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Effect of iron and zinc on growth and yield of French bean in iron and zinc deficient inceptisol soil

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Abstract
A field experiment was conducted at National Agriculture Research Project, Ganeshkhind, Pune (M. S.) on french bean (*cv.* Phule Suyash) during *kharif* 2017 to study the effect of iron and zinc on growth and yield of french bean on iron and zinc deficient inceptisol with eleven treatments and three replications. Among the various treatments the application of GRDF + soil application of $FeSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ @ 10 kg ha^{-1} significantly increased yield contributing parameters *viz.* number of branches $plant^{-1}$, number of green pods $plant^{-1}$, green pod weight, green pod length, green pod breadth. The green pod yield were increased due to application of GRDF + soil application of $FeSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ @ 10 kg ha^{-1} and it was closely followed by GRDF + three foliar sprays of each chelated iron + chelated zinc @ 0.2 % at 25, 40 and 55 days after sowing. The chlorophyll and protein content was also increased as that of yield due to application of GRDF + soil application of $FeSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ @ 10 kg ha^{-1} followed by GRDF + three foliar sprays of each chelated iron + chelated zinc @ 0.2 % at 25, 40 and 55 days after sowing.

Keywords: French bean, iron, zinc, yield, inceptisol

Introduction
French bean (*Phaseolus vulgaris* L.) is a member of family Leguminaceae which is self-pollinated annual plant (Cobley *et al*., 1976) [5]. It is a short season crop having a range 65-110 days from emergence to physiological maturity (Buruchara, 2007) [4]. French bean is good source of energy, it contains high protein content, dietary fiber, complex carbohydrates and also provides folic acid (Edje *et al*., 1980) [7]. Micronutrient deficiency of iron and zinc is increasing in most of the annual crops because of intensive cropping systems, use of modern high yielding cultivars, loss of topsoil organic matter content by erosion, burning crop residues and use of inadequate rates of micronutrients in most cropping systems. Iron is an essential nutrient element for plant growth and development and is involved in chlorophyll and thylakoid synthesis and chloroplast development. Micronutrients, such as zinc (Zn) and iron (Fe) play an important role in human growth, development and maintenance of the immune system (Shenkin, 2006) [16]. Iron (Fe) and zinc (Zn) are most important micronutrients and approximately 2 billion people suffer from Fe and Zn deficiency worldwide, which has often been claimed to be the predominant cause of anemia (Welch and Graham, 1999) [17]. Zinc application increased the grain yield of pea owing to its influence on auxin synthesis, nodulation status and N fixation which promoted plant growth and development, thereby influenced the grain yield favorably (Kasthurikrishna and Ahlawat, 2000) [11].
The demand for increasing pulses production will require a thorough knowledge on the relationship between nutrients and crop growth. The available information regarding the impact of micronutrients on pulse crops is scanty. Based on this background, the present study was undertaken to study the influence of iron and zinc on growth and yield of french bean.

Material and Methods
A field experiment was conducted at National Agriculture Research Project, Ganeshkhind, Pune on french bean during *kharif* 2017 to test the effect of iron and zinc on growth and yield of french bean on iron and zinc deficient Inceptisol with eleven treatments. The treatments comprised of T_1: Absolute control, T_2: GRDF + water spray, T_3: GRDF + foliar spray of chelated iron (0.1%), T_4: GRDF + foliar spray of chelated iron (0.2%), T_5: GRDF + foliar spray of chelated zinc (0.1%), T_6: GRDF + foliar spray of chelated zinc (0.2 %), T_7: GRDF + foliar spray of chelated iron (0.1 %) + foliar spray of chelated zinc

(0.1 %), T_8: GRDF + foliar spray of chelated iron (0.2 %) + foliar spray of chelated zinc (0.2%), T_9: GRDF + soil application of $FeSO_4$ @ 15 kg ha^{-1}, T_{10}: GRDF + soil application of $ZnSO_4$ @ 10 kg ha^{-1} and T_{11}: GRDF + soil application of $FeSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ @ 10 kg ha^{-1}. The GRDF i.e. general recommended dose of fertilizers of N: P_2O_5: K_2O (50:110:110 kg ha^{-1}) + FYM were applied to French bean.

