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Seed Yield and Quality of Broccoli as Affected by Different Levels of Nitrogen and Boron, and Main Head Harvesting in Plain Areas of Chitwan

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Abstract

A study was conducted during the winter season of 2011/12 to find out the suitable measures for quality seed production of broccoli cv. Calabrese. The experiment was laid out in three factorial RCBD with three replications. Treatments consisted of four levels of nitrogenous fertilizer viz. 100, 150, 200, 250 kg ha^{-1} N, two levels of Boron viz. 15 kg ha^{-1} borax and no borax, two levels of head harvesting viz. head harvest at marketable stage and no head harvest. The results revealed that nitrogen levels, application of boron and head harvest significantly influenced the seed yield of broccoli. The highest seed yield (1296 kg ha^{-1}) was obtained with 200 kg ha^{-1} N applied along with 15 kg ha^{-1} borax and main head harvesting. The seed quality parameters like test weight, germination percent and vigor index were also influenced by treatments. Significantly higher test weight was obtained with 200 kg ha^{-1} N, borax @ 15 kg ha^{-1} and head harvesting. Similarly, germination percent and vigor index of seed were significantly higher with 150- 200 kg ha^{-1} N application, borax @ 15 kg ha^{-1} and harvesting of main head. Comparing these treatments nitrogen 200 kg ha^{-1} along with borax 15 kg ha^{-1} and main head harvesting was found superior and economical for seed production of broccoli with B:C ratio of 4.79

Keywords: Nitrogen, Boron, Head harvesting, Seed yield, Seed quality

Introduction

Broccoli, 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. 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. Quality seed is the basic for increasing production and productivity of broccoli sprouts as well as seeds. Nitrogen is the essential element most frequently deficient in soils around the world. Nitrogen deficiency in an early stage of development inhibits vegetative growth, reduces productivity through lower leaf area index and shortens the period of photosynthetic activity (Kappen *et al*., 1998). 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 is essential for plant growth and development. Seed quality includes seed chemical composition, vigor and viability. Seed quality is greatly influenced by the concentration of boron in the seed. Boron plays an important role in the pollination, flower initiation, fertilization and fruit setting. Sufficient yield reduction can occur without expression of any symptoms during prior to vegetative growth in some species (Noppakoonwong *et al.,* 1997). It has been reported that the heads in the axil of the leaves develop strongly, especially after the removal of the terminal head (Chatterjee, 1986) and is a recommended practice for broccoli. It was observed that when apical head is removed then side heads produce profuse seeds (Firoz *et al*., 2000). Removing the terminal head or axillaries heads yielded equally good seed as compared to heads not removed (Ghimire *et al*., 1993). However, information on the influence of boron, main head harvesting and different dose of nitrogen on seed yield and its quality in broccoli is very scanty. Hence this study was to assess the effect of nitrogen, boron and main head harvesting on yield and quality of broccoli seeds in the plain areas of Chitwan.

Materials and Methods

A study was conducted in vegetable block of IAAS, Rampur, Chitwan during the winter season, 2011/12 to find out the suitable measures for quality seed production of broccoli (*Brassica oleracea* var. *Italica*) cv. Calabrese. The experiment was laid out in three factorial Randomized Complete Block Design (RCBD) with three replications. Treatments consisted of four levels of nitrogenous fertilizer viz. 100, 150, 200, 250 kg ha^{-1} N, two levels of Boron viz. 15 kg ha^{-1} borax and no borax, two levels of head harvesting viz. head harvest at marketable stage and no head harvest. There were 25 plants in each experimental plot which were spaced at 60cm × 60cm. There were five rows in each plot, each row containing five plants. The size of individual plot was 9 m^2 (3m × 3m). The plot between the treatments was separated by 0.5m and the replication was separated by 1m. Observations were taken regarding yield attributing characters, yield parameters, seed quality parameters and B:C ratio was calculated. Analysis of variance (ANOVA) was used to test differences among the treatments and means were separated using Duncan's multiple range test (DMRT) at the 5 % level of significance.

Results and Discussion

Effect of Nitrogen, Boron and Main head harvesting on Seed yield per ha

Effect of nitrogen on Seed yield was highly significant. The significantly highest seed yield (750.20 kg ha^{-1}) was recorded in treatment receiving 200 kg ha^{-1} N. All other treatments were at par (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 highly significant. Higher seed yield (809.75 kg ha^{-1}) was recorded in the treatment receiving 15 kg ha^{-1} borax as compared to seed yield of 307.38 kg ha^{-1} in the treatment which did not receive borax (Table 1).

Similarly, the effect of main head harvesting at marketable stage on Seed yield was highly significant. Higher seed yield (701.60 kg ha^{-1}) was recorded with head harvest as compared to 415.52 kg ha^{-1} with no head harvest (Table 1). The lower seed yield obtained from no head harvested treatment could be due to poor aeration, poor pollinator movement, more competition of the branches for food, water, light etc. as there were more number of branches in this treatment (Dawadi, 2005). Seed yield in the present study was found lower than those reported by Ghimire *et al*., 1993, Firoz *et al*., 2000 and Dawadi, 2005. Lower seed yield could be due to late planting and also hailstone at the time of harvesting causing loss to the crop to some extent.

