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Research Article

EFFECT OF NITROGEN AND BORON IN SEED YIELD AND YIELD ATTRIBUTING CHARACTERS OF BROCCOLI

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Abstract
Plant nutrient is one of the limiting factors affecting crop production. Nitrogen and boron are major nutrients in case of broccoli. So, an experiment was carried out to evaluate the effect of nitrogen and boron in seed yield and yield attributing characters of broccoli in Rampur, Chitwan during winter season. The experiment was laid out in factorial RCBD design with four levels of nitrogen and two levels of boron. Each plot consists of 25 plants which were separated by 60 * 60 cm spacing. There are altogether eight treatments replicates thrice. Local variety Calabrese was used. Significant effect of different dose of nitrogen and boron on yield attributing characters was found. Also interactive effect of nitrogen and boron in number of pods, pod length, seed yield and number of seeds per pod was found significantly different.

Keywords: Broccoli; Nitrogen; Boron; Seed yield

Introduction
Broccoli, which is a member of the Brassicaceae family, is a compact, rapidly developing floral vegetable that is usually harvested when the flowering heads are immature (Gray, 1982). It is one of the best and economically lucrative vegetable and more nutritious than any other vegetables of the same genus. Broccoli also contains high concentrations of carotenoids, which are believed to have preventative qualities with regards to human cancer. The seed production of broccoli is difficult in the areas having severe winter (Shinohara, 1984). One of the major problems associated with this crop in Nepal is lack of availability of high quality seeds of desired varieties (Devkota, 2000). It is estimated that over half of the commercially required improved vegetable seeds are met by in country production and rest are met mainly by import. Nitrogen is the essential element most frequently deficient in soils around the world. A yield of 50 ton of broccoli removes 250 kg of nitrogen, 55 kg of phosphrous and 200 kg of potash per hectare from the soil, which must be replenished through external sources (Tandon, 2000). Boron plays an important role in the pollination, flower initiation, fertilization and fruit setting. Low boron results in reduction of seed, fruit quality and yield due to early or late flowering cycle and male sterility (Noppkoowong *et al.*, 1997).

Materials and Methods
An experiment was conducted at vegetable block of Institute of Agriculture and Animal Science, during winter season to evaluate the effect of nitrogen and boron in seed yield and yield attributing characters of broccoli. The variety used was Calabrese. The experiment was laid out in the factorial randomized complete block design with 8 treatments and 3 replications. Treatment consists of four level of nitrogen viz. 100, 150, 200, 250 N kgha^{-1} and two levels of boron viz. no borax and 15 borax kgha^{-1}. Each plot consists of twenty five plants which are spaced at 60 cm both ways. There were five rows in each plot and five plants in each row. The size of individual plot is 9m^2 (3m x 3m). The plot between the treatments was separated by 0.5 m and the replication by 1 m. Observation related to yield attributing characters and yield was taken and analysis was done by MSTAT-C and means was separated by DMRT at 5% level of significance.

Result and Discussion

Effect of Nitrogen and Boron in Number of Primary Flowering Branches and Secondary Branches of Broccoli
Number of primary flowering branches per plant was not significantly influenced by different doses of nitrogen. Plant receiving 200 kg ha^{-1} N exhibited higher flowering branches per plant (15.33) as compared to other dose of nitrogen (Table 1). Similar result was found by Data *et al*. (2005) and Thapa and Maity (2004) while working on fenugreek. Number of primary flowering branches per plant was not significantly influenced by borax application. Treatment receiving borax 15 kg ha^{-1} produced higher number of flowering branches (14.43) per plant as compared to no borax receiving treatment (13.73) (Table 1). Number of

secondary branches per primary branch was significantly influenced by different doses of nitrogen. Higher number of secondary branches (5.01) were recorded in plants receiving 200 kg ha^{-1} N followed by plant receiving 250, 150 and 100 kg ha^{-1} N respectively (Table 1). Moniruzzaman *et al.* (2007) also reported same findings while working in broccoli. The influence of borax in Number of secondary branches per primary branch was not significant. However, treatment receiving borax 15 kg ha^{-1} produced more number (4.68) of secondary branches per branch as compared to no borax treatment (4.25). It is due to the low metabolic processes and obstruction in translocation of food materials due to boron deficiency.

