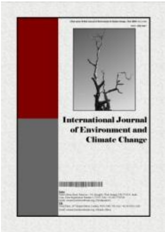

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Effect of Zinc and Iron on Growth and Productivity of Summer Mungbean

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Micronutrients like zinc and iron play an important role in growth and development of mungbean. The scarcity of these micronutrients also has an impact on seed quality of mungbean. A field experiment on optimization of nutrient management practices through soil and foliar application in mungbean was conducted during summer season 2021. The treatments included control, 0.5% $ZnSO_4$ at flower initiation (FI), 0.5% $ZnSO_4$ at FI & pod initiation (PI), 0.5% $FeSO_4$ at FI, 0.5% $FeSO_4$ at FI & PI, 0.5 % $ZnSO_4$ & 0.5% $FeSO_4$ at FI, 25 kg ha^{-1} $ZnSO_4$ soil application, 50 kg ha^{-1} $FeSO_4$ soil application. Plant height (29.85 cm), number of branches per plant (8) and number of nodules per plant (16) were improved significantly by foliar spraying of 0.5% $ZnSO_4$ and 0.5% $FeSO_4$ at FI. Significantly maximum no. of pods per plant, seeds per pod, seed yield (521 kg ha^{-1}) and stover yield (1307 kg ha^{-1}), net returns (Rs. 8020/ha) and benefit cost ratio (1.28) were recorded under 0.5% $ZnSO_4$ and 0.5% $FeSO_4$ spray at Flower initiation stage.

Keywords: Mungbean; foliar spray; zinc; iron; growth; yield and yield attributes; economics.

1. INTRODUCTION

Mungbean (*Vigna radiata* L.) is an important pulse crop grown during summer season. It is commonly called as "Moong Dal" in India. Moong dal is a widely used dal that serves both culinary and medicinal uses. It is well known for its high protein (22-24%), fibre and iron content. It also

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fixes atmospheric nitrogen and improves soil fertility by adding 20-25 N kg ha^{-1}. The yield of summer mungbean is more than that of *kharif* crop because of the abundance sunlight, controlled moisture conditions provided by irrigation, less pest and disease infestation.

Micronutrients like zinc and iron play an important role in growth and development of mungbean. The scarcity of these micronutrients also has an impact on seed quality of mungbean.

Zinc is an essential vitamin which is required by mungbean plant involved in auxin production, dehydrogenase enzyme activation, ribosomal fractions stabilization Babar, H. et al. [1]. The plant's photosynthetic activity is severely hampered by a shift in chloroplast pigments caused by Zn shortage. Application of zinc increased the seedling growth, morphological and yield parameters, grain yield and grain zinc concentration of mungbean Haider, M.U. et al. [2]. Iron is found in several important proteins, including nitrogenase, leghaemoglobin and ferredoxin. It is involved in chlorophyll and thylakoid production as well as chloroplast formation. In legumes, iron deficiency inhibited nodule formation and development. As a result, iron deficiency in legumes is also a clear indicator of nitrogen inadequacy. The application of $FeSO_4$ plays an important role in chlorophyll synthesis and plant growth regulator Jin, Z. et al. [3]. Foliar application of iron solutions in many crops, including legumes, is one of the most commonly used methods for correcting iron deficiency.

Considering the view of above facts, the field investigation was conducted to determine the influence of zinc and iron on growth and productivity of summer mungbean.

2. MATERIALS AND METHODS

The experiment was conducted at the field of Regional Research and Technology Transfer Sub Station (RRTTSS), Kirei, Sundargarh under North Western Plateau Zone of Odisha, during summer season of 2021. The mungbean cultivar used in experiment was 'IPM 02-14'.The experiment was carried out in Randomized Block Design (RBD) with three replications. The soil of the experimental field was sandy loam in texture, acidic in reaction (pH 5.7), low in available nitrogen (145.41 kg ha^{-1}), medium in available phosphorus (35.13 kg ha^{-1}), low in available potassium (71.68 kg ha^{-1}), low in zinc and iron content of 0.53 and 4.23 ppm, respectively. In this investigation the treatments included T_1 control (RDF), T_2 (0.5% $ZnSO_4$ at flower initiation), T_3 (0.5% $ZnSO_4$ at flower initiation & pod initiation), T_4 (0.5% $FeSO_4$ at flower initiation), T_5 (0.5% $FeSO_4$ at flower initiation & pod initiation), T_6 (0.5% $ZnSO_4$ and 0.5% $FeSO_4$ at flower initiation), T_7 (25 kg ha^{-1} $ZnSO_4$ through soil application) and T_8 (50 kg ha^{-1} $FeSO_4$ through soil application). A uniform dose of NPK 20-40-20 kg ha^{-1} and FYM 5 t ha^{-1} were applied as basal to all the treatments.

