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Effect of foliar application of zinc and boron on vegetative growth, fruiting efficiency and yield in field bean

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Abstract

Experiments were conducted to know the effect of foliar application of zinc and boron on vegetative growth, fruiting efficiency and yield in Field bean. Pot experiment was conducted during winter season (October to January) and field experiment was conducted in summer season (April to July) at University of Agricultural Sciences, GKVK, Bengaluru. Results revealed that foliar application of zinc @0.5% and boron @0.2%, 45 days after sowing increases plant height, number of branches and biomass. The number of flowers formed per plant and fruiting efficiency also increases and flower drop decreases significantly. Further, foliar spray of zinc and boron showed increased test weight and seed yield per plant. Fruiting efficiency was also found to be positively correlated with the number of pods and seed yield. Interestingly individual nutrient spray showed positive response whereas combined spray yield no such responses.

Keywords: Foliar spray, zinc, boron, flowering, field bean

Introduction

Field bean (*Lablab purpureus* L. Sweet) is one of the important pulse crops cultivated in dry tropical regions of Asia, Africa, America West Indies, South Central America and China (www.statista.com). In India, field bean is grown in the states like Karnataka, Tamil Nadu, Andhra Pradesh, Kerala and Maharashtra (www.IndiaAgristat.com). The reported seed yield of field bean ranges from 500 to 1500 kg per hectare and fodder yield ranges from 12.5 to 25 tonnes per hectare. Field bean is one of the major sources of protein in the diet of South India. The green pods contain a small amount of vitamin A, C, fat, fibre, proteins, iron and rich in calcium (Sultan Singh *et al.*, 2010) [28]. The nutritive quality of dolichos bean is better than that of French bean. The ripe seed contains 20 to 28 per cent protein. Field is also used for forage purpose (Venugopala, *et al.*, 2014) [35]. Among the several varieties, HA-4 (Hebbal Avare 4) is most popular probably due to its photo and thermo insensitivity property.

There are several factors that are limiting the yield potential of field bean, among them flower drop appears to be the important one. It has been reported that more than 50 flower drop and do not set seeds in this crop. It is understood that nutrients can influence flowering and fruit set in plants along with yield improvement in crop plants. Since, field bean is often grown in off-seasons with less input yield potential is limited. Thus fertilizer application might play an important role in management of this crop. Popularity of field bean and demand for the crop in rural areas is growing day-by-day. Hence, there is a need to enhance the yield potential in this crop. Therefore, in this study it was proposed to spray micronutrients namely Zinc (Zn) and Boron (B) and analyse the influence on growth, flowering, seed set and yield potential.

Material and Methods

Experiments were conducted during the winter season (October to January) and summer season (April to July), 2019 at University of Agricultural Sciences, Bengaluru, Karnataka. HA-4 variety seeds were procured from National Seed Project (NSP), UAS, Bengaluru. Field experiments were conducted at K-block (RCBD, spacing 45 x 10 cm) and Pot experiment (CRD) was conducted in the green house, Department of Crop Physiology, GKVK, Bengaluru with 3 replications. The experimental field was prepared by ploughing and cross ploughing with the cultivator and levelled using tractor. The recommended dose of NPK (25:50:25 kg/ha) was applied as basal dose at the time of sowing. Plant protection measures were adopted whenever required during the crop growth period.

Treatment details: T0- absolute control (no application of fertilizer); T1- control (soil application of recommended Dose of NPK Fertilizers); T2-Zn@ 0.5% foliar spray 45 days after sowing; T3- B@ 0.2% foliar spray 45 days after sowing and T4- Zn@ 0.5% and B@0.2% foliar spray 45 days after sowing

Observations recorded

Growth parameters: Plant height (cm), Number of branches per plant, Leaf chlorophyll content (measured using SPAD-502 Chlorophyll meter, Minolta make, Japan), Fresh weight (gm) and Dry weight (gm).

Flowering parameters: Number of flowers formed per plant (The total number of flower per plant), Number of flowers dropped (number of flower drop per plant) and Fruiting efficiency (Ratio of number of pods formed to the number of flowers formed in that plant).

