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Effect of foliar spray of zinc and iron on productivity of mungbean [*Vigna radiata* (L.) Wilczeck]

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Abstract
A field experiment was conducted during *kharif* season of 2018 at Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot Satna (M.P.) to evaluate the performance of mungbean with foliar spray of zinc and iron. The experiment was laid out in a randomized block design with three replication. Treatments consisted absoult control, 0.5% $ZnSO_4$ Spray at FI, 0.5% $ZnSO_4$ Spray at FI and PI, 0.5% $FeSO_4$ spray at FI, 0.5% $FeSO_4$ spray at FI and PI, 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ Spray at FI, 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ Spray at FI and PI and 25 Kg $ZnSO_4$ Soil application. Plant height nodules/plant and branches/plant were not influenced significantly by foliar spray of zinc and iron treatment. Yield attributes viz: pods per plant was significantly improved with 0.5% $FeSO_4$ spray at FI. Significantly maximum seed yield (571 kg/ha) and pod length (6.30 cm) was recorded under 0.5% $ZnSO_4$ Spray at FI and PI. Foliar applicaton 0.5% $ZnSO_4$ Spray at FI, 0.5% $ZnSO_4$ Spray at FI and PI, 0.5% $FeSO_4$ spray at FI, 0.5% $FeSO_4$ spray at FI, 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ Spray at FI, 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ Spray at FI and PI and T_8: 25 Kg $ZnSO_4$ Soil application enhanced seed yield of mungbean by 36.85%, 47.16%, 14.69%, 27.31%, 32.98%, 18.04% and 43.04% over control, respectively. However Gross returns (₹ 48676/ha) net returns (₹28537/ha) and B:C ratio (2.41) was earned significantly higher under 0.5% $ZnSO_4$ Spray at FI and PI.

Keywords: Mungbean, zinc sulphate, iron sulphate, foliar spray, basal application, yield attributes, yield and economics

Introduction
Mungbean [*Vigna radiata* (L.)] is one of the third prime pulses crop after chickpea and pigeonpea. Being a self pollinated grain legume posses high seed protein content (22-24%) as well as ability to restore soil fertility through biological nitrogen fixation from atmosphere. In India mung bean is grown on an area of about 3.29 million ha with the production of 2.01 million tons and productivity of 472 kg/ha (Anonymous, 2017-18) [2]. The productivity of mungbean is low in farmer field as compare to experimental field. There are a number of biotic and abiotic factors to limit the potential yield of mungbean. Besides the major plant nutrients, micro nutrients viz: iron and zinc are play an important role for boosting productivity of mungbean. The limited availability of these micro nutrients is also influence the quality of seed. Frequent drought in the low rainfall semi-arid areas and water-logging in the high rainfall areas are caused considerable loss in mungbean production. It is of mature pods are picked 2 to 3 times because of non- synchronous and varieties or vegetative and reproductive sink, resulted flower and pod development.
The foliar spray of micro-nutrients was found to have beneficial effect on enhancing growth and increasing seed yield. Zinc sulphate is applied as basal as well as foliar. It is needed by plants in small amounts, but yet crucial to plant development. In plants, zinc is key constituent of many enzymes and proteins. It is essential in the formation of auxins, which help with growth regulation and stem elongation. Growth parameters were increased by zinc application regardless to its concentration and application method. Zinc application either through soil or foliar application, also increases the Zn content of shoot (Abbas and Zaynab, 2010) [1]. Foliar sprays fix the problem for the plant but they have don’t fix the problem in the soil. Method of application of also depends upon the Zn fertilizer used.
Iron is very important to the growth of plants. It is a constituent of several enzymes and some pigments, and assists in nitrate and sulphate reduction and energy production within plant. Although iron is not used in the synthesis of chlorophyll but it is essential for its formation. Iron plays a significant role in various physiological and biochemical pathway in plants. In plants, iron is involved in the synthesis of chlorophyll and it is essential for the maintenance of chloroplast structure and function.

Application of zinc and iron either foliar spray or basal application are fortified the seed quality of mungbean. Bio fortified staple crops, when consumed regularly, will generate measureable improvements in human health and nutrition. Bio fortified crops are also a feasible means of reaching rural populations who may have limited access to diverse diets or other micronutrients level interventions. Keeping, these points in view, the present investigation was undertaken to evaluate zinc and iron application on bio-fortification and productivity of mungbean.

Materials and Methods

A field experiment was carried out during *kharif* season, 2018 at Agricultre farm in the Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrkoot, Satna (M.P.) located at $25^{0}10'$ N latitude and 80^{0} 32′ E longitude at an altitude of 190-210 meter above mean sea level. The soil of experimental field was sandy loam in texture having soil p^{H} 6.9, low in available nitrogen (212 kg/ha), high in available phosphrous (41.3 kg/ha) and medium in organic carbon (0.53%) available potassium (257.6 kg/ha) and available zinc (0.71) kg/ha. In this investigation eight treatment viz; T_1: absolute control, T_2: 0.5% $ZnSO_4$ Spray at FI, T_3:0.5% $ZnSO_4$ Spray at FI and PI, T_4: 0.5% $FeSO_4$ spray at FI, T_5: 0.5% $FeSO_4$ spray at FI and PI, T_6:0.5% $ZnSO_4$ + 0.5% $FeSO_4$ Spray at FI, T_7: 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ Spray at FI and PI and T_8: 25 Kg $ZnSO_4$ soil application were tried in a randomized block design with three replication.