Effect of Nitrogen and Boron in Number of Pods per Plant, Pod Length and Number of Seeds per Pod of Broccoli

Results showed that the effect of nitrogen on Number of pods per plant was significant. Higher numbers of pods per plant were observed in plant receiving 200 kg of N ha^{-1} which is followed by plant receiving 150, 100 and 250 kg N ha^{-1}. Similar results were also reported by Halesh*et al.* (2000) and Sharma (2000) while working on fenugreek. Effect of boron on Number of pods per plant was found significant. Treatment receiving borax 15 kg ha^{-1} produced higher number of pods (848.12) as compared to treatment receiving no borax (Table 1). In soybean, there was an 85% increase in the number of pods and 18% increase in the seed weight per plant with two foliar application of B during flowering (Rerksem and Loneragon, 1994). Decrease in number of pods in response to boron deficiency was observed in Black gram, soyabean (Rerksem and Loneragon, 1994) and green gram (Bell *et al*., 1990). Sink for boron uptake into the pod and seed created by synthesis of cell wall pectin is through the cell wall storage polysaccharide. Where demand cannot be met pod and seed may be aborted. Those seeds that can acquire sufficient boron for growth may benefit from the reduced competition for assimilation by forming larger than the normal seed (Shrestha, 2002). Where the boron supply become limiting later in seed and fruit development, seed and fruits exhibit symptoms of abnormal growth. Effect of nitrogen on Pod length was not significant. However, treatment receiving 200 kg ha^{-1} N gave the highest pod length (8.30 cm) as compared to other doses of nitrogen. Data *et al*. (2005) and Thapa and Maity (2004) reported that pod length increased with increasing levels of nitrogen. Effect of boron on Pod length was found significant. Treatment receiving 15 kg ha^{-1} borax produced longer pods (8.62 cm) as compared to treatment receiving no borax (7.09 cm). Higher number of seeds per pod (16.34) was observed in the treatment receiving 200 kg ha^{-1} N followed by 250, 150 and 100 kg N ha^{-1} respectively. Longer pod length accumulate more assimilates and later on it adds on number of seeds per pod and finally seed weight. Effect of boron on Number of seeds per pod was significant. Treatment receiving 15 kg ha^{-1} borax produced more number of seeds per pod (19.36) as compared to the treatment receiving no borax (10.17). When boron supply becomes limiting factor later in the seed and fruit development, seeds and fruits may exhibit symptoms of abnormal growth i.e. embryo defect and premature stemming of testa (Harkness *et al.,* 1989). There were positive relationship between the pod size, seed size and seed quality. Sanchez (1997) reported that longer pods were able to store greater amount of food reserve, which is later translocated to the developing seed, resulting into higher number of high quality seeds.

Effect of Nitrogen and Boron in Test Weight and Seed Yield of Broccoli

The effect of nitrogen on test weight was not significant. Nitrogen at the rate of 200 kg ha^{-1} gave the highest test weight (3.97 g) which was followed by 150, 100 and 250 kg ha^{-1} N (Table 1). Higher level of nitrogen increases the protein and amino acid content of seeds. Restricted nitrogen reduces the seed weight so increasing dose of nitrogen increase the test weight to certain level (Singh *et al*., 1997). Effect of boron in test weight was not significant. Treatment receiving borax @ 15 kg ha^{-1} produced the highest test weight (3.92 g) as compared to no borax (3.49 g) (Table 1). After sexual fusion the developing seed begins to increase in weight as a result of nutrient and water uptake associated with accelerated cell division and elongation which need boron in this process (Copeland and Mc Donald, 1995). Effect of nitrogen on Seed yield was not significant. Highest seed yield (737.51 kg ha^{-1}) was recorded in treatment receiving 200 kg ha^{-1} N which was followed by 250, 150 and 100 kg ha^{-1} N. (Table 1). Very similar results were obtained in the field experiments with *Brassica juncea* where increasing nitrogen rates from 100 to 150 kg ha^{-1} increased the number of branches/plant, the number of pods per plant, the number of seeds per pod and the seed weight (Singh *et al*., 1997). The results showed that effect of boron on Seed yield was significant. Higher seed yield (844.55 kg ha^{-1}) was recorded in the treatment receiving 15 kg ha^{-1} borax as compared to seed yield of 316.53 kg ha^{-1} in the treatment which did not receive borax (Table 1).

Interactive Effect of Nitrogen and Boron in Number of Pods per Plant of Broccoli

Result shows that interactive effect of nitrogen and boron in number of pods per plant was found significantly different. Treatment receiving 200 kg of nitrogen per ha along with 15 kg borax per ha produce higher number of pods per plant (1144) while the treatment receiving 250 kg of nitrogen per ha without borax produce lowest number of pods (493.2). Number of pods produced by other treatments is statistically par with each other (Fig. 1).

