organic manure, organo complexes are formed. This prevents the nutrient fixation in soil and increase amount of available Zn and

Fe in the root zone of plants. The slow and steady release of micronutrients from the organic manures makes it available for plants for longer time which in turn increases the yield of the crop (Meena *et al.*, 2006; Verma *et al.*, 2001). The application of zinc-enriched poultry manure reduces 50% of Zn fertilizers (Latha *et al.*, 2001). Iron-enriched vermicompost is a rich source of total and available iron. The present study investigates the effect of zinc and iron enriched organic manures on the growth and yield parameters of rice in sodic soil condition.

Materials and Methods

The research was carried out during late Samba of 2019- 2020 at Anbil Dharmalingam Agricultural College and Research Institute, Trichy, which geographically fall under the coordinates - 11°32' North latitude, 78°83' East longitude and 85 m above mean sea level. The composite soil sample was collected from the experimental field and it was analyzed for its physical and chemical properties. The soil was clayey loam in texture, moderately drained classified as *Vetric Ustropept*. The soil pH was 8.7 which was alkaline in nature, EC 0.75 ds/m, having bulk density of 1.28 Mg m⁻³. The soil was low in organic carbon (0.42), low in available N (175.16 kg/ ha) medium in available P (16.8 kg/ ha) and high in available K (292.4 kg/ ha).

The experiment was laid out in randomized block design with three replications using rice (TRY 3 variety) as a test crop. Ten treatment combinations was taken with recommended dose of fertilizers (150:50:50 NPK) and enriched organic manures with zinc and iron (farm yard manure, vermicompost and poultry manure). Since it was sodic soil extra 25% of N was applied along with RDF. The treatments consist of T₁ –RDF + Zn (37.5 kg /ha)+ Fe (30 kg /ha), T₂-RDF + FYM enriched with 100 % zinc + iron, T₃ - RDF +

vermicompost enriched with 100 % zinc + iron, T₄ - RDF + Poultry manure enriched with 100 % zinc + iron, T₅ - RDF + FYM enriched with 75 % zinc + iron, T₆ - RDF + vermicompost enriched with 75 % zinc + iron, T₇ - RDF + Poultry manure enriched with 75 % zinc + iron, T₈ -RDF + FYM enriched with 50 % zinc + iron, T₉ - RDF + vermicompost enriched with 50 % zinc + iron, T₁₀- RDF + Poultry manure enriched with 50 % zinc + iron. The organics viz., FYM, press mud, poultry manure and vermicompost each 500kg/ha were mixed with 100% (37.5kg/ha Zn & 30 kg /ha Fe), 75% (28 kg/ha Zn and 22 kg/ha Fe) and 50 % (18.7kg/ha Zn and 15 kg Fe). The enriched organics were aerobically incubated for 60 days and moisture content was maintained @ 60 %.

The growth parameters (plant height, number of tillers, root length and dry matter production) were recorded at different growth stages viz., tillering, panicle initiation, flowering and harvest. Yield parameters viz., number of panicles/ m², number of grains per panicle, thousand grain weight, grain and straw yield were recorded at the harvest.

Results and Discussion

Effect on growth parameters

The application of enriched organic manures had significantly influenced the growth parameters (Table 1). At harvest the maximum plant height (159.01cm), number of tillers (604 no/m²), root length (25.18cm) and dry matter (12188 kg ha⁻¹) were recorded with the application of enriched poultry manure with 100 % zinc and iron (T₄) compared to the zinc and iron alone application. This was followed by treatment T₃. With regard to plant height and dry matter production both the above mentioned treatments were on par with each other. The lowest plant height,

number of tillers, root length and DMP were observed with the control.

When both micronutrients (zinc and iron) and organic manures were combined together for enrichment, organo complexes were formed due to the fact that under anerobic condition organic carbon present in the manures undergo chelation. This caused increased availability of available zinc and iron to the crops. Increased nutrition caused more branching which in turn increased the plant growth. The increase in plant height, dry matter and root length was owing to that zinc assists in the amino acid synthesis, auxin synthesis and iron catalyst to the formation of chlorophyll (Rout *et al.*, 2012). This sharpen the photosynthetic activity, cell elongation and division. Thus enhanced the growth of the plant. Among all organic manures used in the study, poultry manure had more essential nutrients and enrichment of iron and zinc with poultry manure also increases the availability of Zn and Fe contents in the manures (Mansuri *et al.*, 2019)

Effect on yield parameters and yield

The combination of treatments of enriched organic manures with zinc and iron had shown the impact on the yield and yield parameters of rice (Table 2). Significantly higher number of panicles (479 no/m²) and filled grains per panicle (204) were observed with the application of enriched poultry manure with 100 % zinc and iron. This was on par with treatment T₃.