Mungbean crop (Cv. PDM-139) was sown on July 24, 2018 in furrows at a row spacing of 30 cm apart. Seed @ 20 kg/ha was treated with thiram @ 2.5g/kg seed and inoculated with *Rhizobium* culture and PSB before sowing, Crop was fertilized @ 20 kg N+ 40kg P_2O_5+ 20 kg K_2O. Entire quantity of NPK was applied as basal in furrow below the seed uniformly in all treatments. Zinc sulphate and iron sulphate was applied 0.5% foliar application at flower initiation and pod initiation separately and both the stages (0.5%+0.5% and 0.5%+0.5%) with 666 liters water. Plant spacing of 5 cm was maintained by thinning operation. Pendimethalin @ 1 kg a.i/ha was sprayed next day of sowing for weed control in addition to one manual weeding on 25 days after sowing. Crop was raised under rainfed condition which received 670 mm rainfall during cropping period out of an annual rainfall of 649 mm. The crop was harvested on October 23, 2018. Important observations were taken at appropriate time and economics was calculated on the basis of prevailing market periods.

Results and Discussion

Growth and nodulation

Growth characters of mung bean viz. plant height and branches per plant and nodules /plant were not affected by zinc and iron application but plant height, primary branches/ plant and nodules/plant were numerically better under zinc and iron treatment (Table-1). It might be due to positive response of zinc and iron. The increased in growth parameters due to application of zinc were also reported by Jain (2007), Sharma and Abraham (2010) [10], Dubey *et al.* (2013) [4] Khalil and Prakash (2014) [7] in different crop. Shanti *et al.* (2008) [11] reported that under zinc treatment increased the plant height of mungbean.

Yield attributes

Yield attributes viz. pods/plant, pod length /pod, seeds/pod and grain weight/plant were significantly improved due to foliar spray of zinc and iron. Pods per plant was observed significantly higher in soil application of $ZnSO_4$ @ 25 kg/ha followed by 0.5% $FeSO_4$ at flower initiation. Pod length was noted significantly better in 0.5% $ZnSO_4$ at flower and pod initiation. However, seeds/pod was found significantly more in 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ at flower and pod initiation followed by 0.5% $ZnSO_4$ at flower initiation. Similarly, grain weight/plant was recorded significantly superior in 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ at flower initiation (Table-1). This shows that the use of zinc and iron in all the doses and stages of application enhanced metabolic process of plant which resulted better yield attributes. Similar results were also obtained by Jain (2007), Sharma and Abraham (2010), Dubey *et al. (*2013) [4], Jat *et al. (*2015). Singh and Aggarwal (1998) found that foliar application of zinc sulphate and ferrous sulphate at branching and flower bud initiation stages increased the number of flower/plant, pods/plant, seeds/pod and seed yield in green gram.

Yield and harvest index

Grain yield of mungbean was produced significantly superior by 0.5% $ZnSO_4$ Spray at FI and PI (571 kg/ha) closely followed by in 25 Kg $ZnSO_4$ Soil application (555 kg/ha). Treatment T_2 :0.5% $ZnSO_4$ Spray at FI, T_3: 0.5% $ZnSO_4$ Spray at FI and PI, T_4: 0.5% $FeSO_4$ spray at FI, T_5: 0.5% $FeSO_4$ spray at FI and PI, T_6: 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ Spray at FI, T_7: 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ Spray at FI and PI and T_8: 25 Kg $ZnSO_4$ soil application enhanced seed yield by 36.85%, 47.16%, 14.69%, 27.31%, 32.98%, 18.04% and 43.04% over absolute control. It exhibited beneficial effect of zinc and iron in varying degree. Zinc and Iron is having the stimulatory effect 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 to enhanced seed yield of mung bean. The foliar application of nutrients help specially treatment of zinc sulphate and iron sulphate at flower initiation and bud initiation which might have also responsible for efficient translocation of photosynthate from source to sink, this cause higher number of pod formation and more dry weight plant. Similar results were reported by Jain (2007) Sharma and Abraham (2010) and Dubey *et al. (*2013) [4].
Stover yield was recorded significantly more in spray of 0.5% $FeSo_4$ at FI and PI (2460 kg/ha) followed by 0.5% $ZnSO_4$ +$FeSO_4$ at FI and PI (2387 kg/ha). This increase was associated with growth parameters due to application of zinc were also reported by Jain (2007), Sharma and Abraham (2010) [9], Dubey *et al.* (2013) [4] in different crop. Harvest index of mungbean was significantly increased due to foliar spray of $ZnSO_4$ and $FeSO_4$. It was noted significantly higher in 0.5% $ZnSO_4$ at FI and PI followed by 25 kg $ZnSO_4$ application. This enhancement could be ascribed due to more increase in seed yield attributes as compare to growth parameters i.e. stover yield.

