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Effect of foliar application of zinc, iron and magnesium on growth, yield and quality of soybean (*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 at farm, Department of Agronomy, College of Agriculture, Latur. The experimental field was leveled and well drained. The soil was clayey in texture, low in nitrogen, medium in phosphorus and alkaline in reaction. The environmental conditions prevailed during experimental period was favorable for normal growth and maturity of soybean crop. 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 x 5 cm. The recommended cultural practices and plant protection measures were taken. The recommended dose of fertilizer (30:60:30 kg NPK ha^{-1}) was applied at the time of sowing through Urea, SSP and MOP. The crop was harvested on 14th October, 2013. Application of 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 growth, yield and economics character. 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}).*

Key woods: zinc, iron, magnesium, growth, yield, economics

INTRODUCTION

Soybean (*Glycine max* (L.)Merill) is a leguminous crop and belongs to family leguminaceae with sub family papilionaceae and it is popularly known as 'Wonder crop' and 'Gold in America'. It is basically a pulse crop having 40-42 % protein and gained the importance as an oilseed crop as it contains 20% cholesterol free oil, hence it is considered as highly proteinious and nutritious food. 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 Soya milk, Soya cheese, Soya paneer, Soya yogurt, Soya ice-cream etc. 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 zinc 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 element 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.

MATERIAL AND METHOD

A field experiment was conducted during *kharif*, 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 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}:- 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 x 4.5 m and 4.5 x 4.0 m, respectively. Sowing was done 5th July 2013 by dibbling method at spacing of 45 cm x 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 sulphate, ferrous sulphate and magnesium sulphate was applied as per treatments. The crop was harvested on 14th Oct 2013.

The biometric observations were recorded at various stages of crop growth on different characteristics *viz*., plant height, number of functional leaves and number of branches on five plants selected from each net plot. The leaf area was recorded on plant samples which were uprooted for root nodules and dry matter studies from each gross plot.

Post harvest studies include pod yield per plant, grain yield per plant and number of grains per plant were recorded on five plants sample from each net plot at the time of harvest. The grain and straw yield was also recorded from each net plot at the time of harvest. The seed index (g), grain, straw, biological yields q ha^{-1} and harvest index (%) were also calculated. The nitrogen content in grain was estimated through micro kjeldahl's method and multiplied by factor 6.25 to estimate protein content.

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 as below.

RESULT AND DISCUSSION

The plant growth in respect of plant height, number of functional leaves, leaf area, number of branches, number of pods, number of nodule and total dry matter in soybean crop were significantly influenced by treatments under study. It was observed that (Table 1) maximum height of the plant (31.30 cm) was attained with the application of 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 (T_{12}) which was found at par with the treatments T_9 (30.30 cm), T_{10} (29.68 cm) and T_{11} (29.48 cm). similar type result was obtained in case of number of functional leaves (17.56), leaf area (1.23 dm^2), number of branches (9.87), number of pods per plant (27.37), number of nodule per plant (62.00) and total dry matter (26.79 g day^{-1}) which was significantly superior over where no zinc, iron and magnesium was applied only recommended dose of fertilizer was applied (T_1) It may be due to better utilization of available resources at combination of Zn, Fe and Mg soil and foliar application which resulted in more photosynthesis and hence more dry matter was produced. Similar kind of results were reported by and Banks (2004) and Mondal and Poi (2006).

Minimum plant height (23.83 cm), number of functional leaves (12.57), leaf area (0.65 dm^2), number of branches (5.87), number of pods per plant (17.80), number of nodule per plant (46.00) and total dry matter (19.02 g day^{-1}) recorded in treatment T_1 over other the rest of treatment.

The application of micronutrient *viz*., Zn, Fe and Mg resulted in the increase in growth attributes may be due to better uptake and translocation of plant nutrients to growing plants and more photosynthesis which in turn promoted more number of leaves, leaf area and dry matter production. The beneficial effect of different treatment on plant height, number of functional leaves, leaf area, number of branches, number of pods per plant and total dry matter of soybean were evident during active growth and maturity. Nagaraja and Mohankumar (2010) and Kobraee *et al*. (2011) also reported similar results.

Application of zinc, iron and magnesium significantly affect yield parameters (Table 2). It is evident from the table that application (T_{12}) The application of 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 higher mean seed yield (26.67 q ha^{-1}) and straw yield (33.95 q ha^{-1}) and which was found at par with the treatments T_9 (25.52 q ha^{-1}) and (33.28 q ha^{-1}) and T_{10} (25.21 q ha^{-1}) and (33.04 q ha^{-1}) seed and straw yield respectively. This may be due to favorable effect of soil and foliar application of $ZnSO_4$,$FeSO_4$ and $MgSO_4$ which extracting the micro nutrient from soil by crop and foliar application micro nutrient 30 and 50 day after sowing and also addition of RDF leading to increase uptake of NPK Mostafavi (2012) because of the cumulative effect in increasing growth contributing characters which have been clearly exhibited on the final produce. Lowest seed and straw yield was recorded in control plot where Zn, Fe and Mg were not applied beneficial effect of zinc, iron and magnesium on soybean yield.

