International Journal of Natural and Social Sciences
ISSN: 2313-4461

Effect of zinc and boron on the yield and yield components of French bean

Md. Faridul Islam[1], Sadikun Nahar[2], Jubaidur Rahman[3], Md. Sarowar Alam[4], Mohammed Mainuddin Molla[5]

[1]Scientific Officer, On-Farm Research Division Bangladesh Agricultural Research Institute, Sherpur, Bangladesh
[2]Department of Agronomy Bangladesh Agricultural University, Mymensingh , Bangladesh
[3]Scientific Officer, Agronomy Division, Regional Agricultural Research Station Jamalpur, Bangladesh
[4]Scientific Officer, Plant Breeding Division, Regional Agricultural Research Station Akbarpur,Moulvibazar, Bangladesh
[5]Senior Scientific Officer, Regional Agricultural Research Station Akbarpur, Moulvibazar, Bangladesh

ARTICLE INFO

Article history

Accepted 25 Feb 2018
Online release 27 Feb 2018

Keyword

French bean
Zinc
Boron
Yield

***Corresponding Author**

Jubaidur Rahman
✉ jubaidurjp@gmail.com

ABSTRACT

An experiment was conducted at the research field at Regional Agricultural Research Station (RARS), Akbarpur, Moulvibazar during *Rabi* season of 2016 to observe the effect of zinc (Zn) and boron (B) on the yield and yield components of French bean (*Phaseolus vulgaris* L.). There were four levels of zinc (0, 1.0, 2.0, and 3.0 kg/ha) and boron (0, 0.5, 1.0, and 2.0 kg/ha). The experiment was laid out in randomized complete block design (RCBD) with three replications. Following zinc application, the highest pod yield (10.85 ton/ha) was obtained from (2.0 kg Zn/ha) which was statistically similar with zinc level of 1.0 kg/ha and the lowest one (8.539 ton/ha) in control. For Boron application, the highest pod yield (10.31 ton/ha) was obtained from (0.5 kg Zn/ha) and the lowest (9.783 ton/ha) in control. Results showed that the highest pod yield (11.90 ton/ha) was found in T_{10}=$Zn_{2.0}B_{0.5}$ treatment and the lowest (7.720 ton/ha) in T_5=$Zn_{1.0}B_0$.The combined application of zinc and boron statistically significant on the yield traits of French bean than the single application of zinc and boron. As a result, the simultaneously application of zinc and boron were performed better than single application. Therefore, the combination of 2.0 kg zinc per hectare and 0.5 kg boron per hectare might be considered as a suitable dose for French bean cultivation in Akbarpur, Moulvibazar.

INTRODUCTION

French bean (*Phaseolus vulgaris* L.) is one of the most important leguminous vegetable. It is also called as snap bean, string bean, kidney bean, haricot bean, fresh bean. It is the world's most important legume food. French bean is a dual purpose crop grown as a pulse and vegetable crop. Its dry seeds are very nutritious containing about 24.9% protein, 60.1% carbohydrate, fat, thiamin, riboflavin, Ca, Fe and niacin as well as fibre (Pierce, 1987; Rashid, 1999).Including leguminous crop like French bean could improved cropping system as well as improve soil fertility. Recently cultivation of French bean is gaining popularity in Bangladesh because of its high nutritive value, good taste and wide range of use and also export purpose. Zinc is one of the seven micronutrients essential for crop growth. Zinc plays a significant role in various enzymatic and physiological activities and Performs many catalytic functions in plant system besides transformation of carbohydrates, chlorophyll and protein synthesis. Deficiencies of zinc become so widespread that it ranks next to N and P in many states (Takkar and Randhawa. 1980). There are several examples demonstrating that applying Zn fertilizers or Zn enriched NPK fertilizers to crops improve not only productivity, but also grain Zn concentration of plants. Zinc is involved in auxin formation, activation of dehydrogenase enzymes; stabilization of ribosomal fractions (Hafeez et al. 2013). Currently, Zn deficiency is listed as a major risk factor for human health and death globally. Boron is also one of the essential micronutrients required for the normal growth of most plants. Boron is important in cell division and helps in germination and growth of pollen grains, sugar translocation, and movement of growth regulators within the plant and lignin synthesis. Boron has been found to play a key role in reproductive processes affecting another development, pollen germination and pollen tube growth (Loomis and

