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Effect of Zinc and Iron on the growth and yield of hybrid rice (*Oryza sativa* L.) in the methods of cultivation

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Abstract
A Field trial was conducted to investigate the effect of zinc and iron on growth and yield of hybrid rice. Experimental soil was of red sandy loam soil. Trial Comprising of 12 treatments combination using split plot design with three replications at the wetland of College of Agriculture, V.C. Farm, Mandya, University of Agricultural Sciences, Bengaluru (Karnataka), India during the season of kharif in the year 2014. It was found that among the methods of rice cultivation SRI method of cultivation was found significantly superior over other methods of rice cultivation. Soil application of $ZnSO_4$ and $FeSO_4$ gives higher plant height and grain yield, Seed treatment combined with foilar application of $ZnSO_4$ and $FeSO_4$ at panicle initiation and boot leaf stage showed higher total dry matter production and total number of grains per panicle and number productive tillers per hill was high in seed treatment of $ZnSO_4$ and $FeSO_4$.

Keywords: hybrid rice, micronutrients, growth, methods of rice cultivation

Introduction
Rice is a major food crop of the world and it has become a common dietary in the world, particularly in developing countries. It provides 23% of the calories consumed by the world's population and provides 50–80% of the energy intake of the people in the developing countries which is more than that of wheat or corn. However, rice is a poor source of many essential minerals and organic substances especially iron (Fe), zinc (Zn) and lysine (Lys) and other essential amino acids for human nutrition. Currently, malnutrition of Fe and Zn afflicts more than 50% of the world's population (Tucker, 2003) [1]. This weakens immune function and impairs growth and development and continuous heavy consumption of rice with low concentration of Fe and Zn has been considered a major contributor (Welch and Graham, 1999) [2] and Zn deficiency is currently listed as a major risk factor for human health and causes of death globally. Fertilization is the key point of nutrient-integrated management in agronomic approaches to enhance crop quality and yield, so that fertilization could be one of the sustainable and low cost strategies to improve Fe and Zn density in edible portions of staple food crops (Rengel *et al*., 1999) [3].
Flooded and irrigated rice systems consume two-three times more water than other cereals, such as maize or wheat. Future predications on water scarcity limiting agricultural production have estimated that by 2025 about 2 million ha of Asia's irrigated rice fields will suffer from water shortage in the dry season especially since flood-irrigated rice uses more than 45 % of 90 % of total fresh water used for agricultural purposes. Hence, the major challenges are to produce more rice, increase water productivity and reduce water input in the fields (Bouman *et al*., 2002) [4]. About 3000-5000 litres of water is required to produce 1kg of rice owing to increasing water scarcity, a shifting trend towards less water demanding crops against rice is noticed in most part of India and this warrants alternate methods of rice cultivation that aims at higher water and crop productivity. There are evidences that cultivation of rice through system of rice intensification (SRI) can increase rice yields by two to three fold compared to current yield levels (Abu Yamah, 2002) [5].

Material and Methods
A field experiment was conducted on red sandy loam soil to study the Effect of Zinc and Iron on the growth and yield of hybrid rice in the methods of cultivation. The experiment was laid out in the split plot design with three replication with three main plot as methods of rice cultivation viz., SRI method, Conventional method and Aerobic method and four subplot with micronutrient management practices viz., Control without Zn and Fe, Soil application of $ZnSO_4$ at 20kg/ha and $FeSO_4$ at 10kg/ha, Seed treatment with $ZnSO_4$ at 0.2% and $FeSO_4$ at

0.1% and Seed treatment combined with the Foliar spray of $ZnSO_4$ and $FeSO_4$ at 0.5% each at boot leaf stage and panicle initiation stage. Biometric observations were taken from the randomly selected five plants each plots. The data collected on different parameters during the course, of investigation were subjected to Fishers method of analysis of variance technique (ANOVA).

Results and Discussion

Effect of Zinc and Iron on the growth and yield of hybrid rice in the methods of cultivation

SRI method among the methods of rice cultivation recorded the maximum plant height (81.92cm), Total dry matter (54.98g/hill), Number of Productive tillers per hill (18.5), Total number of grains per panicle (193.92) and grain yield (6377kg/ha) of the hybrid rice compare to the other methods of rice cultivation. it was on par with conventional method of rice cultivation presented in the table 1. Increasing in the growth attritubes due to planting of young seedling, shallow depth of planting, wider spacing results are conformity with Jayadeva (2009) [6] and Pradeep Nayak (2010) [7].

Yield parameter like productive tillers hill^{-1}, total number of grain per hill and grain yield were recorded high in SRI due to wider spacing and large root volume which reduced the Intra species competation in the SRI method compared to conventional method and aerobic method of rice cultivation and that might be attritubed to significantly higher AGR, CGR and total dry matter accumulation in the plants as reported by Makarim *et al.*, 2007 [8].

Soil application of zinc sulphate and iron sulphate recorded higher plant height (77.44cm) and Grain yield (6293kg/ha) (Table 1). It was on par with the seed treatment of zinc sulphate and iron sulphate combined with the foliar application of zinc sulphate and iron sulphate at the panicle initiation and boot leaf stage. Higher total dry matter (49.80g/hill) and Total number of grains per panicle (196.11) with the seed treatment of zinc sulphate and iron sulphate combined with the foliar application of zinc sulphate and iron sulphate at the panicle initiation and boot leaf stage. Higher number of productive tillers per hill (17.24) with seed treatment of zinc sulphate and iron sulphate. Improvement in the growth and yield due to zinc and iron is essential for several enzyme systems that regulate various metabolic activities in plants. It is involved in auxin production, transformation of carbohydrates and regulation of sugar in plants (Gupta, 1995) [9].

Table 1: Effect of Zinc and Iron on the growth and yield of hybrid rice in the methods of cultivation.

Treatment	Plant height(cm)	Total dry matter (g/hill)	No. Productive tillers per hill	Total Number of grains per panicle	Grain yield (kg ha^{-1})
Main plot: Methods of cultivation					
M_1 = SRI method of cultivation	81.92	54.98	18.5	193.92	6377
M_2 = Conventional method of cultivation	74.74	43.46	15.50	193.08	6253
M_3 = Aerobic method of cultivation	71.50	36.22	14.88	157.08	5531
Sem±	1.12	2.47	0.89	5.24	95
CD(P=0.05)	4.40	9.70	3.49	21.28	374
Subplot: Micronutrient management practices					
S_1 = Control without Zn and Fe,	74	38.00	14.44	161.11	5604
S_2 = $ZnSO_4$ at 20 kg/ha + $FeSO_4$ at 10 kg/ha through Soil application	77.44	48.04	16.56	183	6293
S_3 = $ZnSO_4$ at 0.2 % and $FeSO_4$ at 0.1 % as Seed treatment	77.11	43.10	17.24	185.22	6159
S_4 = $ZnSO_4$ at 0.2 % and $FeSO_4$ at 0.1 % as Seed treatment + Foliar spray of $ZnSO_4$ at 0.5 % and $FeSO_4$ at 0.5 % at panicle initiation and boot leaf stage.	75.22	49.80	16.93	196.11	6158
Sem±	1.02	2.60	0.60	9.12	133
CD(P=0.05)	3.05	7.72	1.78	27.08	396

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