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Effect of Zinc and Iron Fertilization on Growth and Yield of Direct Sown Rice

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ABSTRACT

A field experiment entitled "Response of direct sown rice to zinc and iron nutrition" was conducted at Agriculture College Farm, Bapatla, during *kharif*, 2017. The experiment was laid out in randomized block design (RBD) with seven treatments and replicated thrice. The treatments consisted of T_1- RDF (180 :60 :40 N-P_2O_5-K_2O (kg ha^{-1}); T_2- RDF + $ZnSO_4$ @ 50kg ha^{-1} through soil application; T_3- RDF + $FeSO_4$ @ 25kg ha^{-1} through soil application; T_4 - RDF + $ZnSO_4$ @ 50 kg ha^{-1} + $FeSO_4$ @ 25 kg ha^{-1} through soil application; T_5- RDF + foliar spray of $ZnSO_4$ @ 0.2% at 20 and 45 DAS; T_6- RDF + foliar spray of $FeSO_4$ @ 0.5% at 20 and 45 DAS; T_7- RDF + foliar spray of $ZnSO_4$ @ 0.2% and $FeSO_4$ @ 0.5% at 20 and 45 DAS. Recommended dose of nitrogen, phosphorus and potassium were applied to all the plots in the form of urea, single super phosphate and muriate of potash, respectively. The results revealed that, plant height, number of tillers m^{-2}, dry matter production, number of grains per panicle, grain and straw yield of direct seeded rice were significantly higher with RDF + $ZnSO_4$ @ 50 kg ha^{-1}+ $FeSO_4$ @ 25 kg ha^{-1} through soil application (T_4) which was comparable with T_7 treatment (RDF + foliar spray of $ZnSO_4$ @ 0.2% and $FeSO_4$ @ 0.5% at 20 and 45 DAS) RDF applied without Zn and Fe, recorded the lowest growth parameters.

Key words: *Zinc, Iron, Growth and Yield*

Rice (*Oryza sativa* L.) is a staple food for more than one third of the world population (Zhao *et al.,* 2011). In India, it is grown in an area of 44.1 million hectares with a production of 108.9 million tonnes and productivity of 2391 kg ha^{-1}. In Andhra Pradesh, it is grown in an area of 2.39 million hectare with a production of 7.24 million tonnes and productivity of 3022 kg ha^{-1} (Ministry of Agriculture, Govt. of India, 2016-17). In India, rice occupies one-quarter of the total cropped area contributing about 40 to 43 per cent of total food grain production and continues to play a vital role in the national food security system (Viraktamath *et al.,* 2011).

Direct seeding of rice (DSR) refers to the process of establishing the crop from seeds sown in the field rather than by transplanting seedlings from the nursery (Farooq *et al*., 2011). Micronutrients, particularly zinc and iron have attained a great significance in today's intensive and exploitive agriculture which is aiming at higher crop productivity. The application of zinc and iron not only increases their concentration in grain, but also increases grain and straw yield of crop.

MATERIAL AND METHODS

The experiment was conducted at the Agricultural College Farm, Bapatla situated in Krishna zone of Andhra Pradesh. The experimental soil was sandy clay in texture, neutral in reaction (pH 7.48), non- saline (0.53 dS m^{-1}), low in organic carbon (4.0 g kg^{-1}), low in available nitrogen (224 kg ha^{-1}), medium in available phosphorus (38.8 kg ha^{-1}), and potassium (285 kg ha^{-1}) and sufficient in all micronutrients. The treatment setails are as follows T_1- RDF (180 :60 :40 N-P_2O_5-K_2O (kg ha^{-1}); T_2- RDF + $ZnSO_4$ @ 50kg ha^{-1} through soil application; T_3- RDF + $FeSO_4$ @ 25kg ha^{-1} through soil application; T_4 - RDF + $ZnSO_4$ @ 50 kg ha^{-1} + $FeSO_4$ @ 25 kg ha^{-1} through soil application; T_5- RDF + foliar spray of $ZnSO_4$ @ 0.2% at 20 and 45 DAS; T_6- RDF + foliar spray of $FeSO_4$ @ 0.5% at 20 and 45 DAS; T_7- RDF + foliar spray of $ZnSO_4$ @ 0.2% and $FeSO_4$ @ 0.5% at 20 and 45 DAS procedures.

