EFFECT OF FOLIAR APPLICATION OF IRON AND ZINC ON YIELD AND MICRONUTRIENT UPTAKE OF PADDY

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Received: 17/08/2017 | **Edited: 23/08/2017** | **Accepted: 30/08/2017**

Abstract: *A pot culture experiment was conducted during kharif season of 2016-2017 in wire house of division of Soil Science and Agricultural Chemistry, College of Agriculture, Kolhapur. The objectives of experiment was to study the effect of iron and zinc on yield and micronutrient uptake by paddy at harvest. Treatments comprised of two levels with two sources of each iron and zinc. The sources of iron as $FeSO_4$, Fe-EDTA and for zinc as $ZnSO_4$, Zn-EDTA which are replicated thrice along with fourteen treatments. The treatment T8 (Fe-EDTA and Zn-EDTA each @ 0.5 % foliar application with GRDF) recorded significantly superior grain and straw yield (35.54 and 39.01 g pot^{1} respectively) of paddy over all the treatments. The micronutrients Fe, Mn, Zn, Cu uptake (0.496, 0.013, 0.010 and 0.011 mg pot^{1}) was significantly increased due to foliar application of different sources and concentrations of Fe and Zn with GRDF.*

Key words: *rice, yield, micronutrient uptake.*

Introduction

Rice is the principal staple food crop of the world. There are various factors which influence the production of rice like incidence of pest and diseases, water managements, low soil fertility and fertilizer use efficiency, poor agronomic practices. In that nutrient availability as macro and micro nutrients is also a major factor which influences the production of rice. Certain soil conditions induce micronutrient deficiency to a growing crop as soils with very high pH, light textured soils with low pH, soils developed under very high rainfall. In acid sulphate soils, micronutrient toxicity limits the crop growth under upland soil conditions. Iron toxicity in rice is observed in soils rich in Fe, under highly reducing submerged soil conditions due to the presence of easily decomposable organic matter.

Micronutrients play an important role in rice cultivation. Micronutrient does not mean that they are less important to plants than other nutrients. Plant growth and development may be retarded if any of these elements is lacking in the soil or is not adequately balanced with other nutrients. Micronutrient deficiencies are widespread, 50% of world cereal soils are deficient in zinc and 30% of cultivated soils globally are deficient in iron. Steady growth of crop yields during recent decades (in particular through the green revolution) compounded the problem by progressively depleting soil micronutrient pools. In general, farmers only apply micronutrients when crops show deficiency symptoms, while micronutrient deficiencies decrease yields before symptoms appear. Various agronomic approaches can be used to correct micronutrient disorders. Once a deficiency is reliably identified, it can generally be corrected by chemical amendments that suit the plant demand and farmer options. The amount, form, mode and timing are critical, especially if multiple nutrient stresses and antagonisms among nutrients are present. In view of this the present investigation is aimed to evaluate the effect of foliar application of iron and zinc on growth, yield and nutrient uptake of paddy in iron and zinc deficit soil.

Materials and Methods

A pot culture experiment was conducted during *kharif* season of 2016-2017 in wire house of division of Soil Science and Agricultural Chemistry, College of Agriculture, Kolhapur. The experimental soil was iron and zinc deficient, having pH (7.6), moderately high in organic carbon (0.64%), calcareous (5.22 % $CaCO_3$), low in available N (235.90 kg ha^{-1}), medium in available P (18.48 kg ha^{-1}) and low in available K (138.74 kg ha^{-1}) while Fe (3.92 ppm), Mn (2.61 ppm), Zn (0.55 ppm) and Cu (0.21 ppm) were deficient. Treatments comprised of two levels with two sources of each iron and zinc. The sources of iron as $FeSO_4$, Fe-EDTA and for zinc as $ZnSO_4$, Zn-EDTA which are replicated thrice along with fourteen treatments.

The experimental treatment details as T1: Control (No foliar application of any source), T2: GRDF (Application of general recommended dose of fertilizers), T3: (GRDF + Fe-EDTA @ 0.1%), T4: (GRDF + Fe-EDTA @ 0.5%), T5: (GRDF + Zn-EDTA @ 0.1%), T6: (GRDF + Zn-EDTA @ 0.5%), T7: (GRDF + Fe-EDTA + Zn-EDTA each @ 0.1%), T8: (GRDF + Fe-EDTA + Zn-EDTA each @ 0.5%), T9: (GRDF + $FeSO_4$ @ 0.1%), T10: (GRDF + $ZnSO_4$ @ 0.1%), T11: (GRDF + $FeSO_4$ @ 0.5%), T12: (GRDF + $ZnSO_4$ @ 0.5%), T13: (GRDF + $FeSO_4$ + $ZnSO_4$ each @ 0.1%) and T14: (GRDF + $FeSO_4$ + $ZnSO_4$ each @ 0.5%).