The mungbean crop was sown on 9th February, 2021 in furrows at a spacing of 30×10 cm. Before sowing, seed @ 20 kg ha^{-1} was treated with Vitavax power @ 2 g kg^{-1} of seed. Zinc sulphate and iron sulphate were applied 0.5% foliar application at flower initiation and pod initiation separately and both the stages. Hoeing and hand weeding were done at 20 and 35 days after sowing. Irrigation was given prior to the preparation of the field and subsequent irrigations were given after every 15 days from the date of sowing. The crop was harvested on 21st April, 2021. Important observations were recorded at the appropriate time and economics were estimated using market price.

3. RESULTS AND DISCUSSION

Growth parameters: It was observed from the results that different nutrient management practices had significant effect on growth parameters of mungbean in terms of plant height (29.85 cm), number of branches per plant (8) and number of nodules per plant (16) with foliar application of 0.5% $ZnSO_4$ and 0.5% $FeSO_4$ at flower initiation stage. It might be due to positive response of zinc in the production of IAA, sugar translocation and response of Fe as a cofactor of many enzymes help in various physiological processes especially affects photosynthesis and chlorophyll synthesis, cell division, water and nutrients absorption, finally help in improving various plant growth parameters. Corroborative results were given by Sitaram, T. et al. [4], Meena, K.K. et al. [5], Ali, B. et al. [6], Khan and Prakash [7], Lakshmi, E.J. et al. [8], Saini, A.K. [9], Suhathiya and Ravichandran [10] and Masih, A. et al. [11].

Yield attributes and yield: Yield attributes like pod length, 1000-seeds weight showed non-significant effect on different treatments of zinc and iron. Yield attributes viz. pods per plant (15.63) and seeds per pod (10.50) were

Table 1. Effect of zinc and iron on growth attributes of summer mungbean

Treatment	Plant height (cm) at harvest	No. of branches/plant at harvest	No. of nodules/plant at 45 DAS
T_1 - Control (RDF: 20-40-20 kg/ha and FYM 5 tha^{-1})	24.17	4.43	9.67
T_2 - T_1+ 0.5% $ZnSO_4$ FI	28.53	8.10	14.37
T_3 - T_1+ 0.5% $ZnSO_4$ FI & PI	28.90	8.27	15.13
T_4 - T_1+ 0.5% $FeSO_4$ FI	27.23	6.87	12.03
T_5 - T_1+ 0.5% $FeSO_4$ FI & PI	28.23	7.77	12.87
T_6 - T_1+ 0.5% $ZnSO_4$ and 0.5% $FeSO_4$ FI	29.85	8.43	16.00
T_7 - T_1+ 25 kg/ha $ZnSO_4$ soil application	26.53	6.73	11.87
T_8 - T_1+ 50 kg/ha $FeSO_4$ soil application	25.60	6.07	11.10
SE (m)±	0.41	0.20	0.33
CD (P=0.05)	1.22	0.60	0.98

RDF: Recommended dose of fertilizer, *FI: Flower initiation, *PI: Pod initiation, *SEm: Standard error of the mean

Table 2. Effect of zinc and iron on yield attributes and yield of summer mungbean

Treatment	No. of pods/plant	Pod length (cm)	No. of seeds/pod	1000-seed weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)
T_1 - Control (RDF: 20-40-20 kg/ha and FYM 5 tha^{-1})	9.87	6.17	8.00	29.80	402.3	1074.7
T_2 - T_1+ 0.5% $ZnSO_4$ FI	14.77	6.60	10.10	30.73	502.3	1274.7
T_3 - T_1+ 0.5% $ZnSO_4$ FI & PI	15.03	7.03	10.30	31.40	511.3	1296.0
T_4 - T_1+ 0.5% $FeSO_4$ FI	12.97	6.57	9.33	29.50	456.0	1178.7
T_5 - T_1+ 0.5% $FeSO_4$ FI & PI	13.77	6.63	10.00	30.13	450.3	1169.0
T_6 - T_1+ 0.5% $ZnSO_4$ and 0.5% $FeSO_4$ FI	15.63	7.03	10.50	31.27	521.0	1307.0
T_7 - T_1+ 25 kg/ha $ZnSO_4$ soil application	12.90	6.50	9.20	30.27	446.7	1195.0
T_8 - T_1+ 50 kg/ha $FeSO_4$ soil application	12.40	6.20	8.33	28.93	439.0	1202.7
SE (m)±	0.38	0.21	0.17	0.57	9.63	12.20
CD (P=0.05)	1.12	N/S	0.52	N/S	28.60	36.25