Soil sample was collected before sowing of french bean and analyzed as per standard methods (Jackson, 1973) [9]. The experimental soil was clay loam in texture had a pH (7.3) slightly alkaline in reaction, low in soluble salts (EC 0.27 dS m^{-1}), medium in organic carbon (0.67%), low in available N (188 kg ha^{-1}), high in available P (31.3 kg ha^{-1}) and available K (318 kg ha^{-1}). The soil was deficient in iron (4.17 mg kg^{-1}) and zinc (0.51 mg kg^{-1}) content. The data on growth parameters, yield contributing characters and green pod yield were recorded at harvest stage. The data on various parameters recorded during the period of investigation were tabulated and statistically analyzed (Panse and Sukhatme, 1967) [13].

Results and discussion

Growth parameters

Days to 50 per cent flowering

Data pertaining to days to 50 per cent flowering are presented in Table 1. The results revealed that there were no significant differences obtained on days to 50 per cent flowering recorded due to different treatments (Table 1).

Number of primary branches

Data pertaining to the number of branches $plant^{-1}$ are presented in Table 1. The results revealed that treatment T_{11} i.e. GRDF + soil application of $FeSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ @ 10 kg ha^{-1} recorded significantly higher number of branches (6.30) which was closely followed by treatment T_8 i.e. GRDF + foliar spray of chelated iron (0.2 %) + foliar spray of chelated zinc (0.2%). The results are in conformity with the findings of Nagaraju and Yadahalli (1996) [12].

Table 1: Effect of iron and zinc application on growth parameters of french bean

Treat. No.	Treatments	Days to 50% flowering	Number of branches $plant^{-1}$
T_1	Absolute control	31.67	3.20
T_2	GRDF + water spray	31.67	3.50
T_3	GRDF + foliar spray of chelated iron (0.1%).	31.67	4.83
T_4	GRDF + foliar spray of chelated iron (0.2%).	31.33	4.70
T_5	GRDF + foliar spray of chelated zinc (0.1%).	31.67	4.27
T_6	GRDF + foliar spray of chelated zinc (0.2 %)	31.33	4.57
T_7	GRDF + foliar spray of chelated iron (0.1 %) + foliar spray of chelated zinc (0.1 %)	31.00	5.50
T_8	GRDF + foliar spray of chelated iron (0.2 %) + foliar spray of chelated zinc (0.2%)	31.00	6.23
T_9	GRDF + soil application of $FeSO_4$ @15 kg ha^{-1}	31.67	5.13
T_{10}	GRDF + soil application of $ZnSO_4$ @10 kg ha^{-1}	31.00	4.53
T_{11}	GRDF + soil application of $FeSO_4$ @15 kg ha^{-1} + $ZnSO_4$ @ 10 kg ha^{-1}	31.00	6.30
SE±		0.26	0.30
CD (0.05)		NS	0.89

Yield contributing parameters

Number of green pods $plant^{-1}$

The results revealed that application of Fe and Zn either alone or combination through foliar or soil significantly influenced number of green pods $plant^{-1}$ in french bean (Table 2). The soil application of $FeSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ @ 10 kg ha^{-1} along with GRDF recorded significantly higher number of green pods (22.07) $plant^{-1}$ and it was at par with foliar spray of each chelated Fe and chelated Zn @ 0.2 %. While it was lowest in absolute control treatment (15.27). Increased in pods $plant^{-1}$ might be due to increase in plant height and number of branches as zinc as a component of carbonic unhydrase as well as several dehydrogenase and auxin production which in turn enhanced the growth. However, Fe is necessary for biosynthesis of chlorophyll and cytochrome leading to increase in plant height and number of branches (Prasad *et al*., 1984, Jana and Jahangir, 1987) [15, 10].