The lowest values were observed with the treatment only having zinc and iron alone. The grain yield and straw yield ranges from 3309 kg ha⁻¹ to 4535 kg ha⁻¹ and 6328 kg ha⁻¹ to 7259 kg ha⁻¹. Significantly the highest grain and straw yield was recorded with the application of T₄ (4420 kg ha⁻¹ and 7258 kg ha⁻¹) over all treatments.

Table.1 Effect of zinc and iron enriched organic manures on growth parameters of rice at harvest stage

Treatment	Plant height (cm)	Number of tillers/m ²	Root length(cm)	Dry matter production (kg ha ⁻¹)
T ₁ -100 % RDF + Zn (37.5 kg /ha)+ Fe (30 kg /ha)	109.74	328	14.33	9777
T ₂ -100 % RDF + FYM enriched with 100 % Zn+ Fe	142.15	460	19.60	11658
T ₃ - 100 % RDF + VC enriched with 100 % Zn + Fe	147.93	526	22.96	11881
T ₄ - 100 % RDF + PM enriched with 100 % Zn + Fe	159.01	604	25.18	12188
T ₅ - 100 % RDF + FYM enriched with 75 Zn + Fe	134.92	409	16.97	10796
T ₆ - 100 % RDF + VC enriched with 75 % Zn + Fe	140.01	441	17.86	10998
T ₇ - 100 % RDF + PM enriched with 75 % Zn + Fe	142.37	497	18.83	11209
T ₈ - 100 % RDF + FYM enriched with 50 % Zn + Fe	125.72	408	14.93	10248
T ₉ - 100 % RDF + VC enriched with 50 % Zn + Fe	128.02	388	16.01	10401
T ₁₀ - 100 % RDF + PM enriched with 50 % Zn + Fe	131.78	369	16.98	10549
SEd	7.89	30.70	1.05	366.90
CD (P=0.05)	16.57	64.51	2.21	770.83

FYM- Farm yard manure VC – Vermicompost PM – Poultry manure

Table.2 Effect of zinc and iron enriched organic manures Yield and yield parameters of rice

Treatment	No of panicles/ m ²	Filled grain per panicle	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)
T ₁ -100 % RDF + Zn (37.5 kg /ha)+ Fe (30 kg /ha)	245	125	3309	6328
T ₂ -100 % RDF + FYM enriched with 100 % Zn+ Fe	421	181	4252	7023
T ₃ - 100 % RDF + VC enriched with 100 % Zn + Fe	468	196	4365	7121
T ₄ - 100 % RDF + PM enriched with 100 % Zn + Fe	479	204	4535	7259
T ₅ - 100 % RDF + FYM enriched with 75 Zn + Fe	360	170	3808	6702
T ₆ - 100 % RDF + VC enriched with 75 % Zn + Fe	393	175	3938	6770
T ₇ - 100 % RDF + PM enriched with 75 % Zn + Fe	422	182	4057	6853
T ₈ - 100 % RDF + FYM enriched with 50 % Zn + Fe	277	145	3498	6495
T ₉ - 100 % RDF + VC enriched with 50 % Zn + Fe	308	154	3632	6500
T ₁₀ - 100 % RDF + PM enriched with 50 % Zn + Fe	329	159	3751	6527
SEd	13.27	7.03	140	184
CD (P=0.05)	27.89	14.77	294	386

FYM- Farm yard manure VC – Vermicompost PM – Poultry manure

This grain yield increase was upto 30 % when compared to straight application of iron and zinc application. This was on par T₃ and T₂. The lowest grain and straw yield were recorded with the control. The increase in yield and yield components was due to increased zinc and iron availability through enriched organic manures. Maskina and Randhawa (1983) stated that the application of organic manures decrease the soil pH and increase the Zn and Fe availability through formation of Zn and Fe chelates. The increased supply increases the use efficiency of Zn and Fe (Verma *et al.*, 2001). The slow and

steady release of nutrients by organic manure make the nutrients available to crop over long period of time there by increase in plant growth and yield (Meena *et al.*, 2006). The enhanced grain and straw yield might also be due to increased availability of zinc which causes the biosynthesis of IAA and its part in the initiation of primordia of reproductive parts and assimilate partitioning towards them, causes increase in flowering and fruiting which in turn tap more yield (Rathod *et al.*,2012; Mansuri *et al.*,2019)

From the given study, it is concluded that application of enriched poultry manure with 37.5kg/ha Zn &30 kg /ha Fe along with recommended dose of fertilizers increase the growth and yield parameters of rice under sodic soil condition.

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