Table 1: Effect of nitrogen and boron in number of primary flowering branches, number of secondary flowering branches, number of pods per plant, pod length, test weight and seed yield of broccoli

Treatments	Primary flowering branches (Number)	Secondary flowering branches (Number)	Pods per plant (Number)	Pod length (cm)	Seeds per pod (Number)	Test weight (gm)	Seed yield (kg/ha)
Nitrogen levels							
N1: 100 kg N/ha	13.46	3.98b	655.06b	7.57	11.85	3.58	430.00
N2: 150 kg N/ha	14.46	4.26ab	764.20ab	7.99	15.01	3.93	520.01
N3: 200 kg N/ha	15.33	5.01a	940.66a	8.30	16.34	3.97	737.51
N4: 250 kg N/ha	13.06	4.60ab	615.01b	7.54	15.85	3.36	634.66
sEm	1.25	0.29	67.73	0.28	1.58	0.28	110.95
LSD	3.79	0.89	205.5	0.84	4.81	0.85	336.5
Boron levels							
B0: no borax	13.73	4.25	639.35b	7.09b	10.17b	3.49	316.53b
B2: 15 kg borax/ha	14.43	4.68	848.12a	8.62a	19.36a	3.92	844.55a
sEm	0.88	0.20	47.89	0.19	1.12	0.20	78.45
LSD	2.62	0.63	145.3	0.60	3.40	0.60	238
Grand mean	14.08	4.46	743.73	7.85	14.76	3.71	580.54
CV %	21.76	16.17	22.31	8.80	26.35	18.74	46.81

Interactive Effect of Nitrogen and Boron in Pod Length of Broccoli

Result showed that interactive effect of nitrogen and boron in pod length was found significant. Treatment receiving 200 kg of nitrogen per ha along with 15 kg borax per ha produced longest pods (9.11 cm) which was at par with the treatment receiving 100, 150 and 250 kg of nitrogen per ha along with 15 kg borax per ha. Treatments that did not receive borax produce shortest pods as compare to the treatment receiving borax (Fig. 1).

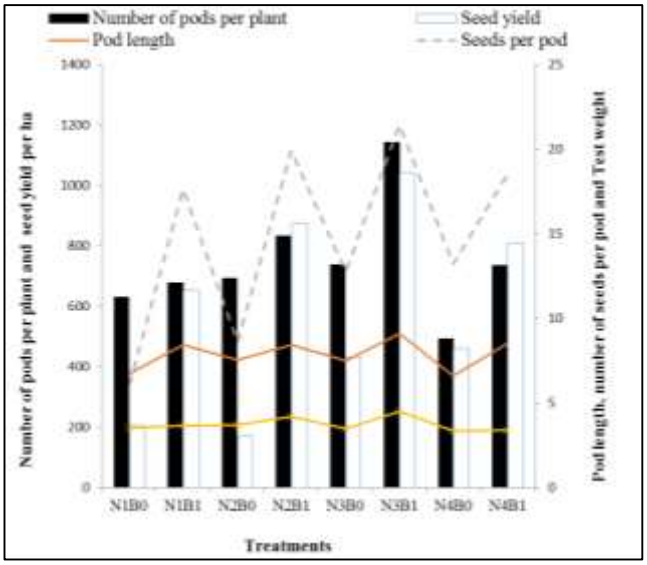

Fig. 1: Interactive effect of nitrogen and boron in number of pods per plant, pod length, number of seeds per pod, test weight and seed yield of broccoli

Interactive Effect of Nitrogen and Boron in Seeds per Pod of Broccoli

Interactive effect of nitrogen and boron in number of seeds per pod of broccoli was found significantly different. Treatment receiving 200 kg of nitrogen per ha along with 15 kg borax per ha produce more number of seeds (21.42) while it is par with other treatments 100, 150 and 250 kg of nitrogen per ha along with 15 kg borax per ha. Treatments receiving borax produce more number of seeds as compared to no borax (Fig. 1).

Interactive Effect of Nitrogen and Boron Test Weight of Broccoli Seeds

Results showed that interactive effect of nitrogen and boron in test weight was not found significant. Treatment receiving 200 kg of nitrogen per ha along with borax 15 kg per ha produce higher test weight (4.48 g) while lowest test weight was produced (3.32 g) in the treatment receiving 250 kg of nitrogen per ha along with no borax treatment. Effect of nitrogen is more when borax is applied. Without borax nitrogen only cannot give higher test weight.