Green pod length

The green pod length was significantly influenced due to application of iron and zinc either through foliar or soil application along with GRDF (Table 2). The soil application of $FeSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ @ 10 kg ha^{-1} along with GRDF recorded significantly higher green pod length (13.20 cm) and closely followed by application of each chelated iron and chelated zinc @ 0.2% foliar spray (13 cm). Both the treatments were at par with each other and significantly superior over rest of the treatments. While lowest green pod length (8.20 cm) was recorded in absolute control treatment. The improvement in pod length could be attributed to combined effect of iron and zinc either through soil or foliar application. The beneficial effects of iron and zinc in cowpea crop were also reported by Anitha *et al.* (2005) [3] and Patel *et al.* (2008) [14].

Green pod breadth

The results showed that soil application of $FeSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ @ 10 kg ha^{-1} along with GRDF recorded significantly higher green pod breadth (1.13 cm). It was closely followed by foliar application of each chelated iron and chelated zinc @ 0.2% along with GRDF (Table 2). Both the treatments were significantly superior over rest of treatments and at par with each other. This might be due to role of zinc in production of biomass and that of iron is necessary to chlorophyll synthesis and many essential roles in plant growth and development (Abdollahi *et al*., 2010) [2].

Green pod weight

Among the various treatments the soil application of $FeSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ @ 10 kg ha^{-1} along with GRDF recorded significantly higher green pod weight (8.03 g) which was on par with foliar application of each chelated iron and chelated zinc @ 0.2% along with GRDF (Table 2). Both the treatments were significantly superior over rest of the treatments. Similar results were also reported by Abd-El-Lateef *et al*. (1998) [1] and El-Tohamy and El-Greadly (2007) [8] in mung bean and snap bean respectively.

Table 2: Effect of iron and zinc application on yield contributing parameters of french bean

Tr. No.	Treatments	Number of green pods plant^{-1}	Green pod length (cm)	Green pod breadth (cm)	Green pod weight (g)	Green pod yield (q ha^{-1})
T_1	Absolute control	15.27	8.20	0.99	6.17	119.51
T_2	GRDF + water spray	16.67	8.73	1.01	6.27	168.17
T_3	GRDF + foliar spray of chelated iron (0.1%).	16.63	9.27	1.03	6.47	177.79
T_4	GRDF + foliar spray of chelated iron (0.2%).	19.07	10.60	1.06	7.17	180.17
T_5	GRDF + foliar spray of chelated zinc (0.1%).	18.03	9.77	1.04	6.67	178.49
T_6	GRDF + foliar spray of chelated zinc (0.2 %)	19.40	10.97	1.08	7.43	181.41
T_7	GRDF + foliar spray of chelated iron (0.1 %) + foliar spray of chelated zinc (0.1 %)	20.67	12.17	1.07	7.67	183.18
T_8	GRDF + foliar spray of chelated iron (0.2 %) + foliar spray of chelated zinc (0.2%)	21.63	13.00	1.12	7.93	189.28
T_9	GRDF + soil application of $FeSO_4$ @ 15 kg ha^{-1}	18.67	10.10	1.06	6.87	178.90
T_{10}	GRDF + soil application of $ZnSO_4$ @ 10 kg ha^{-1}	19.90	11.43	1.07	7.43	181.79
T_{11}	GRDF + soil application of $FeSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ @ 10 kg ha^{-1}	22.07	13.20	1.13	8.03	189.89
SE+		0.18	0.09	0.004	0.04	0.26
CD (0.05)		0.53	0.26	0.01	0.12	0.76

Green pod yield

The green pod yield of french bean was significantly influenced by iron and zinc application either through soil or foliar application is presented in Table 2. The results revealed that the soil application of $FeSO_4$ @ 15 kg ha^{-1} and $ZnSO_4$ @ 10 kg ha^{-1} along with GRDF recorded significantly higher green pod yield (189.89 q ha^{-1}) and closely followed by foliar application of each chelated iron and chelated zinc @ 0.2% along with GRDF.

Conclusion

From the results it concluded that either the application of GRDF + soil application of $FeSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ @ 10 kg ha^{-1} or three foliar sprays of each chelated iron + chelated zinc @ 0.2 % at 25, 40 and 55 days after sowing is beneficial to increase in growth and yield of french bean.

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