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EFFECT OF ZINC AND IRON FERTILIZATION ON GROWTH AND DEVELOPMENT OF RICE

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Abstract

A field experiment was conducted during Kuruvai and Navarai seasons of 2018 at agronomic research area, faculty of agriculture, Annamalai University to assess the Effect of zinc and iron fertilization on growth and development of rice (*Oryza sativa L.*)The experiment was laid out in Randomized block design replicated thrice with thirteen treatments which combination with zinc and iron forms of fertilizers. The results were showed that combined soil application of $ZnSO_4$, $FeSO_4$ and foliar application of Zn-EDTA, Fe-EDTA (T_{13}) expressed the highest growth and yield attributing characters.
Keywords: Rice, $ZnSO_4$, $FeSO_4$, Zn-EDTA, Fe-EDTA.

Introduction

In general soils used for cereal production in the world containing low level of plant available micro nutrients, reduces not only the grain yield but also the nutritional quality .Micronutrients play a vital role in growth and development of plant and occupy an important portion by virtue of their essentiality in increasing crop yields. Rice is one of the most important food grains crops of the world and it is the second most widely consumed in the world after the wheat .Trend to more intensive crop production with higher yields, heavier usage of fertilizers increases the need for the greater consideration and usage of micronutrients. After the green revolution in the developing countries like India, agriculture produces lower in micro nutrient content failed to meet up the Zn and Fe requirement for the human nutrition. Keeping in view the important role of iron in crop production, chelated application Fe and Zn may help to overcome the above problems and help the increase in crop growth and yield Kandoliya and Kunjadia (2018); Kandoliya *et al.* (2018). Iron plays an important role in respiration, photosynthesis and the production of healthy green leaves. Zinc is an essential micro nutrient for the normal growth and metabolism of the plant plays an important role in membrane integrity, synthesis of carbohydrates, enzymes activation such as dehydrogenise, carbonic anhydride, super oxide dismutase, alkaline phosphatise etc. Singh *et al.* (2005). Zinc deficiency is a well-known nutritional and health problems in human populations where rice is the dominating stable food crop, Stein (2010). Zinc and iron deficiency weaken immune system function and may impair the growth and development afflict more than 50% of the world population. Recent trend to more intensive crop production with higher yields, heavier usage of fertilizers increase the need for the greater consideration and usage of micronutrients. As farmers strive for top yields and quality, they must give more attention to micronutrient needs like Fe and Zn. The highest increase in grain yield was obtained with soil, soil +foliar, and seed + foliar applications Cakmak, (2008). Keeping in view the importance of zinc and iron nutrition and its use efficiency in rice, a field experiment was conducted to study the effect of zinc and iron fertilization on rice productivity.

Materials and Methods

The study was conducted in Kuruvai and Navarai seasons for the Effect of zinc and iron fertilization on growth and development of rice at agronomic research area, Faculty of Agriculture, Annamalai University situated at 11°24 N latitude and 79°41 E longitude at an altitude of +5.79 meters above mean sea level. The soil of the experimental field were clay and clay loamy in texture with available nitrogen (234 kg ha^{-1}), phosphorus (20.50 kg ha^{-1}) and potassium(305.7 kg ha^{-1}). The experiment comprised of thirteen treatments combination with $ZnSO_4$, $FeSO_4$ and Zn-EDTA, Fe-EDTA which are laid out at Randomized block design with three replication. The $ZnSO_4$ and $FeSO_4$ applied as basal and the Zn-EDTA, Fe-EDTA were foliar sprayed at active tiller, panicle initiation and milking stages. The test variety was co-47 and its spacing was 15 × 10 cm. The following biometric observation of plant height, LAI, No. of tiller/hill, No of productive tillers/hill, No of grains per panicle, Grain yield and straw yield were recorded.

Results and Discussion

Plant Height

Soil and foliar application of nutrients influenced plant height of rice significantly over control. The significant increase of plant height might be due to the internodes elongation and vigorous root growth. Soil application of zinc sulphate, iron sulphate as basal and foliar application of Zinc EDTA, Iron EDTA (T_{13}) at active tiller, panicle initiation and milking stage with RDF increased the plant height was due to increase in protein synthesis and cell growth. The maximum height of the plant was 55.06 cm and 56.56 cm at 60 DAT and at harvest respectively. Iron has a structural in chlorophyll, energy transfer within the plant and enters in to the root cells also zinc increased the plant height via increasing internode distance. It was closely followed by the soil application of $ZnSO_4$ @ 25 kg/ha and $FeSO_4$ @30 kg/ha (T_5) as basal.

Similar results was obtained by Ananda and Patil (2010), Kadam *et al.* (2018), Kandoliya *et al.* (2018) also found increase in the plant height in the rice from their experiment might be due to combined application of zinc sulphate and ferrous sulphate with recommended dose of fertilizer. These results are also line with the findings of Khanda *et al.* (1997), Sreenivasa Rao (2003), Vignesh and Sudhagar Rao (2019).