How to cite this article: Islam MF, Nahar S, Rahman J, Alam MS and Molla MM (2018). Effect of zinc and boron on the yield and yield components of French bean. International Journal of Natural and Social Sciences, 5(1): 59-63.

Durst, 1992). Boron application has a positive influence on growth, yield and quality of the crop (Sharma et al., 2013). B is also functionally associated with one or more of the processes of calcium utilization, cell division, flowering and fruiting, carbohydrate and nitrogen metabolism, disease resistance, water relations, and catalyst for certain reactions (Sprague, 1951). Common B deficiency symptoms in crop plants are interruption in flowering and fruiting (Ho, 1999) and poor yields, with deformed or discolored fruit or grain (Shorrocks, 1997). Though, there is a need for use of micronutrients which are helpful in the nitrogen fixation, by which, requirement of high dose of nitrogen can be minimized and optimum dose for higher yield can be achieved. Zinc and Boron leaves residual effect to the succeeding crops (Singh, 2004). Since limited information is available on residual effect of Zn and B fertilization on growth and yield of French bean. The present investigation was, therefore, carried out to determine the optimum level of Zn and B for obtaining maximum yield of French bean.

MATERIALS AND METHODS

Experimental site

A field experiment was conducted under Agro-Ecological Zone 29 (UNDP & FAO, 1988) at Regional Agricultural Research Station (RARS), Akbarpur, Moulvibazar during *Rabi* season of 2016. Soil texture of the experimental field was sandy clay (43-85%), silt (<50%), clay (>20%) and highland soil type with pH 4.5. Annual rainfall was 256 cm at the experimental site.

Cultivation procedure and experimental design

The experiment was laid out in a randomized complete block design (RCBD) with three replications. The unit plot size was 4.0 m × 2.0 m. There were 16 treatment combinations comprising four levels each of zinc (0, 1.0, 2.0, and 3.0 kg/ha and boron (0, 0.5, 1.0, and 2.0 kg/ha). The treatments were arranged as follows: T_1=$Zn_0B_{0,}$ T_2= $Zn_0B_{0.5,}$ T_3= $Zn_0B_{1.0,}$ T_4= $Zn_0B_{2.0,}$ T_5= $Zn_{1.0}B_{0,}$ T_6= $Zn_{1.0}B_{0.5,}$ T_7= $Zn_{1.0}B_{1.0,}$ T_8=$Zn_{1.0}B_{2.0,}$ T_9= $Zn_{2.0}B_{0,}$ T_{10}= $Zn_{2.0}B_{0.5,}$ T_{11}= $Zn_{2.0}B_{1.0,}$ T_{12}= $Zn_{2.0}B_{2.0,}$ T_{13}= $Zn_{3.0}B_{0,}$ T_{14}=$Zn_{3.0}B_{0.5,}$ T_{15}= $Zn_{3.0}B_{1.0}$ and T_{16}= $Zn_{3.0}B_{2.0.}$ The variety was BARI Jharsheem-1. Blanket dose of fertilizers were applied at the time of final land preparation. Zinc and Boron were applied as zinc sulphate and boric acid, respectively, in the respective treatments plot during final land preparation. Seeds were sown on 30 November, 2016 with a spacing of 50 cm × 20 cm. Two weeding were done at 25 and 40 days after sowing (DAS). The diseases and insects were controlled properly. Two irrigations were given at 25 and 40 DAS.