Economic

The lowest cost of cultivation was noted in control (₹ 18821/ha) and highest of (₹ 21275/ha) in T_8: $ZnSO_4$ soil application. These variations were because of higher quantity of applied $ZnSO_4$ as basal compared to foliar feeding treatment. Gross (₹ 48676 /ha) and net returns (₹ 28537 /ha) was recorded significantly more under treatment T_3: 0.5% $ZnSO_4$ spray at FI and PI. Foliar application of 0.5% $ZnSO_4$ at FI and 0.5% $ZnSO_4$ at FI and PI (T_2 and T_3) earned more net returns by ₹ 1139 /ha (76.20%) and ₹ 13698 /ha (91.97%)

than control, however, all foliar fertilized treatment exhibited significantly greater net returns over control. This increase was due to significantly higher value of grain and stover yield as compared to cost of cultivation of concerning treatment. The results were supported by Sharma *et al.* (2018) and Sajid *et al.* (2016). Significantly highest benefit cost ratio was obtained under T_3: 0.5% $ZnSO_4$ spray at FI and PI (2.41) closely followed by T_2: 0.5% $ZnSO_4$ spray at FI and PI (2.34). This could be associated because of high value of gross returns as compared to cost of cultivation. Result confirmed by the finding of Atul *et al.* (2017), Shivay *et al.* (2014) [10] and Jat *et al.* (2015).

Table 1: Effect of foliar spray of zinc and iron on growth and yield attributes of mungbean.

Treatment	Plant height (cm)	Nodules /plant	No. of branches/plant at harvest		Yield attributes				
	At harvest	35 DAS	Primary	Secondary	Pods/ Plant	Pods length /pod	Seeds / pod	1000- seed wt.	Grain Wt. /plant
T_1 -Absolute control	52.67	0.03	5.93	3.00	11.33	6.10	10.65	28.37	2.90
T_2- 0.5% ZnSO4 FI	53.00	0.08	5.53	3.00	10.40	6.07	10.78	30.67	2.68
T_3 – 0.5% ZnSO4 FI & PI	51.40	0.19	5.93	2.97	10.20	6.30	10.28	30.03	2.66
T_4–0.5% FeSO4 FI	53.80	0.16	5.40	2.13	11.67	6.00	10.47	28.93	2.60
T_5 – 0.5% FeSO4 FI & PI	50.70	0.07	5.60	1.63	10.40	6.17	9.65	30.23	2.12
T_6 – 0.5% $ZnSO_4$ + 0.5% FeSO4 FI	49.33	0.14	6.87	2.17	9.73	5.70	10.32	28.23	3.07
T_7 – 0.5% $ZnSO_4$ + 0.5% FeSO4 FI &PI	53.07	0.05	5.47	2.13	9.87	5.80	10.95	29.27	2.43
T_8 – 25 Kg $ZnSO_4$ SOIL Application	49.67	0.09	5.60	1.53	12.53	5.95	9.83	30.97	2.73
SEm±	3.43	0.06	0.70	0.72	0.53	0.12	0.26	1.25	0.16
CD(P=0.05)	NS	NS	NS	NS	1.61	0.35	0.79	NS	0.50

Table 2: Effect of foliar spray of zinc and iron on yield and economics of mungbean.

Treatments	Grain yield (kg/ha)	Stover yield (kg/ha)	Harvest index (%)	Cost of cultivation (₹/ha)	Gross Returns (₹/ha)	Net returns (₹/ha)	B:C ratio
T_1-Absolute control	388.86	1828.87	17.47	18821.50	33714	14893.67	1.79
T_2– 0.5% $ZnSO_4$ FI	531.71	2125.00	20.95	19479.63	45721	26242.00	2.34
T_3 -0.5% $ZnSO_4$ FI & PI	571.39	1824.67	23.87	20139.00	48676	28537.00	2.41
T_4 – 0.5 $FeSo_{4\ FI}$	445.58	1971.33	19.05	19428.28	38540	19112.00	1.98
T_5 – 0.5% $FeSO_4$ FI & PI	494.67	2460.00	16.69	20035.60	43060	23025.67	2.15
T_6 -0.5% $ZnSO_4$ + 0.5% $FeSO_4$ FI	516.67	2293.33	21.42	19402.90	44695	25293.33	2.30
T_7 – 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ FI & PI	485.90	2387.33	16.28	19672.90	42322	22650.67	2.15
T_8 – 25 Kg $ZnSO_4$ soil application	555.47	2045.00	23.23	21275.60	47592	26317.67	2.23
SEm±	34.16	102.52	1.36	0.09	2842	2660.58	0.12
CD(P=0.05)	103.63	311.00	4.12	0.29	8623	8070.76	0.37

FI = Flower initiation PI = Pod initiation

Conclusion

Thus foliar application of 0.5% $ZnSO_4$ at flower and pod initiation was found the best treatment for obtained maximum grain yield and net profit of mungbean in Kymore Plateau of Madhya Pradesh.

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