Yield parameters: Number of pods per plant, Test weight (100 seeds dry weight), Seed yield (dry seed weight was recorded and expressed as seed yield per plant) and Harvest Index (HI):

Statistical analysis: The data was analyzed using statistical package (OPSTAT) and tested for statistical significance (Gomez and Gomez, 1984) [9].

Results and Discussion

Vegetative growth parameters

Plant height: Plant height was observed 60 days after sowing. The plant height was increased with foliar application of Zinc (@0.5%) and Boron (@0.2%) over control. This indicates that both nutrients namely Zn and B enhance the growth in Field bean. Several others have reported that Zinc and Boron increases plant height. For instance, Sarkar *et al.*, (2002) [23] showed that application of boron at different levels showed a significant effect on growth parameters. Boron @ 4 kg ha⁻¹ produced higher plant height and number of branches in soybean. Necat Togay *et al.*, (2004) [19] showed that plant height and number of branches increased in dry bean with soil application of zinc @ 30 kg ha⁻¹. Nasri *et al.*, (2011) [18] showed that foliar application of zinc significantly improved the plant height, number of branches, radiation use efficiency and extinction coefficient in *Phaseolous vulgaris*. Usama *et al.*, (2013) [30] reported higher plant height in *Alternaria* infected fababean with foliar spraying of zinc @ 0.4% along with iron @ 0.4%.

Primary branches: In Field bean there was increase in number of branches with the foliar spray of Z and B however, the difference was not found significant statistically. Earlier studies did indicate that number of branches increases with application of zinc and boron in soybean (Sarker *et al.*, 2002) [23], in dry bean (Necat Togay *et al.*, 2004) [19], in Faba bean (Ati & Ali 2011; Usama *et al.*, 2013) [4, 30]. Thaloorth *et al.*, (2006) [29] reported that number of branches per plant increased with foliar application of Zinc EDTA @ 300 ppm on Mungbean grown under water stressed conditions.

Fresh weight of Plant: Fresh weight of plant was recorded after harvest. It was observed that, boron treatment recorded highest fresh weight followed by zinc treatment over control (Table 1). Although both field and pot experiment showed similar results, fresh weight was much higher in the pot conditions than filed situation.

Biomass or Dry matter per plant (TDM): Biomass of plant was recorded after harvest. It was observed that, boron treatment recorded highest dry weight followed by zinc treatment over control (Table 1). Although both field and pot experiment showed similar results, biomass accumulation was much higher in the pot conditions than filed situation.

Both fresh weight and biomass increased with foliar spray zinc and boron. Zinc is known to activate several enzymes and improve the metabolic activity thereby biomass. Boron play a role in cell differentiation and development, translocation of photosynthates from source to sink and its involvement in protein synthesis (Ati and Ali, 2011) [4]. Sarkar and Aery (1990) [22] indicated that soil application of zinc increases tap root length, dry matter accumulation, leaf area, nodule weight and number in soybean. Higher values of crop growth rate (CGR) and net assimilation rate (NAR) were recorded in soybean with foliar application of zinc (Heidarian *et al.*, 2011) [10]. Bellaloui *et al.*, (2013) [5,6] reported that foliar boron application @ 1.1 kg ha⁻¹ under well-watered conditions improves protein, oleic acid, sucrose, glucose and fructose content in seeds.

Chlorophyll content: SPAD meter reading was recorded on the plants to correlate with leaf chlorophyll content. It was observed that values range from 27 to 42. Across the treatments there was a difference with regards to leaf chlorophyll content observed (Table 1). Earlier, Weisany *et al.*, (2011) [36] and Soheil *et al.*, (2011) [27] showed that chlorophyll a, chlorophyll b, carotenoids and protein contents of soybean increased with supply of zinc. Similarly, Hemantaranjan *et al.*, (2000) [11] Sarker *et al.*, (2002) [23] and Bellaloui, (2011) [5] reported that foliar application of boron on soybean increases leaf chlorophyll content. However, in this experiment SPAD meter reading recorded was found be similar across the treatments. No treatment effect was noticed.