Data collection and statistical analysis

The yield component data were recorded from 10 randomly selected plants from each plot. Yield (kg/ha) was recorded from the whole plot technique. The data were analyzed statistically with MSTAT-C.

RESULTS AND DISCUSSION

Effect of zinc

Effect of zinc on the yield and yield components of French bean have been presented in Table 1.The plant height showed significant variation due to different levels of zinc application. The highest plant height (48.49cm) was obtained from Zn level 3.0 kg/ha and the lowest one (42.55cm) from 1.0 kg/ha. Days to 50% flowering have no significant difference for application of different Zn levels. Pod length and pod width also found insignificant for application of different doses of Zn. Number of green pods per plant was highest (27.58) for Zn level 2.0 kg/ha which was statistically similar with control and 3.0 kg Zn/ha and lowest (25.09) in 1.0kg Zn/ha. Similar results about the number of pods per plant (MacDonald et al., 1990). The maximum individual pod weight (4.068g) was found in zinc level of 2.0 kg/ha and the minimum pod weight (3.517g) in 3.0 kg Zn/ha. The highest pod yield (10.85 ton/ha) was obtained from (2.0 kg Zn/ha) which was statistically similar with zinc level of 1.0 kg/ha and the lowest one (8.539 ton/ha) in control. 1000-dry seed weight was found non-significant difference by the doses for application of Zn. Similar results found 1000-dry

seed weight (Singh et al., 1995). Highest seed yield (2.947 ton/ha) which was significantly higher than control. It was observed that the yield increased gradually with the increase of Zn level up to 2.0 kg/ha but decreased with Zn level (3.0 kg/ha). Similar trends were also observed by several authors (Quddus et al., 2011; Ryan and El-Moneim, 2007; Valenciano et al. (2011) in chickpea in acidic soil).

Table1
Effect of zinc on the yield and yield components of French bean.

Levels of zinc(kg/ha)	Plant height (cm)	Days to 50% flowering	Pod length (cm)	Pod width (cm)	No. of green Pod /plant	Individual pod weight (g)	Pod yield (t/ha)	1000-dry seed weight (g)	Seed yield (t/ha)
0	45.54ab	43.25	16.05	1.165	26.87ab	3.641ab	8.539c	262.6	2.506b
1.0	42.55b	43.17	15.99	1.177	25.09b	3.860ab	10.72ab	265.8	2.552ab
2.0	43.05b	43.67	15.79	1.175	27.96a	4.068a	10.85a	271.7	2.947a
3.0	48.49a	43.17	15.58	1.167	27.58ab	3.517b	9.748b	268.6	2.574ab
CV (%)	4.97	3.31	5.22	5.98	5.94	8.72	6.21	7.07	9.79

Column having the same letter (s) are statistically identical and different letter (s) statistically different ($P \leq 0.01$)

Table 2
Effect of Boron on the yield and yield components of French bean.

Levels of Boron(kg/ha)	Plant height (cm)	Days to 50% flowering	Pod length (cm)	Pod width (cm)	No. of green Pod /plant	Individual pod weight (g)	Pod yield (t/ha)	1000-dry seed weight(g)	Seed yield (t/ha)
0	46.45	43.17	15.66	1.163	26.23	3.623	9.783	263..3	2.603
0.5	45.71	43.42	15.82	1.173	27.35	3.937	10.31	270.9	2.700
1.0	42.98	43.42	15.98	1.180	27.60	3.826	9.964	270.8	2.581
2.0	44.49	43.25	15.95	1.167	26.32	3.700	9.793	263.6	2.694
CV (%)	4.97	3.31	5.22	5.98	5.94	8.72	6.21	7.07	9.79

