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Effect of Zinc and Zn-Enriched Compost on Growth, Yield and Nutrient Content in Rice (*Oryza sativa* L.) in an Inceptisol of Varanasi

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ABSTRACT

A field investigation was undertaken during *kharif* 2019 to study the effect of Zn enriched compost on growth, yield and nutrient content in rice (*Oryza sativa* L.) in inceptisol of Varanasi. There were ten treatments combination comprising of recommended dose of compost, NPK fertilizers, $ZnSO_4$ and zinc enriched compost. The experiment was laid out in Randomized Block Design and replicated thrice. Significantly higher growth, yield and nutrient content (N, P, K and Zn) in rice were recorded in NPK + Zn-Enriched compost @ 45 kg ha^{-1} followed by 30 and 15 kg ha^{-1}. Grain yield and straw yield were also superior in the same treatments. The same trend was noticed for primary, secondary and micronutrients.

Keywords Rice, Growth, Yield, Content, Zn-Enriched compost.

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INTRODUCTION

Rice (*Oryza sativa* L.) is the main cereal crop grown both in India and within the globe. Among 112 countries, India is the second largest producer and consumer of rice after China. Rice productivity remains very low in India. Though, some increase in productivity has been witnessed by the country in previous few decades. Increasing the assembly of rice fertilizer will still be a really important and indispensable input due to various factors. In these recent years fertilizers use is mixed with intensive cropping that accelerates the exhaustion of micro-nutrient reserves in the soil. Normally, Micro-nutrient malnutrition is basically caused due to deficiency of Zinc, Iron, Iodine and fat-soluble vitamins (A, D, E and K). Around 3 billion people are at a risk of Zinc deficiency everywhere in the world (FAO and WHO 2002). In developing countries, the dominance of cereals in cropping system is linked to the rise in micro-nutrients, which are generally low in micro-nutrients. Such cereal dominant dietary system appears to be the foremost likely reason for the emergence of micro-nutrient deficiencies over the last 15-20 years (Welch and Graham 1999). Recent reports indicate that almost 500,000 infants die annually due to Zn deficiencies (Black *et al*. 2008). Low dietary intake of Zn appears to be the key reason for the widespread prevalence of Zn deficiency in human population. Increasing Zn density in rice grains is thus essential for human nutrition (Sperotto *et al*. 2010, Wu Chun Yong *et al.* 2010). Large variations within the content of zinc in grains of rice varieties are observed. The aromatic cultivars have a consistently higher concentration of zinc in grain than the non-aromatic types (Graham *et al.* 1997). Generally, Zinc density in rice varied from 16-58 mg kg^{-1}. However nearly all the widely grown varieties content of Zn is 12 mg kg^{-1} (Senadhira and Graham 1999). In India, among micro-nutrients, Zn deficiency is that the most widespread under high-yielding crop varieties areas, where 45% of soils are deficient in Zn supply, related to coarse texture soil with high pH, low organic carbon, and high $CaCO_3$. Among cereals, wheat and rice specifically suffers from Zn deficiency and raise serious implications for human health in countries where consumption of cereal-based diets predominate.The challenge now could be to support a replacement paradigm for agriculture- An agriculture that aims not just for productivity and sustainability but also for balanced nutrition. These effects are most pronounced in micro-nutrient deficient soils (Yilmag *et al.* 1997). Thus, micro-nutrient dense seeds are more desirable both for the farmer as well as the consumer.