Flowering parameters

Number of flowers per plant: The number of flowers formed per day was counted till maturity and cumulative number was treated as number of flowers per plant. The number of flowers formed varied across the treatments. Among the treatments, it was observed that zinc application enhance the number of flowers formed both in filed and pot conditions (Table 2). However, boron influence on flower formation was not noticed.

Flowers drop per plant: The number of flower dropped was counted on daily basis and cumulative number was treated as number of flowers dropped per plant. The number of flowers dropped ranged from 5 to 30 flowers per plant. Flower dropped ranged from 40 to 75 per cent across the treatments. Percentage flower drop observed was much higher in the pot conditions than filed situation. Flower drop was reduced due to application of both Zinc and Boron (Table 2). However, Boron influence on the flower drop reduction was much more than Zinc.

Fruiting efficiency (per cent): Fruiting efficiency was obtained by calculating ratio of pods formed to that of total number of flowers produced per plant. These values were obtained with a range of 40 to 65. Fruiting efficiency was enhanced up to 8% due to application of nutrients namely zinc and boron (Table 2). However, comparatively Boron influence on fruiting was much more than Zinc.

One of the main reasons for lower yield in pulses is due to abscission of flowers and immature pods. If the abscission of flowers decreased yields of pulses may increase. There has been much debate whether the yield of legumes is sink or source limiting, and much of the argument is in favour of the latter, as earlier-formed pods are heavier than the later-formed ones (Fakir, 2011) [8]. This suggests inadequate assimilate supply to later formed pods. Moreover, genotypes, which produced more flowers within a shorter time, had a greater likelihood of setting pods and retaining until maturity (Fakir, 2011) [8]. In this study we observed that foliar spray of zinc and boron increases the number of flowers per plant and fruiting efficiency in Field bean. Further, the flower drop also reduced due to application of zinc and boron. Correlation analysis indicated that number of flowers formed show positive relationship with fruiting efficiency ($R^2=0.699^{**}$) and negative relation with flower drop ($R^2=0.977^{**}$). Further, fruiting efficiency also showed negative relationship with flower drop ($R^2=0.522^{**}$).

The studies have also indicated that flowering could be enhanced through application of Zinc and Boron. Kalyani (1993) [12] reported that number of pods per plant (25%), number of seeds per plant (32%), grain yield per plant (32%) and reduced number of days to flowering with application of Boron (300 ppm) in Pigeon pea.

Yield parameters

Number of pods per plant: Number of pods per plant ranged from 4 to 30 with a mean of 11.95. The highest number of pods per plant was found with zinc treatment followed by boron treatment (Table 3). Although both conditions showed similar pattern but treatment effect was much stronger in the pot conditions.

Pod weight: Using a sensitive balance pod weight was recorded after harvest. Pod weight ranged from 2 to 20gm with. Mean pod weight was found increase with nutrient spray (Table 3). Among the nutrients applied, comparatively Zinc showed greater impact than Boron.

Test weight: Dry seeds were selected randomly and 100 seeds were separated. Then weight was recorded using an electronic sensitive balance and expressed in gram as test weight. 100 seed weight increased comparatively with the nutrient treatments. Highest mean test weight was observed in Boron @ 0.2% and lowest mean test weight was found in Absolute control (Table 3).

Seed Yield: All dry seeds in each plant were pooled and weight was recorded and expressed as seed yield per plant. Highest seed yield (6.53 gm) was observed with Zinc treatment (Table 3). Although both field and pot experiment showed similar results, seed yield was much higher in the field conditions than pot.

Harvest Index: All dry seeds in each plant were pooled and ratio of dry seed weight to total dry matter of plant was recorded and expressed as harvest index. Harvest index was tend to increase with nutrient application over control (Table 3). However, harvest index observed was found to lower than other crops. Thus there is potential to enhance yield through nutrient application.