Leaf area Index

The data revealed that highest leaf area index of 13.74 and 10.92 at 60 DAT and at harvest respectively were recorded in Soil application of zinc sulphate, iron sulphate as basal and foliar application of zinc EDTA, Iron EDTA (T_{13}) at active tiller, panicle initiation and milking stage with RDF (T_{13}). This was closely followed by the soil application of $ZnSO_4$ @ 25 kg/ha and $FeSO_4$ @30 kg/ha (T_5) as basal recorded the leaf area.

Similar to the present experiment, Jat *et al.* (2018) also observed that the application of zinc@ 3 kg ha^{-1} significantly increase in the biosynthesis of IAA, an important growth hormone responsible for plant growth, resulted in increased plant growth. It was also observed in the higher amount of chlorophyll content in a treatment of zinc and iron, Sole *et al.* (2018); Kandoliya *et al.* (2018). This indicates the increase in photosynthetic process, which might be reason for increase in growth.

No. of tillers

Soil application of zinc sulphate, iron sulphate as basal and foliar application of zinc EDTA, Iron EDTA (T_{13})at active tiller, panicle initiation and milking stage with RDF recorded the highest number of 18 tillers per hill. Followed that the soil application of $ZnSO_4$ @ 25 kg/ha and $FeSO_4$ @30 kg/ha (T_5) as basal recorded the 17.06 tillers per hill. Iron and zinc application either as soil or foliar application increases the No of tillers. This may be due to the effect of increased photosynthetic process, chlorophyll synthesis, protein synthesis and nitrogen fixation in response to the application of Zn and Fe. Kadam *et al.* (2018) also reported that increased the No. of tillers in response to soil application of zinc and iron.

Productive tillers

The highest number of Productive tillers of 11.33 per hill were observed in the Soil application of zinc sulphate, iron sulphate as basal and foliar application of zinc EDTA, Iron EDTA (T_{13}) at active tiller, panicle initiation and milking stage with RDF. This was followed by the soil application of $ZnSO_4$ @ 25 kg/ha and $FeSO_4$ @ 30 kg/ha (T_5) as basal recorded the 11.06 productive tillers per hill.

The increased in productive tillers might be due to increased photo synthetic rate, excessive accumulation of sucrose, glucose and fructose in leaves which might have increased physiological parameters of the plant. Uma Shankar Ram *et al.* (2013) also reported that combined application of zinc as soil application through Zn-EDTA @ 1.00 kg ha^{-1} followed by iron as foliar spray through Fe-EDTA @ 0.5 kg ha^{-1} applied in two splits at 15 DAT and at 50 % panicle initiation produces significantly higher plant height, number of leaves per hill, leaf area index and number of productive tillers. Similar results were also reported by Ravikiran and Reddy (2004).

Grain yield

Grain is the important economic part of the grain. Soil application of zinc sulphate, iron sulphate as basal and foliar application of zinc EDTA, Iron EDTA (T_{13}) at active tiller, panicle initiation and milking stage with RDF recorded the highest grain yield of 5.82 tonnes/ha. This was followed by the soil application of $ZnSO_4$ @ 25 kg/ha and $FeSO_4$ @ 30 kg/ha (T_5) as basal recorded the grain yield of 5.61tonnes/ha .Iron as a constituent of the electron transport enzymes like cytochrome and ferridoxin are actively involved in photosynthesis and mitochondrial respiration. It is also a constituent of the enzyme catalase and peroxidase, which catalyse the breakdown of H_2O_2 (peroxide released during respiration) in H_2O and O_2. And O_2, preventing H_2O_2 toxicity. All these physiological process proved instrumental in increasing yield by the application of iron.

The favourable influence of applied zinc on yield may be due to its catalytic or stimulatory effect on most of the physiological and metabolic process of plants Madal *et al.* (2009). Zinc and iron plays a major role in biosynthesis of IAA and especially due to its role in initiation of primordial reproductive part and portioning of photosynthetic towards them which promotes the yield (Barua and Saika, 2018). Increase of grain yield with foliar application of Zn was reported by Potarzycki and Grzebisz (2009), Phattarakul *et al.* (2012), Rehman *et al.* (2012) and Beutler *et al.* (2014).

Straw yield

Favourable effect of Zn and Fe on the proliferation of roots and thereby increasing the uptake of the plants nutrients from the soil supplying in to the aerial parts of the plant and ultimately enhancing the vegetative growth of the plant (Barua and Sakia 2018). Soil application of zinc sulphate, iron sulphate as basal and foliar application of zinc EDTA, Iron EDTA (T_{13}) at active tiller, panicle initiation and milking stage with RDF recorded the highest straw yield of 7.85 tonnes/ha. This was followed by the soil application of $ZnSO_4$ @ 25 kg/ha and $FeSO_4$ @ 30 kg/ha (T_5) as basal recorded the straw yield of 7.50 tonnes/ha. Zn and Fe provided in combination with RDF as soil application distribution of Fe and Zn within the rice plant occurs through xylem and re-translocation in phloem which increases vegetative tissue formation resulted in improved photosynthetic activity which slows boosted growth of the plant parts and increment in dry matter (Nadim *et al.,* 2012).