RESULTS AND DISCUSSION

Plant height

The maximum plant height of 95.54, 112.27 and 115.54cm was recorded in the treatment T_4 (RDF + $ZnSO_4$ @50 kg ha^{-1} + $FeSO_4$ @ 25 kg ha^{-1} through soil application) followed by T_7 (RDF+ foliar spray of $ZnSO_4$@0.2% and $FeSO_4$ @0.5% at 20 and 45 DAS) with 86.66,104.90 and 106.61cm. The minimum plant height (77.08, 91.26 and 93.51 cm) was recorded in treatment T_1 (RDF) where no zinc and iron was applied

at all the stages of the crop growth period. (tillering , panicle initiatin and at harvest). This might be due to availability of nutrients in adequate amount with balanced proportion, resulted in improved crop establishment with better root development (Sudhakar *et al*., 2006).

Number of tillers per square meter

At tillering, panicle initiation and at harvest, the maximum (333,371 and 377, respectively) number of tillers per square meter was recorded in the treatment T_4 (RDF + $ZnSO_4$ @50 kg ha^{-1} + $FeSO_4$ @ 25 kg ha^{-1} through soil application) which was on par with T_7 (RDF+ foliar spray of $ZnSO_4$@0.2% and $FeSO_4$ @0.5% at 20 and 45 DAS (307, 339 and 343, respectively) The minimum number of tillers per square meter at the above three different stages (251,275 and 299, respectively) was recorded in treatment T_1 (RDF) where no zinc and iron was applied. This might be due to improved metabolic activity with micronutrients that enhanced the floral primordia development in many tillers, Jena *et al*., 2006. who reported that micronutrients application recorded higher production and conversion of vegetative tillers into reproductive tillers. Soil application of zinc and iron due to the availability of optimum quantity of micronutrients which facilitated more number of tillers at all the growth stages of the crop (Mustafa *et al.,* 2013).

Dry matter production (kg ha^{-1})

Dry matter production ranged from 2174 to 2775 and 5120 to 6136 kg ha^{-1} at tillering and panicle initiation stages respectively. Significantly the highest dry matter production of 2775 and 6136 kg ha^{-1} was recorded with the application of RDF + $ZnSO_4$ @50 kg ha^{-1} + $FeSO_4$ @ 25 kg ha^{-1} through soil application (T_4) which was on par with T_7 (RDF+ foliar spray of $ZnSO_4$@0.2% and $FeSO_4$ @0.5% at 20 and 45 DAS) followed by T_2 (RDF+ $ZnSO_4$ @50kg ha^{-1} through soil application) at tillering and panicle initiation stage, respectively. The lowest dry matter production (2174 and 5120 kg ha^{-1} at tillering and panicle initiation stage, respectively) was recorded in treatment T_1 (RDF) where, no zinc and iron were applied. This indicated that the combined application helped towards balanced availability of nutrients throughout the crop growth period. This enhanced availability of nutrients especially zinc and iron, under aerobic conditions, lead to better accumulation of photosynthates in the form of dry matter. This confirmed the findings of Asewar *et al*. (2000) and Pal *et al*. (2008). The superiority might be due to availability of sufficient amount of NPK nutrients along with zinc and iron in both basal and foliar application, which enhanced the photosynthetic activity of the crop and ultimately the dry matter production. The soil available nutrient status might have helped in enhancing leaf, there by resulted in higher photo-assimilation and more dry matter production. These results were accordance with those of Sunil and Shankaralingappa (2014).