The results of the experiment indicated that both the micro nutrients used in the study have positive impact on the reproductive and yield components. Both have contributed in improvement of number of pods per plant, pod weight, Seeds

per pod, Test weight, Seed yield per plant and harvest index (HI). The results are in line with the earlier experiments. Several researchers have reported the positive impact of the Zn application on crops. Varma *et al.*, (2004) [33] reported that Zn and B application improves growth and yield in pigeonpea. Usama *et al.*, (2013) [30] reported in fababean, Siddaraju, (2012) [26] in cluster bean. Nalini *et al.* (2013) [16] in blackgram, Madani *et al.*, (2007) [14] and Vahid *et al.* (2010) [31] in soybean. Rathod *et al.* (2020) [21] in chick pea. Increased straw weight, seeds per pod, test weight and biological yield were observed in mungbean by Thaloorth *et al.*, (2006) [29]. In chickpea enhanced pods weight, number of pods per plant, more dry matter mainly and increased yield observed by Valenciano *et al.*, (2009) [32]. Ahmad and Garib (2010) [1] observed high seed yield, oil yield, 1000 seed weight, seed weight in canola. Nasri *et al.* (2011) [18] reported foliar application of zinc (along with soil application of NPK) in *Phaseolous vulgaris* significantly increased number of pods per plant, number of pods, number of seed per pod, 100 seed weight, fresh pod yield, seed yield, biological yield and harvest index. Seifinadergholi *et al.* (2011) [25] reported that foliar application of zinc sulphate along with manganese sulphate at flowering and seed set noticeably improved yield components and grain yield in common bean. Foliar application of zinc enhanced the pod number, test weight and seed yield in mung bean (Ezzat *et al.*, 2012; Ali and Adel 2013) [7,3].

Several researchers have reported that B application enhances seed, pod and yield attributes. It has been reported that application of boron @ 1 kg ha⁻¹ improves biological yield, seed yield and harvest index in Soybean (Schon and Dale, 1990; Sarker *et al.*, 2002; Vaseghi *et al.*, 2013) [24,23,34]. Mahmoud *et al.*, (2006) [15] reported that applying nitrogen @ 40 kg nitrogen per faddan along with 50-100 ppm boron enhanced number of pods per plant, number of seeds per pod, seed yield per plant, straw and seed yield. Pradeep and Elamathi (2007) [20] reported that significant increase in number of pods per plant, test seed weight, seed yield in green gram with foliar application of boron @ 0.2 per cent along with DAP @ 2 per cent, NAA @ 40 ppm and Mo @ 0.05 per cent at 30 days after sowing (DAS). Ajmi Larbi *et al.*, (2011) reported that boron sprays @ 300 mg L⁻¹ improved blooming rate and olive yield in trees during off season. Ati and Ali (2011) [4] reported that dried seed yield increases with 2.0 kg Boron application (per ha in 8 split dose) in fababean. Nandini Devi *et al.* (2012) [17] reported that soil application of boron @ 1.5 kg ha⁻¹ resulted in maximum yield, net returns, low cost benefit ratio in soybean. This might be due to the role of boron in cell differentiation and development, translocation of photosynthates and growth regulators from source to sink and its involvement in protein synthesis (Ati and Ali, 2011) [4].

Conclusion

The results of the study indicated that the vegetative growth like plant height, number of branches and biomass and reproductive efficiency of Field bean like the number of flowers formed, flower drop and fruit drop percentage were significantly influenced by Zn and B foliar spray treatments. The treatment with foliar application of 0.5% zinc significantly increased the total number of flowers formed per plant decreased the number of flower shed and flower drop percentage compared to control and resulted in significant increase in number of pods formed percentage of fruit set and grain yield respectively.

Table 1: Effect of nutrients on plant height, number of branches, biomass and Chlorophyll content in field bean