MATERIALS AND METHODS

During the *kharif* season in 2019-20 field experimentation was conducted in the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. The soil of the experimental field was Gangetic alluvial with pH 7.9. It was moderately fertile being low in carbon (0.46 %), available nitrogen (216.30 kg ha^{-1}), phosphorus (12.89 kg ha^{-1}), potassium (181.5 kg ha^{-1}), zinc (0.52 ppm) and sulfur (10.39 kg ha^{-1}). Field experiment was carried out in Randomized Block Design and application of fertilizer along with zinc enriched compost in different plots. The experimental plot was further divided into 30 plots to accommodate micronutrient treatment combinations i.e. T_1 (control), T_2 NPK (alone), T_3 (NPK + Compost (FYM), T_4–(NPK + Compost + Recommended $ZnSO_4$), T_5 (NPK + Zn – Enriched compost @ 15 kg ha^{-1}), T_6 (NPK + Zn-Enriched compost @ 30 kg ha^{-1}), T_7 (NPK + Zn – Enriched compost @ 45 kg ha^{-1}), T_8 (NPK + $ZnSO_4$ @ 15 kg ha^{-1}), T_9 (NPK + $ZnSO_4$ @ 30 kg ha^{-1}), T_{10} (NPK + $ZnSO_4$ @ 45 kg ha^{-1}). Treatments were randomly allocated to the plots separately and replicated three times. N, P, K were applied as basal through Urea, DAP and MOP while micro-nutrient (Zn) applied through Zn enriched compost.

RESULTS AND DISCUSSION

The nature of ideal soil conditions, its genetic potentiality and the environment working through its internal physiological and biochemical processes all play a role in the quantity and quality of growth observed by plants. Application of nutrients as NPK + Zn-Enriched compost @ 45 kg ha^{-1} had maximum height at all growth stages. Compost enriched with different levels of zinc along with NPK had also performed better with maximum height, chlorophyll SPAD value, number of leaves and tillers per hill at any time during growth. These treatments obtained maximum of 107 cm height. This was succeeded by different levels of $ZnSO_4$ with NPK application. The trend remained same for production of number of leaves per hill and number of tillers per hill. Similarly Oahiduzzaman *et al*. (2016) reported that $ZnSO_4$ applied @ 4 kg ha^{-1} enhanced the plant height at harvest (88.3 cm) in rice variety, BRRI dhan-33. Ghasal *et al.* (2016) revealed that CGR, RGR and NAR were not significantly influenced by Zn fertilization. However, the highest values were recorded with soil application of Zn- EDTA @ 1.25 kg ha^{-1} + foliar spray of 0.5 % at maximum tillering and panicle initiation stage.The beneficial impact was primarily due to increased cell division and expansion due to improved nutrient availability in soil following the application of nutrient sources. In comparison, $ZnSO_4$ application with compost or enriched with zinc and NPK performed better and were on par with the best practices kit. A significant increase in yield attributes

Table 1. Effect of zinc and Zn-enriched compost on plant height, chlorophyll content, number of tillers (m^{-2}) at different growth stages of rice crop. Treatments: T_1 Control (Absolute), T_2 NPK (alone), T_3 NPK + Compost (FYM), T_4 NPK + Compost + Recommended $ZnSO_4$, T_5 NPK + Zn - Enriched compost @ 15kg ha^{-1} , T_6 NPK + Zn - Enriched compost @ 30kg ha^{-1}, T_7 NPK + Zn –Enriched compost @ 45kg ha^{-1}, T_8 NPK + $ZnSO_4$ @ 15kg ha^{-1}, T_9 NPK + $ZnSO_4$ @ 30 kg ha^{-1}, T_{10} NPK + $ZnSO_4$ @ 45kg ha^{-1}.

Treatments	Tillering stage	Panicle initiation stage Plant height (cm)	Harvest stage	Tillering stage	Panicle initiation stage Chlorophyll content	Tillering stage	Panicle initiation stage Number of tillers (m^{-2})	Harvest stage
T_1	38.05	78.21	98.88	31.07	36.73	287.41	451.19	409.21
T_2	39.81	79.51	99.01	32.86	39.4	290.17	452.81	410.07
T_3	39.56	79.11	99.73	33.09	39.56	292.03	454.56	411.65
T_4	43.14	82.14	104.05	38.23	43.03	296.72	459.41	413.2
T_5	45.21	82.13	105.94	39.04	44.85	297.12	459.17	415.91
T_6	47.18	86.04	106.52	41.46	46.73	298.19	462.5	416.71
T_7	48.23	87.13	107.13	42.06	47.83	299.02	463.22	417.14
T_8	40.81	80.18	101.18	35.83	40.26	293.11	456.34	412.37
T_9	41.23	81.17	102.54	37.76	41.5	295.37	457.21	412.11
T_{10}	46.05	85.12	106.21	40.66	45.62	297.31	460.12	415.03
SEm ±	0.37	0.28	0.57	0.33	0.33	0.29	0.30	0.32
CD (p=0.05)	1.0	0.8	1.6	0.99	0.99	0.87	0.90	0.95