The present investigation was carried out in Completely Randomized Block Design in which each pot was filled with 10 kg iron and zinc deficient soil including FYM @ 5 t ha^{-1}. The rice variety Bhogawati was sown as five seeds per pot at convenient distance. Fertilizers were applied as recommended (100:50:50 N:P_2O_5:K_2O kg ha-1, respectively) dose for rice. At the time of sowing, complete dose of P_2O_5 and K_2O were applied and N was applied in three splits as 40% at sowing, 40% at tillering and 20% at panicle initiation. The foliar

The increase in grain yield with Fe-EDTA and Zn-EDTA foliar spray each @ 0.5% with GRDF significantly influenced the grain yield, it might be due to combined effect of many yield components including higher number of tillers.

The increase in grain and straw yield with iron and zinc application is attributed to increase in number of tillers pot and improved nutrition of paddy due to foliar application of iron and zinc.

spray of Fe-EDTA, Zn-EDTA, $FeSO_4$ and $ZnSO_4$ applied as per the treatments at tillering ad panicle initiation stage. The nutrients were applied in the form of urea, single super phosphate, muriate of potash, ferrous EDTA (ethylene di-amine tetra acetic acid), zinc EDTA, ferrous sulphate and zinc sulphate. Observations of growth parameters as plant height (cm), no. of tillers pot-1 were recorded at maturity stage, yield observations as grain and stover yield g pot-1 were recorded at harvesting and total nutrients uptake (N, P and K) were recorded after harvest of paddy. Estimation of N was done by methods given by Subbiah and Asija (1973), P and K (Jackson, 1973). Yield of different treatments were recorded and computed.

Results and Discussion

Effect of different treatments on grain and stover yield of paddy

The data in respect of yield revealed that the yield differences in different treatments were found statistically significant. The treatment T8 (Fe-EDTA + Zn-EDTA each @ 0.5% foliar spray with GRDF) recorded highest grain yield (35.54 g pot^{-1}) which was significantly superior to rest of the treatments. However in grain yield treatment T4, T14 are found to be at par with each other. The treatment T1 (control) recorded lowest grain yield (14.52 g pot^{-1}).

Similarly the treatment T8 (Fe-EDTA + Zn-EDTA each @ 0.5% foliar spray with GRDF) recorded highest straw yield (39.01 g pot^{-1}) which was significantly superior to rest of the treatments. However in straw yield treatment T3, T4, T7, T13, T14 are found to be at par with each other. The treatment T1 (control) recorded lowest straw yield (16.79 g pot^{-1}).

Partitioning of photosynthesis towards them is responsible for increased yield. The FYM sources also improve the content of Fe and Zn by supplying chelating agents, which helps in maintaining the solubility of micronutrients including Fe and Zn.

Similar results reported as increase in grain and straw yields of paddy by foliar application of Fe and Zn as Fe-EDTA and Zn-EDTA by Ram *et al.*

(2013) and Shivay*et al.* (2015), Singh and Sharma (1994).

Table 1: Effect of different treatments on yield of paddy

Treatment detail	Grain yield (g pot^{-1})	Stover yield (g pot^{-1})
T1: Control	14.52	16.79
T2: GRDF	28.28	31.10
T3: GRDF + Fe-EDTA @ 0.1%	30.42	36.50
T4:GRDF + Fe-EDTA@ 0.5%	33.66	37.02
T5:GRDF + Zn-EDTA @ 0.1%	28.99	31.88
T6:GRDF + Zn-EDTA @ 0.5%	27.96	30.75
T7:GRDF + Fe-EDTA +Zn-EDTA each @ 0.1%	32.14	35.99
T8:GRDF + Fe-EDTA + Zn-EDTA each @ 0.5%	35.54	39.01
T9: GRDF + $FeSO_4$@ 0.1%	31.19	34.30
T10:GRDF + $ZnSO_4$@ 0.1%	29.80	32.78
T11: GRDF + $FeSO_4$@ 0.5%	30.33	33.36
T12:GRDF + $ZnSO_4$@ 0.5%	30.42	33.46
T13: GRDF + $FeSO_4$+ $ZnSO_4$ each @ 0.1%	31.30	36.64
T14: GRDF + $FeSO_4$ + $ZnSO_4$ each @ 0.5 %	32.71	35.98
SE ±	0.33	0.33
CD (P=0.05)	0.97	0.96

Effect of different treatments on total uptake of micronutrients (Fe, Mn, Zn and Cu) by paddy

The data in respect of total uptake of Fe in plant showed that there was significant difference in total uptake of Fe in plants due to various treatments. The treatment T4 (Fe-EDTA @ 0.5% with GRDF) recorded significantly superior uptake of Fe in plants (0.496 mg pot^{-1}) over rest of the treatments, however treatment T3 (0.404 mg pot^{-1}) and T14 (0.413 mg pot^{-1}) were at par with each other.The treatment T1 (control) recorded lowest total uptake of Fe (0.120 mg pot^{-1}).