Treatment	Field experiment					Pot Experiment				
	Plant height (cm)	Branch number	Fresh weight (gm)	Dry weight (gm)	SPAD	Plant height (cm)	Branch number	Fresh weight (gm)	Dry weight (gm)	SPAD
T0-absolute control	37.40	1.90	42.50	10.47	41.51	69.59	3.00	100.21	28.05	40.10
T1-control(RDF)	40.91	2.00	43.00	11.61	41.20	78.30	3.00	112.75	31.57	39.67
T2-Zn@ 0.5%	52.60	2.80	57.86	15.00	41.07	96.10	5.00	138.38	38.74	39.30
T3- B@ 0.2%	52.80	2.73	58.08	15.68	36.83	99.33	4.33	142.98	40.03	27.43
T4- Zn@ 0.5%+ B@0.2%	40.90	2.67	45.00	12.15	40.84	79.97	4.00	115.15	32.24	38.60
CD	11.45	N/A	2.22	1.39	N/A	5.47	N/A	3.60	3.40	3.71
Se(m)	3.25	0.23	0.63	0.39	1.49	1.65	0.53	1.09	1.027	1.12
C.V.	12.24	17.18	2.16	5.21	6.43	3.33	23.81	1.53	5.14	1.59

Table 2: Effect of nutrients on Flowers formed, Flower drop and Fruiting efficiency in field bean

Treatment	Field experiment			Post Experiment		
	Flowers formed	Flower drop numbers and percentage *	Fruiting efficiency (%)	Flowers formed	Flower drop numbers and percentage *	Fruiting efficiency (%)
T0-absolute control	16.47	9.50 (56.58)	43.4	15.0	10.8 (71.86)	28.10
T1-control(RDF)	16.60	9.35 (56.36)	43.6	16.3	11.5 (70.35)	29.70
T2-Zn@ 0.5%	30.00	14.86 (49.41)	50.6	40.3	28.0 (69.31)	30.70
T3- B@ 0.2%	19.40	9.43 (48.69)	51.3	24.7	13.1 (52.82)	47.20
T4- Zn@ 0.5%+ B@0.2%	21.90	12.15 (55.68)	44.3	26.0	17.6 (67.48)	32.50
CD	5.72	3.92	6.71	3.023	3.073	5.9
Se(m)	1.62	1.11	1.90	0.913	0.928	1.8
C.V.	13.62	17.86	6.97	6.565	10.098	9.1

Table 3: Effect of nutrients on Pods per plant, Pod length, Pod width, Pod weight, Seeds per pod, Test weight, Seed yield, HI in field bean.

Treatments	Field experiment					Post Experiment				
	Pods per plant	Pod weight (gm)	Test weight (gm)	Seed yield (gm)	HI	Pods per plant	Pod weight (gm)	Test weight (gm)	Seed yield (gm)	HI
T0- absolute control	6.97	5.80	12.75	3.20	0.20	4.2	2.80	15.53	1.91	0.06
T1control (RDF)	7.25	6.07	13.00	3.60	0.20	4.8	3.17	16.30	2.28	0.07
T2-Zn@ 0.5%	15.14	9.76	13.00	6.53	0.26	12.4	8.18	16.47	5.88	0.13
T3- B@ 0.2%	9.97	6.61	13.50	3.90	0.17	11.6	7.67	15.87	5.52	0.12
T4- Zn@ 0.5%+ B@0.2%	9.75	3.64	13.17	4.24	0.22	8.4	5.54	16.63	4.00	0.11
CD	2.34	1.96	0.26	1.38	0.02	1.04	2.18	N/A	1.36	0.04
Se(m)	0.66	0.56	0.07	0.39	0.01	0.31	0.66	0.69	0.41	0.01
C.V.	11.68	13.64	0.96	15.69	4.20	6.58	20.96	7.38	0.58	21.70