Number of grains per panicle

The highest number of grains $panicle^{-1}$ (172) were recorded with T_4 (RDF + $ZnSO_4$ @50 kg ha^{-1} + $FeSO_4$ @ 25 kg ha^{-1} through soil application). The treatment T_4 was found to be significantly superior to RDF treatment (T_1). while the rest of the treatments were statistically on par with each other. The increase in number of grains $panicle^{-1}$ may be ascribed to better nutrition due to application of combined soil or foliar application of zinc and iron fertilizers along with recommended dose of fertilizers. Improvement in soil fertility and productivity due to combined soil and foliar application of zinc and iron might have produced more number of filled grains per panicle. Similar observations were recorded by Yadav *et al.* (2011).

Thousand grain weight (g)

The highest thousand grain weight (19.29g) was recorded with T_4 (RDF + $ZnSO_4$ @50 kg ha^{-1} + $FeSO_4$ @ 25 kg ha^{-1} through soil application). Lowest thousand grain weight (17.83g) was recorded with T_1 (RDF) where, no zinc and iron were applied.The thousand grain weight of direct sown rice was not significantly influenced by zinc and iron fertilization. A slight increase in 1000 grain weight could be due to efficient participation of zinc in number of metabolic processes involved in the production of healthy seed. Similar results were also reported by Abid *et al*. (2011).

Grain and Straw yield (kg ha^{-1})

The grain yield of direct sown rice was significantly influenced by zinc and iron fertilization The highest grain yield (5312 kg ha^{-1}) was recorded with T_4 (RDF + $ZnSO_4$ @50 kg ha^{-1} + $FeSO_4$ @ 25 kg ha^{-1} through soil application) which was on par with T_7 (4890 kg ha^{-1}) (RDF+ foliar spray of $ZnSO_4$ @0.2% and $FeSO_4$ @0.5% at 20 and 45 DAS). The lowest grain yield (3736 kg ha^{-1}) was recorded with T_1 (RDF) where, no zinc and iron were applied. The more grain yield with Zn and Fe application could be attributed to increased total dry matter production (Zayed *et al*., 2011) due to better uptake of Zn and Fe and their translocation to reproductive parts. Soil application of $ZnSO_4$ and $FeSO_4$ recorded significantly higher grain yield attributed to better performance of growth and yield parameters through adequate availability of major

Table 1. Effect of zinc and iron fertilization on plant height, No. of tillers m^{-2} and dry matter production of direct sown rice

Treatments	Plant height(cm)			No.of tillers m^{-2}			Dry matter production (kg ha^{-1})	
	Tillering	Panicle initiation	Harvest	Tillering	Panicle initiation	Harvest	Tillering	Panicle initiation
T_1: RDF	77.08	91.26	93.51	251	275	299	2174	5120
T_2: RDF + $ZnSO_4$ @ 50kg ha^{-1} through soil application	85.09	99.97	104.35	306	337	340	2570	5735
T_3: RDF + $FeSO_4$ @ 25kg ha^{-1} through soil application	81.95	98.6	102.20	287	323	330	2394	5504
T_4: RDF + $ZnSO_4$ @ 50 kg ha^{-1} + $FeSO_4$ @ 25 kg ha^{-1} through soil application	95.54	112.27	115.54	333	371	377	2775	6136
T5: RDF + Foliar spray of ZnSO4 @ 0.2% at 20 and 45 DAS	84.3	98.84	101.04	299	325	332	2455	5603
T6: RDF + Foliar spray of FeSO4 @ 0.5% at 20and 45 DAS	80.29	98.49	100.45	286	321	322	2364	5439
T7: RDF + Foliar spray of ZnSO4 @ 0.2% and FeSO4 @ 0.5% at 20 and 45 DAS	86.66	104.9	106.61	307	339	343	2695	5964
S.Em(±)	3.04	3.6	3.54	10.47	11.28	11.82	89.25	191.89
CD (P=0.05 %)	9.39	11.11	10.92	32.00	35.00	36.00	275.00	591.00
C.V (%)	6.25	6.2	5.94	6.14	5.97	6.12	6.21	5.89