like numbers of panicle grain and straw yield, harvest index were noticed in the treatments which received Zn-E compost at 45 kg ha^{-1} (53.14 and 75.23 q ha^{-1}) and 30 kg ha^{-1} (52.37 and 74.18 q ha^{-1}) it was at par with other treatments. Similarly Shivay *et al*. (2015) reported that soil application (5 kg Zn ha^{-1}) plus foliar application (1 kg Zn ha^{-1}) recorded the highest grain and straw yield in rice. Application of Zn @ 5 mg kg^{-1} soil was found optimum for obtaining good yield in soils deficient in Zn (Kalala *et al*. 2016). Increased grain yield may be due to improved yield and yield components, such as better carbohydrate partitioning from the leaf to the reproductive sections, which results in increased yield. The yield attributes were directly contributed for the higher grain and straw yield. Yield attributes such as number of productive tillers per hill, number of grains per panicle and test weight were recorded maximum in treatment. Zinc enriched compost treatments were significantly superior over other treatments. The increase in yield might be due to the better partitioning of carbohydrates from leaf to reproductive parts resulting in increased yield.

Table 2. Effect of Zinc and Zn-enriched compost on number of panicles, grain yield, straw yield, biological yield, test weight and harvest index of rice. Treatments : T_1 Control (Absolute), T_2 NPK (alone), T_3 NPK + Compost (FYM), T_4 NPK + Compost + Recommended $ZnSO_4$, T_5 NPK + Zn - Enriched compost @ 15kg ha^{-1} , T_6 NPK + Zn - Enriched compost @ 30kg ha^{-1}, T_7 NPK + Zn -Enriched compost @ 45kg ha^{-1}, T_8 NPK + $ZnSO_4$ @ 15kg ha^{-1}, T_9 NPK + $ZnSO_4$ @ 30 kg ha^{-1}, T_{10} NPK + $ZnSO_4$ @ 45kg ha^{-1}.

Treatments	No. of panicles per (m^2)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	Test weight (g)	Harvest index (%)
T_1	359.11	45.24	67.09	112.33	18.12	40.26
T_2	361.19	46.29	68.32	114.61	19.66	40.38
T_3	361.82	46.91	69.61	116.52	19.71	40.38
T_4	366.49	50.02	71.43	121.45	21.1	41.17
T_5	367.87	50.73	72.15	122.88	21.44	41.28
T_6	370.18	52.37	74.18	126.55	22.42	41.33
T_7	371.53	53.14	75.23	128.37	22.92	41.43
T_8	362.67	48.19	70.47	118.66	20.56	40.64
T_9	365.02	49.21	71.81	121.02	20.81	40.65
T_{10}	369.21	51.03	73.25	124.28	21.97	41.05
SEm ±	0.30	0.18	0.20	1.72	0.20	0.08
CD (p=0.05)	0.90	0.55	0.60	5.12	0.59	0.25

CONCLUSION

Application of Zn-Enriched compost along with fertilizers showed its significant superiority over T_1 (control) in respect of growth parameters, yield attributes and yield and recorded significantly higher N, P, K and Zn content by rice. Application of NPK + Zn-Enriched compost @ 45 kg ha^{-1} proved most effective in increasing growth, yield attributes and yield of rice. Among all other different treatments, sequential application of NPK+ Zn-Enriched compost @ 45 kg ha^{-1} (T_7) followed by NPK + Zn-Enriched compost @ 30 kg ha^{-1} (T_6) was found most effective in increasing almost all parameters, yield attributes and yield. Soil application of T_7 (NPK + Zn-Enriched compost @ 45 kg ha^{-1}) should be preferred over all other different treatments for achieving higher yield and better nourishment of the rice crop along with higher Zn content in grains.

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