References

- Ahmad B, Garib M. Evaluation of application methods efficiency of zinc and iron for canola (*Brassica napus* L.). Notulae Scientia Biologicae. 2010; 2(1):94-103.
- Ajmi Larbi, Kamel Gargouri, Mohamed Ayadi, Ali Ben Dhiab, Monji Msallem. Effect of foliar boron application on growth, reproduction, and oil quality of olive trees conducted under a high density planting system. Journal of Plant Nutrition. 2011; 34:2083-2094.
- Ali EA, Adel M. Mahmoud. Effect of foliar spray by different salicylic acid and zinc concentrations on seed yield and yield components of mung bean in sandy soil. Asian Journal of Crop Science. 2013; 5(1):33-40.
- Ati AS, Ali NS. The effect of boron fertilization on faba bean (*Vicia faba*) yield, fertilizer and water productivity. Researches of the first international conference (babylon and Razi universities), 2011.
- Bellaloui N. Effect of water stress and foliar boron application on seed protein, oil, fatty acids, and nitrogen metabolism in soybean. American Journal of Plant Sciences. 2011; 2:692-701.
- Bellaloui N, Yanbo Hu, Alemu Mengistu, My A Kassem, Craig AA. Effects of foliar boron application on seed composition, cell wall boron and seed $\delta^{15}N$ and $\delta^{13}C$ isotopes in water-stressed soybean plants. Frontiers in Plant Science. 2013; 4:1-12.
- Ezzat M, Abd El Lateef, Tawfik MM, Hozyin M, Bakry BA, Elewa TA *et al.* Soil and foliar fertilization of mungbean (*Vigna radiata* (L.) Wilczek) under Egyptian conditions. Elixir Agriculture. 2012; 47:8622-8628.
- Fakir M, Mondal M, Mohd Raziismal, Ashrafuzzaman M. Flowering pattern and reproductive efficiency in mung bean. Int. J Agri. Biol. 2011; 11:966-970.
- Gomez KA, Gomez AA. Statistical procedures for agricultural research, 2nd edition, 1984.
- Heidarian AR, Kord H, Khodadad Mostafavi, Amir Parviz Lak, Faezeh Amini Mashhadi. Investigating Fe and Zn foliar application on yield and its components of soybean (*Glycine max* (L) Merr.) at different growth stages. Journal of Agricultural Biotechnology and Sustainable Development. 2011; 3(9):189 -197.
- Hemantaranjan A, Trivedi AK, Maniram. Effect of foliar applied boron and soil applied iron and sulphur on growth and yield of soybean (*Glycine max* L. Merr). Indian Journal of Plant Physiology. 2000; 5(2):142-144
- Kalyani R Ratna, Devi V Sree, Satyanarayana NV, Rao KV Madhava. Effect of foliar application of boron on crop growth and yield of pigeon pea (*Cajanus cajan* (L.) Millspaugh). Indian Journal of Plant Physiology 1993; 36(4):223-226.
- Kuroda T, Saitoh K, Mahmood T, Yanagawa K. Differences in flowering habit between determinate and

