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Effect of Zinc, Iron and Magnesium and its Methods of Application on Available Nutrient and Uptake of Nutrient by Soybean Crop (*Glycine max* (L.) Merill)

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Abstract The field investigation entitled effect of foliar application of zinc, iron and magnesium on growth, yield and quality of soybean (*Glycine max* (L.) Merill) was conducted . The soil was clayey in texture, low in nitrogen, medium in phosphorus and alkaline in reaction. The experiment was laid out in a randomized block design with twelve treatments and 3 replications. Sowing was done on 5th July, 2013 by dibbling the seeds at spacing 45 cm × 5 cm. The recommended dose of fertilizer (30 : 60 : 30 kg NPK ha^{-1}) was applied at the time of sowing through Urea, SSP and MOP. Application of RDF + $ZnSO_4$10kg ha^{-1} + $FeSO_4$ 10 kg ha^{-1} + $MgSO_4$ 10 kg ha^{-1} +1.5% foliar application of $ZnSO_4$,$FeSO_4$ and $MgSO_4$ at 30 and 50 DAS recorded significantly yield, quality, economics and uptake of nutrient followed by application of RDF + $ZnSO_4$10 kg ha^{-1} + 1% $ZnSO_4$ through foliar application at 30 and 50 DAS (T_9), RDF + $FeSO_4$ 10 kg ha^{-1} + 1% $FeSO_4$ through foliar application at 30 and 50 DAS (T_{10}) and RDF + $MgSO_4$ 10 kg ha^{-1} + 1% $MgSO_4$ through foliar application at 30 and 50 DAS (T_{11}).

Keywords Zinc, Iron, Magnesium, Nutrient, Soybean.

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Introduction

Soybean (*Glycine max* (L.) Merill) is a leguminous crop and belongs to family Leguminaceae with sub family Papilionaceae. It is referred as wonder crop as it contains 40% good quality protein and 20 % oil high in essential unsaturated fatty acids [1]. Soybean protein is rich in essential amino acid i.e. lysine (5g/ 100g protein) and thus compliments cereal based diets. Soybean, fixes atmospheric nitrogen through a symbiotic association between the bacteria of the genus *Bradyrhizobium* and soybean crop. It can also be easily processed into a number of processed food products like soys milk, soya cheese, soya paneer, soya yogurt, soya ice-cream. It can give a boost to the food-processing industry in rural areas.

Zinc deficit soil as one of the most important factor reducing production of such plants as corn, soybean, bean, rice and wheat. Not only deficit reduces these crops yield and production, but also results in reduction of their nutritional value. In addition to having an important role in activating plants enzymatic systems, zinc is essential for synthesis of chlorophyll and carbohydrates. This elements plays an important role in metabolism of nitrogen, synthesis of amino acid tryptophan, metabolism of starch, plants flowering and fruit set, increasing plant resistance to fungal disease and expanding plant roots.

Iron plays an important role in nitrogen fixation and photosynthesis Synthesis of chlorophyll, thylakoid and many ferrous proteins are depends upon this element. Iron (Fe) enters many plant enzymes that play dominant roles in redox reactions of photosynthesis and respiration. Iron participates in content of many enzymes cytochromes, ferrodoxine, superoxide dismutase (SOD), catalyse (CAT), peroxidise and nitrate reductase. The deficiency of Fe in plants causes significant changes in the plant metabolism and induces chlorosis, especially in young leaves.

Magnesium is also an important component of chlorophyll and hence its deficiency leads to adverse effect on synthesis of carbohydrates, enzymes, protein synthesis and m-RNA synthesis with poor metabolism. Chlorosis of leaves except midrib was noticed at first 15 days after planting. The cause of chlorosis appears to be due to retention of chlorophyll for longer period in vascular bundles than in parenchyma cells between them. The older affected leaves ultimately defoliated.

Materials and Methods

A field experiment was conducted during *kharif* of 2013 at Farms, Department of Agronomy, College of Agriculture, Latur. Geographically Latur is situated between 18°05′ to 18°75′ North latitude and between 76°25′ to 77°25′ East longitude . To study effect of zinc, iron and magnesium and method of application on soybean. The experimental field was leveled and well drained the soil of experimental plots was clayey in texture. The chemical composition of experimental plots indicated that the soil was low in available nitrogen (118.86 kg ha^{-1}), medium in available phosphorus (20.42 kg ha^{-1}), very high in available potassium (385.89 kg ha^{-1}) content and alkaline in reaction having pH of 8.5. The environmental condition prevailed during experimental period was favorable for normal growth and development of soybean crop.