Effect of boron

Effect of boron on the yield and yield components of French bean have been presented in Table 2. There was no significant variation observed in all the characters of French bean. But the highest plant height (46.45cm) showed in control and the lowest (42.98cm) in the Boron level of 1.0kg/ha. Days to 50% flowering (43.17) was earlier in the Boron level of control and the later flowering (43.42) in the level of 0.5kg/ha which was identical in 1.0kg/ha. The highest pod length (15.98cm) and pod width (1.180cm) was found in the same level of Boron 1.0 kg/ha and the lowest (15.66cm and 1.163cm) in 1.0 kg/ha respectively. Number of green pods per plant was highest (27.60) for Boron level 1.0 kg/ha and lowest (25.09) in control. The maximum individual pod weight (3.937g) was found in Boron level of 0.5 kg/ha and the minimum pod weight (3.623) in control. The highest pod yield (10.31 ton/ha) was obtained from (0.5 kg Zn/ha) and the lowest (9.783 ton/ha) in control. 1000-dry seed weight was highest (270.9g) in the level of Boron 0.5 kg/ha and lowest (263.3g) in control. Highest seed yield (2.70 ton/ha) was observed in Boron level of 0.5 kg/ha and the lowest (2.581 ton/ha) in the level of 1.0 kg/ha. Verma and Mishra (1999) reported the similar trend but different with Anonymous (2000).

Interaction effect of zinc and boron

The interaction effect of Zinc and Boron on yield and yield components of French bean have been presented in Table 3. All the characters showed

significant variation except pod width. The interaction between Zn and B on plant growth, when the availability of Zn and B is low, has also been documented in other crops (Hosseini et al., 2007). The highest plant height (48.63cm) was recorded with level of T_2=$Zn_0B_{0.5}$ kg/ha and the lowest (40.72cm) in T_{11}=$Zn_{2.0}B_{1.0}$. The earlier days to 50% flowering (41.67) was observed in the interaction level of T_{16}=$Zn_{3.0}B_{2.0}$ and the later (45.33) in the level of T_{14}=$Zn_{3.0}B_{0.5}$.The highest pod length (16.82cm) was obtained from T_7=$Zn_{1.0}B_{1.0}$ and the lowest (14.91cm) in T_{15}=$Zn_{3.0}B_{1.0}$. Number of green pods per plant (29.83) was highest found in the interaction level T_{15}=$Zn_{3.0}B_{1.0}$ which was statistically similar with T_3=$Zn_0B_{1.0}$ and lowest (23.58) in T_5=$Zn_{1.0}B_0$. The number of pods per plant is the most influential yield component, and is the component that is the most closely correlated with seed yield (Maiti and Wesche-Ebeling, 2001).The maximum individual pod weight (4.457g) was obtained from interaction level of T_{10}=$Zn_{2.0}B_{0.5}$ and the minimum pod weight (3.160g) in T_{15}=$Zn_{3.0}B_{1.0}$. The highest pod yield (11.90 ton/ha) was found in T_{10}=$Zn_{2.0}B_{0.5}$ treatment and the lowest (7.720 ton/ha) in T_5=$Zn_{1.0}B_0$. 1000-dry seed weight was highest (283.3g) in the level of T_{10}=$Zn_{2.0}B_{0.5}$ and lowest (246.7g) in T_4=$Zn_0B_{2.0}$ treatment. Highest seed yield (3.170 ton/ha) was recorded with the dose T_{10}=$Zn_{2.0}B_{0.5}$ and the lowest (2.40 ton/ha) in the interaction level of T_2=$Zn_0B_{0.5}$. The combined application of Zinc and Boron showed significant effect on French bean yield than the single application of Zinc and Boron. Sakal et al. (1986) observed the similar trend. Abdo (2001) reported the same with foliar spray of Zn and B.

Table 3
Interaction effect of zinc and boron on the yield and yield components of French bean.