- indeterminate types of soybean. *Pl. Prod. Sci.* 1998; 11:18-24.
14. Madani H, Bakhsh Kelarestaghi K, Yarnia M, Bazoobandi M. The agronomical aspects of zinc sulfate application on soybean in Iranian condition "Gonbad region" Iran. *Proceeding of Zinc Crops Conference*, Istanbul, Turkey, 2007.
 15. Mahmoud, Shaaban M, Abdalla, Fouad El-Sayed, Abou El-Nour, El-Zanaty Abdel Mottaleb Aly *et al.* Boron/Nitrogen interaction effect on growth and yield of fababean plants grown under sandy soil conditions. *International Journal of Agricultural Research*. 2006; 1(4):322-330.
 16. Nalini P, Bhavana Gupta, Girish Chandra Pathak. Foliar application of Zn at flowering stage improves plant's performance, yield and yield attributes of black gram. *Indian Journal of Experimental Biology*. 2013; 51:548-555.
 17. Nandini Devi K, Khomba Singh LN, Sumarjit Singh M, Basanta Singh S, Khamba Singh K. Influence of sulphur and boron fertilization on yield, quality, nutrient uptake and economics of soybean (*Glycine max*) under upland conditions. *Journal of Agricultural Sciences*. 2012; 4(4):1-10.
 18. Nasri M, Mansoureh Khalatbari, Hossein Aliabadi Farahani. Zn-foliar application influence on quality and quantity features in *Phaseolus vulgaris* under different levels of N and K Fertilizers. *Advances in Environmental Biology*. 2011; 5(5):839-846.
 19. Necat Togay, Vahdettin Ciftci, Yesim Togay. The effects of zinc fertilization on yield and some yield components of dry bean (*Phaseolus vulgaris* L.). *Asian Journal of Plant Sciences*. 2004; 3(6):701-704.
 20. Pradeep MD, Elamathi S. Effect of foliar application of DAP, micronutrients and NAA on growth and yield of green gram (*Vigna radiate* L.). *Legume Research*. 2007; 30(4):305-307.
 21. Santosh Rathod, Channakeshava S, Basavaraja B, Shashidhara KS. Effect of soil and foliar application of zinc and Boron on growth, yield and micro nutrient uptake of Chickpea. *Journal of Pharmacognosy and Phytochemistry*. 2020; 9(4):3356-3360.
 22. Sarkar S, Aery NC. Effect of zinc on growth of soybean. *India Journal of Plant Physiology*. 1990; 33(3):239-241.
 23. Sarker SK, Chowdhury MKH, Zakir HM. Sulphur and boron fertilization on yield quality and nutrient uptake by Bangladesh soybean-4. *Journal of Biological Sciences*. 2002; 2(11):729-733.
 24. Schon MK, Dale GB. Foliar boron applications increase the final number of branches and pods on branches of field-grown soybeans. *Plant Physiology*. 1990; 92:602-607.
 25. Seifinadergholi M, Yarnia M, Rahimzade Khoei F. Effect of zinc and manganese and their application method on yield and yield components of common bean (*Phaseolus vulgaris* L. CV. Khomein). *Middle-East Journal of Science and Research*. 2011; 8(5):859-865.
 26. Siddaraju R, Narayanaswamy S, Shanthala J. Seed yield and quality parameters influenced by different varieties and fertilizer levels in cluster bean. *Mysore J Agric. Sci.* 2012; 42(2):437-441.
 27. Soheil K, Keyvan Shamsi, Siros Ekhtiari. Soybean nodulation and chlorophyll concentration (SPAD value) affected by some of micronutrients. *Annals of Biological Research*. 2011; 2 (2):414-422.
 28. Sultan Singh, Kundu SS, Negi AS, Pachouri VC. Performance of growing kids on rations with lablab (*Lablab purpureus*) grains as protein source. *Livestock Research for Rural Development (LRRD News letter)* 2010; 22(5):1-11.
 29. Thalooth AT, Tawfik MM, Magda Mohamed HA. comparative study on the effect of foliar application of zinc, potassium and magnesium on growth, yield and some chemical constituents of mung bean plants grown under water stress conditions. *World Journal of Agricultural sciences*. 2006; 2(1):37-46.
 30. Usama A, Abd El-Razek, Elham A Dorgham, Morsy SM. Effect of certain micronutrients on some agronomic characters, chemical constituents and alternaria leaf spot disease of faba bean. *Asian Journal of Crop Science* 2013; 5(4):426-435.
 31. Vahid G, Amir Ghalavand, Ali Soroosh Zadeh, Alireza Pirzad. The effect of iron, zinc and manganese on quality and quantity of soybean seed. *Journal of Phytology*. 2010; 2(11):73-79.
 32. Valenciano JB, Miguélez-Frade MM, Marcelo V. Response of chickpea (*Cicer arietinum* L.) to soil zinc application. *Spanish Journal of Agricultural Research*. 2009; 7 (4):952-956.
 33. Varma CB Lallu, Yadav RS. Effect of boron and zinc application on growth and yield of pigeonpea. *Indian J Pulses Res*. 2004; 17(2):149-151.
 34. Vaseghi S, Valinejad M, Mehran Afzali. Boron fertilizer effects on soybean yield, leaf and boron concentration in seed. *World of Sciences Journal*. 2013; 1(10):178-188.
 35. Venugopala NG, Rama Prasanna KP, Channakeshava BC, Narayanaswamy S, Krishnamurthy N, Suresha HS. Influence of Plant Population and Nutrition on Seed Yield and Quality in Field bean (*Lablab purpureus* L. Sweet.) cv. Hebbal Avare-3. *Mysore J. Agric. Sci.* 2014; 48(4):534-540.
 36. Weria Weisany, Yousef Sohrabi, Gholamreza Heidari, Adel Siosemardeh, Kazem Ghassemi-Golezani. Physiological responses of soybean (*Glycine max* L.) to zinc application under salinity stress. *Australian Journal of Crop Science*. 2011; 5(11):1441-1447.