No of grains/panicle

Soil application of zinc sulphate, iron sulphate as basal and foliar application of zinc EDTA, Iron EDTA (T_{13}) at active tiller, panicle initiation and milking stage with RDF recorded the highest number of grains per panicle of 130. This was followed by the soil application of $ZnSO_4$ @ 25 kg/ha and $FeSO_4$ @ 30 kg/ha (T_5) as basal recorded the grains per panicle of 128. Adequate level of zinc in soil increase tiller and consequently increased number of panicle/m^2 and again as zinc in responsible for pollen formation, seed production and number of grains/panicle. Foliar application of zinc has been reported to increase the viability of pollen grains. The results are agreement with the findings of Meena and Shivay (2010), Karim *et al.* (2012), Khan *et al.* (2008), Asad and Rafique (2002), Jat *et al.*, (2011).

Table 1 : Growth attributes of different growth stages of rice influenced by soil and foliar application of Zinc and Iron

Treatments	Plant height(cm) at harvest	No.of tillers per hill	Productive tillers per hill	Leaf area index per plant
T_1:Control	48.83	13.40	7.33	4.63
T_2-RDF	49.20	13.93	8.60	4.9
T_3-Soil Application of $ZnSO_4$ @25 kg ha^{-1}	51.30	14.80	10.00	5.37
T_4-Soil Application of $FeSO_4$ @25 kg ha^{-1}	50.93	14.33	10.00	5.33
T_5-Soil Application of $ZnSO_4$ @25 kg ha^{-1} + Soil Application of Fe SO_4 @35 kg ha^{-1}	56.26	17.06	11.06	6.20
T_6-Foliar Application of Zn EDTA@1%	49.80	14.00	9.53	5.15
T_7-Foliar Application of Fe EDTA@ 0.5%	48.30	14.00	9.00	4.99
T_8-Foliar Application of Zn EDTA@1% + Foliar Application of Fe EDTA@ 0.5%	49.80	14.26	9.86	5.19
T_9-Soil Application of $ZnSO_4$ @25 kg ha^1+Foliar Application of Zn EDTA@1%	55.60	16.80	11.00	6.00
T_{10}-Soil Application of $ZnSO_4$ @25 kg ha^{-1} + Foliar Application of Fe EDTA@ 0.5%	53.00	15.93	10.46	5.96
T_{11}- Soil Application of $FeSO_4$ @25 kg ha^{-1}+ Foliar Application of Zn EDTA@1%	56.33	16.66	10.66	6.04
T_{12}- Soil Application of $FeSO_4$ @25 kg ha^{-1}+ Foliar Application of Fe EDTA@ 0.5%	52.46	14.90	10.13	5.73
T_{13}-Soil Application of $ZnSO_4$ @25 kg ha^{-1} + Soil Application of Fe SO_4 @35 kg ha^{-1}+Foliar Application of Zn EDTA@1% + Foliar Application of Fe EDTA@ 0.5%	56.56	18.00	11.33	6.92
CD (P=0.05)	2.03	1.01	0.30	0.04

Table 2 : Yield attributes of rice influenced by soil and foliar application of Zinc and Iron

Treatments	No. of grains/ panicle	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1:Control	65	3.10	4.95
T_2-RDF	89	4.32	6.44
T_3-Soil Application of $ZnSO_4$ @25 kg ha^{-1}	118	5.14	6.66
T_4-Soil Application of $FeSO_4$ @25 kg ha^{-1}	111	5.07	6.45
T_5-Soil Application of $ZnSO_4$ @25 kg ha^{-1} + Soil Application of Fe SO_4 @35 kg ha^{-1}	128	5.61	7.50
T_6-Foliar Application of Zn EDTA@1%	102	4.90	6.80
T_7-Foliar Application of Fe EDTA@ 0.5%	98	4.88	6.58
T_8-Foliar Application of Zn EDTA@1% + Foliar Application of Fe EDTA@ 0.5%	105	5.03	6.15
T_9-Soil Application of $ZnSO_4$ @25 kg ha^1+ Foliar Application of Zn EDTA@1%	127	5.52	7.43
T_{10}-Soil Application of $ZnSO_4$ @25 kg ha^{-1} + Foliar Application of Fe EDTA@ 0.5%	120	5.29	7.10
T_{11}- Soil Application of $FeSO_4$ @25 kg ha^{-1}+ Foliar Application of Zn EDTA@1%	123	5.34	7.31
T_{12}- Soil Application of $FeSO_4$ @25 kg ha^{-1}+ Foliar Application of Fe EDTA@ 0.5%	120	5.21	6.85
T_{13}-Soil Application of $ZnSO_4$ @25 kg ha^{-1} + Soil Application of Fe SO_4 @35 kg ha^{-1}+ Foliar Application of Zn EDTA@1% + Foliar Application of Fe EDTA@ 0.5%	130	5.82	7.85
CD (P=0.05)	3.0	0.08	0.06

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