Levels of zinc and Boron (kg/ha)	Plant height (cm)	Days to 50% flowering	Pod length (cm)	Pod width (cm)	No. of green pod/plant	Individual pod weight (g)	Pod yield (t/ha)	1000-dry seed weight(g)	Seed yield (t/ha)
T_1=Zn_0B_0	46.13bcd	43.33ab	15.41bc	1.180	25.60def	3.460ef	10.87abc	260.0ab	2.643bcd
T_2=$Zn_0B_{0.5}$	48.63b	42.33b	16.04abc	1.173	25.80def	4.287abc	10.50bcd	253.3ab	2.400d
T_3=$Zn_0B_{1.0}$	44.04cdefg	44.00ab	16.73ab	1.147	29.09ab	4.373ab	11.50ab	270.0ab	2.503bcd
T_4=$Zn_0B_{2.0}$	43.33defg	43.33ab	16.01abc	1.160	27.00bcde	4.070abcd	10.50bcd	246.7b	2.750abcd
T_5=$Zn_{1.0}B_0$	44.52cdef	42.33b	15.46abc	1.187	23.58f	3.653def	7.720i	266.7ab	2.437d
T_6=$Zn_{1.0}B_{0.5}$	42.33efg	43.33ab	16.01abc	1.167	26.60bcde	3.493ef	8.867gh	263.3ab	2.590bcd
T_7=$Zn_{1.0}B_{1.0}$	41.00fg	43.00ab	16.82a	1.200	25.11ef	3.803cde	8.540hi	260.0ab	2.570bcd
T_8=$Zn_{1.0}B_{2.0}$	42.33efg	44.00ab	15.67abc	1.153	25.07ef	3.613def	9.030fgh	273.3ab	2.490cd
T_9=$Zn_{2.0}B_0$	41.87efg	44.00ab	15.88abc	1.167	26.95bcde	3.810cde	10.45cd	270.0ab	2.550bcd
T_{10}=$Zn_{2.0}B_{0.5}$	44.25cdefg	42.67b	16.23abc	1.147	29.00abc	4.457a	11.90a	283.3a	3.170a
T_{11}=$Zn_{2.0}B_{1.0}$	40.72g	44.00ab	15.45abc	1.207	26.35cde	3.883bcde	10.18cde	273.3ab	2.473d
T_{12}=$Zn_{2.0}B_{2.0}$	45.37bcde	44.00ab	15.61abc	1.180	28.02abcd	3.373ef	10.36cd	261.0ab	2.510bcd
T_{13}=$Zn_{3.0}B_0$	53.27a	43.00ab	15.87abc	1.120	28.80abc	3.570def	10.09cde	273.3ab	2.610bcd
T_{14}=$Zn_{3.0}B_{0.5}$	47.63bc	45.33a	15.01c	1.207	28.00abcd	3.593def	9.987cdef	276.7ab	2.933ab
T_{15}=$Zn_{3.0}B_{1.0}$	46.15bcd	42.67b	14.91c	1.167	29.83a	3.160f	9.630defg	263.3ab	2.777abcd
T_{16}=$Zn_{3.0}B_{2.0}$	46.91bcd	41.67b	16.52ab	1.173	25.20ef	3.743cde	9.280efgh	273.3ab	2.907abc
CV (%)	4.97	3.31	5.22	5.98	5.94	8.72	6.21	7.07	9.79

Column having the same letter (s) are statistically identical and different letter (s) statistically different ($P \leq 0.01$)

CONCLUSION

This study showed that the combined application of Zinc and Boron statistically significant on the yield traits of French bean than the single application of Zinc and Boron. As a result, the simultaneously application of Zinc and Boron were performed better than single application. Therefore, the combination of 2.0 kg Zinc per hectare and 0.5 kg Boron per hectare might be considered as a suitable dose for French bean cultivation in Agro- Ecological Zone 29 (AEZ 29).

REFERENCES

Abdo FA (2001).The response of two mungbean cultivers to zinc, manganese and boron I. Morphological, physiological and anatomical aspects. Bulletin of Faculty of Agriculture, Cairo University, 52(3): 445-466.

Hafeez Z, Khanif YM et al. (2013). Role of Zinc in plant nutrition-A Review-American Journal of Experimental Agri-culture, 3(2), 374–391.