Same trends observed in other post-harvest observation highest parameter was recorded in T_{12} higher dry pod yield per plant (9.14 g), seed yield (6.83 g $plant^{-1}$), number of grains per plant (59.27). More pod yield due to application of Zn, Fe and Mg soil and foliar may be due to more growth and photosynthesis which more beneficial effect of zinc, iron and magnesium on yield parameter, was also reported by Kobraee *et al*., (2011) and Odeleye *et al.,* (2007).The effect of different treatments on mean seed index (100 seeds) and harvest index was found to be non-significant. Since seed index is a factored control genetically here the micronutrient applies fraction fueled to include it significantly.

Application of zinc, iron and magnesium significantly economic of soybean crop (Table 2). It is evident from the table that application (T_{12}) The application of 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 higher gross monetary returns (Rs 92364 ha^{-1}) which was at par with the treatments T_9 (₹ 88432 ha^{-1}) and T_{10} (₹ 87377 ha^{-1}). And higher net monetary returns T_{12} (₹ 62266 ha^{-1}) T_{10}(₹61113 ha^{-1}). Which was due to higher yield obtained with them. Net monetary was higher due to more yield and growth. There four benefit cost ration highest found in T_{11} (3.44) Billore *et al.*, (2005) also found similar result.

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Table 1: Effect of different treatment on growth and growth attributes character of soybean

Treatment	Plant height (cm)	Number of Functional leave	Leaf area (dm^2)	Number of branches	Dry matter (g day^{-1})	Number of pod $plant^{-1}$	Number of nodule $plant^{-1}$
T_1	23.83	12.57	0.65	5.87	19.02	17.80	46.00
T_2	26.72	14.69	0.87	7.27	21.83	20.93	51.17
T_3	26.12	14.59	0.86	7.13	21.79	20.33	50.33
T_4	25.89	14.35	0.81	7.00	21.91	20.27	48.33
T_5	28.56	15.03	0.93	8.60	23.54	23.33	52.00
T_6	27.93	15.00	0.88	8.47	23.37	23.00	51.33
T_7	28.19	14.98	0.91	8.13	23.32	23.20	51.83
T_8	28.70	15.13	0.99	8.73	23.70	23.59	52.33
T_9	30.30	16.22	1.15	9.67	24.95	25.23	53.67
T_{10}	29.68	16.09	1.13	9.20	24.64	25.19	53.50
T_{11}	29.48	16.00	1.04	9.07	24.31	25.13	53.33
T_{12}	31.30	17.56	1.23	9.87	26.79	27.37	62.00
S.Em $\pm$	0.64	0.62	0.05	0.34	0.73	0.80	0.71
C.D. at 5 %	1.85	1.79	0.15	0.99	2.13	2.34	2.07
Mean	28.06	15.19	0.95	8.25	23.26	22.95	52.15

Table 2: Effect of different treatment on yield, yield attributes and economics character of soybean

Treatment	Number of seeds plant^{-1}	Seed yield plant^{-1} (g)	pod yield plant^{-1} (g)	Seed index (g)	Seed yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)	GMR (₹ ha^{-1})	Cost of cultivation (₹ ha^{-1})	NMR (₹ ha^{-1})	B:C ratio
T_1	41.80	4.58	23.83	13.65	19.82	27.86	47.68	41.57	68781	24382	44399	2.82
T_2	46.56	5.23	26.72	15.90	22.82	30.38	53.19	42.89	79096	29982	49113	2.64
T_3	46.42	5.28	26.12	15.78	22.56	30.35	52.91	42.64	78222	27582	50639	2.84
T_4	46.10	5.14	25.89	15.65	22.01	30.02	52.03	42.30	76335	25182	51153	3.03
T_5	51.95	5.67	28.56	16.64	24.01	31.32	55.33	43.39	83189	33182	50006	2.51
T_6	50.23	5.42	27.93	16.00	23.33	30.96	54.29	42.97	80859	28382	52476	2.85
T_7	50.39	5.40	28.19	16.47	23.50	31.10	54.60	43.04	81455	30782	50673	2.65
T_8	52.80	5.58	28.70	16.87	24.31	32.52	56.83	42.77	84269	33982	50286	2.48
T_9	55.35	6.03	30.30	17.83	25.52	33.28	58.80	43.40	88432	28883	59548	3.06
T_{10}	55.34	5.93	29.68	17.93	25.21	33.04	58.25	43.28	87377	26954	60423	3.24
T_{11}	52.81	5.81	29.48	17.40	24.86	32.51	57.37	43.33	86138	25025	61113	3.44
T_{12}	59.27	6.83	31.30	18.27	26.67	33.95	60.60	44.00	92364	30098	62266	3.07
S.Em ±	1.72	0.34	0.64	0.29	0.61	0.73	0.77	-	1796	-	1049	-
C.D. at 5 %	5.01	0.97	1.85	0.84	1.76	2.13	2.24	-	5222	-	3050	-
Mean	50.75	5.57	28.06	16.53	23.72	31.44	55.16	-	82210	28868	53508	2.88