Table 2. Effect of zinc and iron fertilization on yield attributes and yield of direct sown rice

Treatment	No. of grains/ panicle	1000 grain weight(g)	Yield (kg ha^{-1})		Harvest index (%)
			Grain	Straw	
T_1: RDF	141	17.83	3736	5830	38.98
T_2: RDF + $ZnSO_4$ @ 50kg ha^{-1} through soil application	158	19.01	4896	7120	39.73
T3: RDF + FeSO4 @ 25kg ha-1 through soil application	155	18.26	4762	6812	39.59
T_4: RDF + $ZnSO_4$ @ 50 kg ha^{-1} + $FeSO_4$ @ 25 kg ha^{-1} through soil application	172	19.29	5312	7748	40.45
T5: RDF + Foliar spray of ZnSO4 @ 0.2% at 20 and 45 DAS	157	18.87	4787	6937	39.73
T6: RDF + Foliar spray of FeSO4 @ 0.5% at 20 and 45 DAS	154	18.11	4727	6795	39.41
T_7: RDF + Foliar spray of $ZnSO_4$ @ 0.2% and $FeSO_4$ @ 0.5% at 20 and 45 DAS	159	19.16	4985	7151	40.14
S.Em (±)	4.63	0.78	137.9	210.3	1.25
CD (0.05%)	14	NS	425	648	NS
C.V (%)	5.12	7.41	5.14	5.26	5.46

and micro nutrients in soil, which in turn, favourably influenced physiological processes and build up of photosynthates (Tabassum *et al.,* 2013). . The straw yield of direct sown rice was significantly influenced by zinc and iron fertilization The highest straw yield (7748 kg ha^{-1}) were recorded with T_4 (RDF + $ZnSO_4$ @50 kg ha^{-1} + $FeSO_4$ @ 25 kg ha^{-1} through soil application) which was statistically on par with T_7 (RDF+ foliar spray of $ZnSO_4$@0.2% and $FeSO_4$ @0.5% at 20 and 45 DAS) (7151 kg ha^{-1}) and T_2 (RDF+$ZnSO_4$@50kg ha^{-1} through soil application) (7120 kg ha^{-1}). The lowest straw yield (5830 kg ha^{-1}) was recorded with T_1 (RDF) where no zinc and iron was applied. Soil application of $ZnSO_4$ and $FeSO_4$ recorded significantly higher straw yield due to attributed to better performance of growth and yield parameters through adequate availability of major and micro nutrients in soil, which in turn, favourably influenced physiological processes and build up of photosynthates. The results were in conformity with those of Tabassum *et al.,* 2013. Soil application of zinc and iron along with recommended dose of fertilizers produced higher straw yield and compared to foliar spray of zinc and iron over control. This results were in conformity with those of Jadhav *et al*. (2014).

Harvest index (%)

The highest harvest index (40.45%) was recorded with T_4 (RDF + $ZnSO_4$@50 kg ha^{-1} + $FeSO_4$ @ 25 kg ha^{-1} through soil application). Lowest harvest index (38.98%) was recorded with T_1 (RDF) where no zinc and iron was applied. The harvest index of direct sown rice was not significantly influenced by zinc and iron fertilization. The highest harvest index was associated with combined soil application of zinc and iron indicated the optimum vegetative growth and better source sink relationship (Chaudhary and Sinha, 2007).

CONCLUSION

These results showed that soil application of ZnSO 4 and FeSO 4 along with recommended fertilizers increase in the plant growth and yield of rice crop followed by foliar application $ZnSO_4$ and $FeSO_4$ along with recommended fertilizers compared to control. Soil application of $ZnSO_4$ and $FeSO_4$ recorded significantly higher growth and yield due to attributed to better performance through adequate availability of major and micro nutrients in soil.

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