The data in respect of total uptake of Mn in plants showed that treatment T13 ($FeSO_4$ + $ZnSO_4$ each @ 0.1% foliar application with GRDF) and T14 ($FeSO_4$ + $ZnSO_4$ each @ 0.5% foliar application with GRDF) recorded significantly higher uptake of Mn in plants (0.013 mg pot^{-1} each), and the treatments T2, T3, T4, T5, T6, T7 and T10 (0.012, 0.010, 0.012, 0.010, 0.009, 0.011 and 0.012 mg pot^{-1} respectively) were at par with treatments T13 and T14. The treatment T1 (control) recorded lowest total uptake of Mn (0.003 mg pot^{-1}).

The data in respect of total uptake of Zn in plants showed that treatment T6 (Zn-EDTA @ 0.5% foliar spray with GRDF) recorded significantly higher uptake of Zn in plants (0.010 mg pot^{-1}), and treatments T8, T12 (0.009 mg pot^{-1} each) were at par with treatment T6. The treatment T1 (control) recorded lowest total uptake of Zn (0.002 mg pot^{-1}).

In respect of Cu in plants showed that treatments T9, T11, T13, T14 recorded significantly higher uptake Cu (0.011 mg pot^{-1}) in plants, and all other treatments were at par with treatments T9, T11, T13, T14 except T1 and T2.

Application of N, P, K with micronutrients Fe and Zn are known to increase the uptake of Zn and Fe due to increased metabolic activities in plant.

Similar results reported as maximum total uptake of micronutrients (Fe, Mn, Zn and Cu) of paddy by separate foliar application ofFe-EDTA and Zn-EDTA than their combined application by Ram *et al.* (2013), Shivay *et al.* (2015), Verma and Tripathi (2010) and Sharma, *et al.* (1986).

Table 2: Effect of different treatments on total uptake of micronutrients (Fe, Mn, Zn and Cu) by paddy

Treatment detail	Total uptake of micronutrients			
	Fe	Mn	Zn	Cu
	mg pot^{-1}			
T1: Control	0.120	0.003	0.002	0.003
T2: GRDF	0.244	0.012	0.003	0.006
T3: GRDF + Fe-EDTA @ 0.1%	0.404	0.010	0.005	0.008
T4: GRDF + Fe-EDTA @ 0.5%	0.496	0.012	0.007	0.008
T5: GRDF + Zn-EDTA @ 0.1%	0.291	0.010	0.008	0.010
T6: GRDF + Zn-EDTA @ 0.5%	0.305	0.009	0.010	0.008
T7: GRDF + Fe-EDTA +Zn-EDTA each @ 0.1%	0.357	0.011	0.007	0.009
T8: GRDF + Fe-EDTA + Zn-EDTA each @ 0.5%	0.482	0.006	0.009	0.008
T9: GRDF +$FeSO_4$@ 0.1%	0.356	0.012	0.005	0.011
T10: GRDF +$ZnSO_4$ @ 0.1%	0.277	0.008	0.007	0.008
T11: GRDF + $FeSO_4$ @ 0.5%	0.431	0.008	0.005	0.011
T12: GRDF +$ZnSO_4$ @ 0.5%	0.319	0.008	0.009	0.009
T13: GRDF + $FeSO_4$ + $ZnSO_4$each @ 0.1%	0.353	0.013	0.006	0.011
T14: GRDF + $FeSO_4$ + $ZnSO_4$ each @ 0.5 %	0.413	0.013	0.008	0.011
SE ±	0.007	0.001	0.0003	0.001
CD (P=0.05)	0.020	0.004	0.0008	0.004

Conclusion

Grain and stover yield (35.54 and 39.01 respectively) per pot of paddy and total uptake of Fe, Mn, Zn and Cu was significantly increased due to the combined foliar application of Fe-EDTA and Zn-EDTA @ 0.5% with GRDF at tillering and panicle stage over all the treatments.

References

Jackson, M. L. (1973). Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi: pp 256-260.

Ram, U. S. Srivastava, V. K., Hemantaranjan, A., Sen, A.Singh, R. K., Bohra, J. S. and Shukla, U. (2013). Effect of Zn, Fe and FYM application on growth, yield and nutrient content of rice.*Oryza* Vol. 50:4, 351-357.

Sharma, B. L., Rathore, G. S., Dubey, S. B., Khamparia, R. S. and Sinha, S. D. (1986). Response of rice to zinc and evaluation of some soil test methods for zinc. *J. Indian Soc. Soil Sci*., 34 : 106-110.

Shivay, Y. S., Rajendra, P., Kaur, R., Pal, M. (2015). Relative efficiency of zinc sulphate and chelated zinc o zinc biofortification of rice grains and zinc use-efficiency in Basmati rice. Proc. Natl. Acad. Sci., India, Sect. B Biol. Sci.

Singh, R. and Sharma, M. P. (1994). Response of rice to different zinc carries and their methods of application in partiallyreclaimed salt affected soil. *Fertilizer News*.39 (7) : 51-52.

Subbiah B.V. and Asija, G.L. (1956). A rapid procedure for estimation of available nitrogen in soil.*Current Sci*., 25: 256-260.

Verma, T. S., Tripathi, B. R. 2010. Zinc and iron interaction in submerged paddy, *plant and soil*. 72: 107-116.