The experiment was laid out in a randomized block design with 12 treatments replicated thrice. The treatments were T_1 : RDF, T_2 : RDF + $ZnSO_4$ 20 kg ha^{-1}, T_3 : RDF + $FeSO_4$ 20 kg ha^{-1}, T_4 : RDF + $MgSO_4$ 20 kg ha^{-1}, T_5 : RDF + $ZnSO_4$ 20 kg ha^{-1} +$FeSO_4$ 20 kg ha^{-1}, T_6 : RDF+ $FeSO_4$ 20 kg ha^{-1} + $MgSO_4$ 20 kg ha^{-1} , T_7 : RDF+ $MgSO_4$ 20 kg ha^{-1} + $ZnSO_4$ 20 kg ha^{-1}, T_8 : RDF + $ZnSO_4$ 20 kg ha^{-1} + $FeSO_4$ 20 kg ha^{-1} + $MgSO_4$ 20 kg ha^{-1}, T_9 : RDF + $ZnSO_4$ 10 kg ha^{-1} + 1%$ZnSO_4$ through foliar application at 30 and 50 DAS, T_{10} 10 RDF + $FeSO_4$ 10 kg ha^{-1} + 1% $FeSO_4$ through foliar application at 30 and 50 DAS, T_{11} : RDF + $MgSO_4$ 10 kg ha^{-1} + 1% $MgSO_4$ through foliar application at 30 and 50 DAS and T_{12} : RDF + $ZnSO_4$ 10 kg ha^{-1} + $FeSO_4$ 10 kg ha^{-1} + $MgSO_4$ 10 kg ha^{-1} + 1.5% foliar application of $ZnSO_4$, $FeSO_4$ and $MgSO_4$ at 30 and 50 DAS.

The gross and net plot size of each experimental unit was 5.4 m × 4.5 m and 4.5 m × 4.0 m respectively. Sowing was done 5th July 2013 by dibbling method at spacing of 45 cm × 5 cm. The recommended cultural practices and plant protection measures were undertaken. The recommended dose of fertilizer (30 : 60 : 30 kg NPK ha^{-1}) was applied as basal dose at the time of sowing through urea, SSP, MOP and zinc sulfate , ferrous sulfate and magnesium sulfate was applied as per treatments. The crop was harvested on 14th Oct 2013.

Various ancillary observations on growth of crop were periodically recorded along with post-harvest studies to evaluate treatment effects. The important findings obtained from the present investigation are summarized (Table 1).

Table 1. Initial states of soil.

Sl. No.	Chemical composition	
a	Soil pH	8.5
b	Electrical conductivity (dSm^{-1} at 25° C)	0.20
c	Organic carbon ($g\ kg^{-1}$)	0.74
d	Available nitrogen ($kg\ ha^{-1}$)	118.86
e	Available phosphorus ($kg\ ha^{-1}$)	20.42
f	Available potash ($kg\ ha^{-1}$)	385.89
g	Available zinc ($mg\ kg^{-1}$)	0.44
h	Available iron ($mg\ kg^{-1}$)	2.87
i	Available magnesium ($mg\ kg^{-1}$)	14.56

Results and Discussion

The effect of different treatments on available of N, P and K was found to be significant (Table 2). When the application of (T_{12}) RDF + $ZnSO_4$ 10 kg ha^{-1} + $FeSO_4$ 10 kg ha^{-1} + $MgSO_4$ 10 kg ha^{1} + 1.5% foliar application of $ZnSO_4$, $FeSO_4$ and $MgSO_4$ at 30 and 50 DAS recorded significantly higher available of nitrogen, phosphorus and potassium (240.25, 26.27 and 593.69 kg ha^{-1}) followed by the application of (T_9) RDF + $ZnSO_4$ 10 kg ha^{-1} + 1.5 % foliar application of $ZnSO_4$ at 30 and 50 DAS (232.03, 24.23 and 573.34 kg ha^{-1}) and (T_{10}) RDF + $FeSO_4$ 10 kg ha^{-1} + 1.5% foliar application of $FeSO_4$ and at 30 and 50 DAS (189.61, 24.54 and 326.15 kg ha^{-1}) respectively than rest of treatments. More available of nitrogen, phosphorous and potassium due application RDF as well as $ZnSO_4$, $FeSO_4$ and $MgSO_4$ of nutrient was due to application soil and foliar spray different growth stage of crop. Hence availability NPK, which more in soil than control treatments.