RDF: Recommended dose of fertilizer, *FI: Flower initiation, *PI: Pod initiation, *SEm: Standard error of the mean

Table 3. Effect of application of zinc and iron on production economics of summer mungbean

Treatment	Cost of cultivation (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)	B:C ratio
T_1 - Control (RDF: 20-40-20 kg/ha and FYM 5 tha^{-1})	27595	28140	545	1.02
T_2 - T_1+ 0.5% $ZnSO_4$ FI	28200	35140	6940	1.25
T_3 - T_1+ 0.5% $ZnSO_4$ FI & PI	28505	35770	7265	1.25
T_4 - T_1+ 0.5% $FeSO_4$ FI	28145	31920	3775	1.13
T_5 - T_1+ 0.5% $FeSO_4$ FI & PI	28445	31500	3055	1.11
T_6 - T_1+ 0.5% $ZnSO_4$ and 0.5% $FeSO_4$ FI	28450	36470	8020	1.28
T_7 - T_1+ 25 kg/ha $ZnSO_4$ soil application	29645	31290	1645	1.06
T_8 - T_1+ 50 kg/ha $FeSO_4$ soil application	30095	30730	635	1.02
SE (m)±	8.12	623.80	618.03	0.02
CD (P=0.05)	24.88	1910.44	1892.78	0.06

RDF: Recommended dose of fertilizer, *FI: Flower initiation, *PI: Pod initiation, *SEm: Standard error of the mean, *Rs: Rupees

observed significantly higher in foliar spray of zinc and iron sulphate i.e. 0.5% $ZnSO_4$ and 0.5% $FeSO_4$ at flower initiation stage. These results attributed to stimulatory effect of zinc and iron on most of the physiological and metabolic processes and nitrogen metabolism, synthesis of chlorophyll, plant growth regulator, improves photosynthesis and assimilates transportation to sink resulted enhanced seed yield of mungbean. The foliar application of zinc sulphate and iron sulphate at flower initiation and bud initiation stage are responsible for efficient translocation of photosynthate from source to sink, this causes' higher number of pod formation and higher test weight. These results are in accordance with Awlad, H.M. et al. [12] and Teixeira, I.R. et al. [13], Kumawat, R.N. et al. [14], Meena, K.K. et al. [5] and Soni and Kushwaha [15].

Seed yield (521 kg ha^{-1}) and stover yield (1307 kg ha^{-1}) was found to be higher with application of 0.5% $ZnSO_4$ and 0.5% $FeSO_4$ at flower initiation stage, that might be due to significant effect on yield attributing characters like number of pod bearing branches per plant, pods per plant and 1000-seeds weight. Similarly higher yield attributes and yield were noticed with the combined foliar spray of micro nutrients with zinc attributed to optimum availability of nutrients for luxurious crop growth and efficient partitioning of assimilates from source to sink. Higher stover yield of mungbean might be due to direct influence of zinc on auxin production which in turn enhanced the elongation processes of plant development Masih, A. et al. [11], Prasanna, K.L. et al. [16] and Choudhary, P. et al. [17].

Economics: The highest cost of cultivation (Rs..30095 ha^{-1}) was observed in 50 kg ha^{-1} $FeSO_4$ soil application. This was because of higher quantity of applied $FeSO_4$ as basal compared to foliar feeding treatments. Gross returns (Rs.36470 ha^{-1}) and net returns (Rs.8020 ha^{-1}) and benefit cost ratio (1.28) was recorded highest under treatment 0.5% $ZnSO_4$ and 0.5% $FeSO_4$ at flower initiation stage. Foliar application of 0.5% $ZnSO_4$ at flower initiation and 0.5% $ZnSO_4$ at flower initiation and pod initiation earned more net returns by Rs. 7265 ha^{-1} and Rs. 6940 ha^{-1} than control, however, all foliar fertilized treatment exhibited greater net returns over control. This increase in net return was due to significantly higher value of seed and stover yield as compared to cost of cultivation of corresponding treatment. The results were supported by Soni and Kushwaha [15], Sharma, A. et al. [18] and Sajid, M. et al. [19].

4. CONCLUSION

From the results of above study, it was concluded that foliar spray with 0.5% $ZnSO_4$ and 0.5% $FeSO_4$ at flower initiation stage in summer mungbean produced maximum seed (521 kg ha^{-1}) and stover yield (1307 kg ha^{-1}) with maximum net return of Rs. 8020 ha^{-1} and benefit cost ratio (1.28) because at this level we recorded maximum plant growth and yield of mungbean as compared to control. So this nutrient management practice can be recommended to farmers for getting higher productivity and profitability of summer mungbean.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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