Interactive Effect of Nitrogen and Boron on Seed Yield of Broccoli

The results showed that the interactive effect of nitrogen and boron on Seed yield of broccoli was significant. Seed yield without boron was found very low. The effect of nitrogen on seed yield was prompt only after the application of boron. The highest seed yield of 1043 kg ha^{-1} was recorded when 200 kg ha^{-1} N along with 15 kg ha^{-1} borax was applied (Figure 1). The treatment receiving 100, 150, 200 and 250 kg ha^{-1} N without boron were at par. Boron cannot perform its function with higher dose of nitrogen. With higher dose of nitrogen the acidity of the soil increases

and the availability of boron in acidic soil is less. So, this might be the reason why there was lower seed yield with higher level of nitrogen (250 kg ha^{-1} N).

Conclusion

From this study we can conclude that 200 kg N/ha along with 15 kg boron/ha is the best combination for seed production of broccoli. Higher and lower dose of nitrogen than 200 kg produces lower seed yield with low quality. Also, from this research we conclude that boron is essential micro-nutrients for the seed production of broccoli. Without the application of boron seed production is not suggested.

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References

Bell RW, Mclay L, Plaskett D, Dell B and Loneragan JF (1990) Internal boron requirement of green gram. *In:* M. L. Van Beusichem (ed.) Plant nutrition- Physiology and application. KewerAcedamic Publication, Dordrecht, The Netherland. pp. 275-280.DOI: 10.1007/978-94-009-0585-6_46

Copeland LD and Mcdonald MB (1995) Principle of seed science and technology. Burgress Publishing. Minneapolis USA. pp. 111-126.

Data S, Alam K and Chatterjee R (2005) Effect of different levels of nitrogen and leaf cutting on growth, leaf and seed yield of fenugreek (*Trigonella foenum-graecum* L.). Indian Journal of Agricultural Sciences. 75(9): 580-581.

Devkota FR (2000) Comparative pollination behavior of *Apis cerena* and *Apis mellifera* L. on broccoli and their impact on seed production under Chitwan condition. M.Sc. Thesis. Institute of Agriculture and Animal Science, Rampur, Chitwan, Nepal.

Gray AR (1982) Taxonomy and evolution of broccoli. *Econ. Bot*. **36**: 397. DOI: 10.1007/BF02862698

Halesh DP, Gowda MC, Forooqi AA, Vasundhara M and Srinivasappa KN (2000) Influence of nitrogen and phosphorus on growth, yield and nutrient content of fenugreek (Trigonella foenum-graecum L.). Spices and aromatic plants: Challenges and opportunities in the new century. Contributory papers. Centennial conference on spices and aromatic plants, 20-23 September, Calicut, Kerala, India. 191-194.

Moniruzzaman M, Rahman SML, Kibria MG, Rahman MA and Hossain MM (2007) Effect of Boron and Nitrogen on Yield and Hollowstem of Broccoli. *J .Soil .Nature*. **1**(3): 24-29.

Noppkoowong RN, Bell RW, Dell B and Loneragan JF (1997) Progenesis and Diagonosis of B Deficiency in Black gram (Vignamungo) in the field by using plant analysis. *In*: R. W. Bell and B. Rerkasm (eds.) B in soil and Plant Proceeding. Kluwer Academic Publication, Dordrecht, The Netherland.

Rerksem B and Loneragan JF (1994) Boron deficiency in two wheat genotypes in a warm, subtropical region. *Agron. J.* **86**: 887-890. DOI: 10.2134/agronj1994.00021962008600050024x

Sanchez PA (2002) Soil fertility and hunger in Africa. *Science* **295**(5562): 2019-2020.

Sharma SK (2000) Response of nitrogen and spacing on fenugreek seed production. Horticultural Journal. 13(2): 39-42.

Shinohara DC (1984) Cauliflower and broccoli. *In*: S. Suteki (ed.) Vegetable seed production technology of Japan. pp. 55-81.

Shrestha RL (2002) Critical stage of boron application on the seed development and quality of bush snap bean (*Phaselous vulgaris* L). M. Sc. Thesis. University of The Philippines, Los Banos. 34p.

Singh J, Kumar S and Dhingra KK (1997) Effect of nitrogen and plant population levels on yield and yield attributes of raya (*Brassica juncea*). J. Res. Punjab agric. Univ. 34(3): 271-274.

Tandon HLS (2000) PPIC-IP Workshop on "Review and Refinement of fertilizer Recommendation for major crops of west Bengal.

Thapa U and Maity TK (2004) Influence of nitrogen, phosphorus and number of cutting on seed yield of fenugreek (*Trigonella foenum-graecum* L.). Seed Research. 32(1): 33-35.