The effect of different treatments on available zinc, iron and magnesium was found to be significant higher in treatments T_{12} higher availabity of zinc (0.82 mg ha^{-1}), iron (8.11 mg ha^{-1}) and magnesium (18.63 mg ha^{-1}) followed by treatments (0.77 mg ha^{-1}),(6.78 mg ha^{-1}) and (13.03 mg ha^{-1}) Zn, Fe and Mg respectively. More available of zinc, iron and magnesium was due to application soil as well foliar application of micronutrient as well as application of RDF which was enhanced due to different treatments similar result was recorded earlier [2—4].

The effect of different treatments on uptake of N, P and K was recorded to be significant. The application of (T_{12}) RDF + $ZnSO_4$ 10 kg ha^{-1} + $FeSO_4$ 10 kg ha^{-1} + $MgSO_4$ 10 kg ha^{-1} + 1.5% foliar application of $ZnSO_4$ and $MgSO_4$ at 30 and 50 DAS recorded significantly higher uptake of nitrogen, phosphorus and potassium (240.46, 42.85 and 91.18 kg ha^{-1}) respectively. Followed by the application of (T_9) RDF + $ZnSO_4$ 10 kg ha^{-1} + 1.5% foliar application of $ZnSO_4$ at 30 and 50 DAS (211.04, 40.66 and 80.88 kg ha^{-1}) and (T_{10}) RDF + $FeSO_4$ 10 kg ha^{-1} + 1.5% foliar application of $FeSO_4$ and at 30 and 50 DAS (213.40, 40.49 and 78.77 kg ha^{-1}). More uptake of

Table 2. Effect of different treatments on availability and uptake NPK, Zn, Fe and Mg .

Treatments	Available kg ha^{-1}			Available Mg kg^{-1}			Uptake kg ha^{-1}			Uptake mg kg^{-1}		
	N	P	K	Zn	Fe	Mg	N	P	K	Zn	Fe	Mg
T_1	143.35	21.05	280.42	0.43	3.44	11.97	158.058	32.97	59.36	1.63	2.11	16.35
T_2	174.38	23.09	373.49	0.70	3.64	12.70	186.052	35.39	63.77	2.10	1.97	18.47
T_3	167.73	22.60	279.64	0.55	5.42	13.30	185.392	36.01	64.55	1.80	2.718	18.11
T_4	161.11	22.65	254.59	0.53	4.22	16.20	184.624	35.84	63.04	1.78	1.91	20.03
T_5	165.27	23.34	484.30	0.62	5.70	14.70	199.41	37.39	66.56	2.30	3.34	19.84
T_6	153.93	23.23	306.44	0.59	5.75	15.63	192.26	37.83	65.93	2.01	3.57	22.72
T_7	159.60	23.29	395.37	0.30	5.72	14.07	195.83	37.61	64.80	2.16	3.46	21.28
T_8	181.24	24.23	308.83	0.60	6.11	16.97	204.89	40.18	70.46	2.68	4.01	25.13
T_9	232.03	24.89	573.34	0.77	5.63	15.34	211.05	40.45	79.07	3.30	2.72	22.59
T_{10}	189.61	24.54	326.15	0.66	6.78	13.03	213.40	40.66	80.88	2.58	4.71	22.82
T_{11}	201.99	23.71	301.78	0.68	6.64	17.56	218.96	40.49	78.77	2.53	2.49	26.02
T_{12}	240.25	26.27	593.69	0.82	8.11	18.63	240.46	42.85	91.18	3.76	5.33	29.10
SEm±	1.92	0.33	15.63	0.01	0.15	0.36	6.83	1.12	2.25	0.11	0.23	0.73
CD at 5%	5.57	0.98	45.44	0.03	0.43	1.05	19.86	3.26	6.55	0.31	0.67	2.13
Mean	118.86	20.42	385.89	0.44	2.87	14.56	199.20	38.14	70.69	2.39	3.19	21.87

nutrient was due to application RDF and micronutrient which was enhanced due to different treatments. The effect of different treatments on uptake zinc, iron and magnesium was found to be more in treatment T_{12} recorded significantly higher uptake of zinc (3.76 kg ha^{-1}), iron (5.33 kg ha^{-1}) and magnesium (29.10 kg ha^{-1}) followed by the application of T_9 (3.30 kg ha^{-1}), (4.71 kg ha^{-1}) and (26.02 kg ha^{-1}) Zn, Fe and Mg respectively. More uptakes of zinc, iron and magnesium was due to application soil as well foliar application of zinc which was enhanced due to different treatments it was also reported by Mostafavi [5] and choudhary et al. [2]. The initial states and final avaiable nutrient was more due to apply nutrient in soil which uptake by plant which has impact on yield and soil physical character has been changed, NPK uptake more when soil and foliar application micro nutrient to soybean crop it means method of application also enhanced uptake and availability of nutrient and absorb by plant.

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