Ho SB (1999).Boron deficiency of crops in Taiwan. In: Proceedings of International Workshop on Micronutrient in Crop Production held on Nov. 8-Â 13, 1999, National Taiwan University, Taipei, Taiwan ROC.

Hosseini SM, Maftoun M, Karimian N, Ronaghi A, Emam Y (2007)..Effect of zinc × boron interaction on plant growth and tissue nutrient concentration of corn. Journal of Plant Nutrition 30, 773-781.

Loomis WD and Durst RW (1992).Chemistry and biology of boron. Biotic Factors. 3: 229-239.

MacDonald GE, NH Peck and J Barnard (1990). Snap bean plant responses to zinc sulfate and manganese sulfate fertilization on tile-drained calcareous glacial till soils. Journal of American Society of Horticultural Science, 115:540-546.

Maiti RK, Wesche-Ebeling P (2001).Vegetative and reproductive growth and productivity. In: Advances in chickpea science (Maiti R., Wesche-Ebeling P.,eds).

Science Publishers, Enfield, NH, United States.pp. 67-104

Pierce LC (1987). Legumes In: Vegetable: Characters, Production and Marketing. John Wiley and Sons, New York. pp 561-567.

Quddus MA, Rashid MH, Hossain MA and Naser HM (2011).Effect of zinc and boron on 210 yield and yield contributing characters of mungbean in low Ganges river floodplain soil at 211 Madaripur, Bangladesh. Bangladesh Journal of Agricultural Research, 36(1), 75-85.

Rashid MM (1999). Sabji Biggan. In Bangla. 2nd Ed., Rashid Publishing House, Dhaka.pp.396 -399.

Ryan J and El-Moneim AMA (2007). Implications of Zinc deficiency for ameliorating toxicity (lathyrism) in grasspea. In Conf. Proc.; Zinc Crops 2007: Improving Crop Production and Human Health, Istambul, Turkey.

Sakal R, Singh AP and Singh BP (1986). Annual report of all Indian Coordinated Scheme of Micronutrients in Soil and Plants, RAU, Pusa, Bihar, India.

Sharma J, Gupta JAK, Kumar C and Gautam RKS (2013). Influence of zinc, calcium and boron on vegetative and flowering parameters of Gladiolus cv. Aldebran.

The Bioscan. 8(4): 1153-1158.

Shorrocks VM (1997).The occurrence and correction of boron deficiency. Plant Soil, 193, 121-148.

Singh MV (2004). Micronutrient deficiencies in Indian soils and field usable practices for their correction. IFA International Conference on Micronutrients, Feb, 23-24, 2004, at New Delhi.

Singh AK, Singh UN, Raju MS and Singh JP (1995). Effect of potassium, zinc and iron on yield, protein harvest and nutrition uptake in French bean (*Phaseolus vulgaris* L.). Journal of Potassium Research,11:75-80.

Sprague HB (1951). Hunger Signs in Crops. McKay, New York, USA.

Takkar PN and Randhawa NS (1980). Zinc deficiency in Indian soils and plants. In: Proceedings of Seminar on Zinc Wastes and their Utilization, held during 15-16 October, 1980 organized by India Lead-Zinc information Centre, Fertilizer Association of India at New Delhi.

UNDP - FAO, (1988). Land resources appraisal of Bangladesh for agricultural development. Report to Agro-ecological regions of Bangladesh. UNDP-FAO, BGD/81/ 035 Technical Report 2 . 570 pp.

Valenciano JB, Boto JA and Marcelo V (2011). Chickpea (*Cicer arietinum* L.) response to zinc, 232 boron and molybdenum application under field conditions. New Zealand Journal of Crop and 233 Horticultural Science, 39(4), 217-229.

Verma RJ and Mishra RH (1999). Effect of doses and methods of boron application on growth and yield of mungbean. Indian Journal of Pulses Research, 12 (11): 115-118.