Interactive effect of nitrogen and boron on seed yield per ha of broccoli

The results showed that the interactive effect of nitrogen and boron on Seed yield of broccoli was highly 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 1054 kg ha^{-1} was recorded when 200 kg ha^{-1} N along with 15 kg ha^{-1} borax was applied (Table 2). The treatment receiving 100, 150 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 avaibility 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).

Interactive effect of Nitrogen and Main head harvesting at marketable stage on Seed yield of broccoli

Interactive effect of Nitrogen and Main head harvesting at marketable stage on seed yild was highly significantly. With the head harvest the application of 200 kg ha^{-1} N gave the highest seed yield (1014.1 kg ha^{-1}) (Table 3). The other nitrogen treatments along with main head harvest did not differ significantly. Seed yield was always higher with head harvest along with different nitrogen doses as compared to no head harvest.

Interactive effect of Boron and Main head harvesting at marketable stage on Seed yield of broccoli

Interactive effect of Boron and Main head harvesting on Seed yield was highly significant. The highest seed yield (926.9 kg ha^{-1}) was obtained where there was main head harvesting and borax application @ 15 kg ha^{-1}. The lowest seed yield (138.4 kg ha^{-1}) was recorded in the treatment combination of without head harvest and without boron (Table 4).

Interactive effect of Nitrogen, Boron and Main head harvesting at marketable stage on Seed yield of broccoli

Interactive effect of Nitrogen, Boron and Main head harvesting at marketable stage on Seed yield of broccoli was found highly significant. The results showed that without application of boron and no head harvesting, the effect of nitrogen treatments was at par; while without boron but with head harvest the effect of nitrogen was significant. The significantly highest seed yield (1296 kg ha^{-1}) was recorded with the combined application of borax 15 kg ha^{-1}, nitrogen 200 kg ha^{-1} and main head harvesting (N3B1H1) of broccoli. It was followed by N2B1H1, N1B1H1 and N4B1H1 viz. 881.6, 798.2 and 731.5 kg seed yield ha^{-1} (Table 5). The highest seed yield in N3B1H1 may be attributed to proper functioning of the both nutrients as well as less competition among the flowering branches for light, space, nutrients, pollinators etc.

Interactive effect of Nitrogen and Boron Germination percentage of broccoli

Interactive effect of nitrogen and boron on Germination percentage was highly significant. Higher germination percentage (86.50%) was recorded with 200 kg ha^{-1} N along with borax 15 kg ha^{-1} while lower germination percentage (49.83%) was recorded with 250 kg ha^{-1} N along without borax which was at par with 100 kg ha^{-1} N and without borax (Table 6).

Interactive effect of Nitrogen and Boron on Vigor index of broccoli

The interactive effect of nitrogen and boron on Vigor index of broccoli was significant. Treatment receiving 200 kg ha^{-1} N along with borax 15 kg ha^{-1} produced higher vigor (1003.0) while treatment receiving 250 kg ha^{-1} N along with no borax produced low vigor (512.6) which was at par with treatment receiving 100 kg ha^{-1} N along with no borax (Table 7). Result showed that application of borax 15 kg ha^{-1} produced higher vigor as compared to no application of borax.

Benefit cost ratio

Financial analysis revealed that combination of nitrogen 200 kg ha^{-1} along with 15 kg borax ha^{-1} and main head harvest at marketable stage was found superior over other treatments with regard to net profit and benefit cost ratio (4.79) followed by nitrogen 150 kg ha^{-1} + borax 15 kg ha^{-1} + main head harvest at marketable stage (3.02). The lowest B: C ratio was found with combination of nitrogen 100kg ha^{-1} + no borax + no head harvest (-0.53).

Conclusion

The present study showed that the application of 200 kg N and 15 kg borax ha^{-1} and head harvesting resulting into the highest number of flowering branches, seed yield and good quality seeds with high B:C ratio. The application of 100 kg N and without borax and head harvest at marketable stage gives lowest B:C ratio. Thus, from this study it can be concluded that in plain areas of Nepal where the small farmers have interest in seed production of broccoli can produce seed of broccoli with the application of 200 kg N and 15 kg borax ha^{-1} and main head harvesting at marketable stage for obtaining better yield and quality of broccoli seeds and higher net profit as well.

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Table 1: Effect of Nitrogen, Boron and Main head harvesting on Seed yield per ha of broccoli in the plain areas of Chitwan 2011/2012

Treatments	Seed yield (kg ha^{-1})
Nitrogen levels	
N1 (100 kg ha^{-1})	448.06b
N2 (150 kg ha^{-1})	548.76b
N3(200 kg ha^{-1})	750.20a
N4(250 kg ha^{-1})	487.24b
sEm	38.24
LSD	110.5**
Boron levels	
B0 (No Borax)	307.38b
B1 (Borax@ 15 kg ha^{-1}	809.75a
sEm	27.04
LSD	78.12**
Harvesting levels	
H0 (No harvesting of main head)	415.52b
H1 (Harvesting of main head at marketable stage)	701.61a
sEm	27.04
LSD	78.12**
Grand mean	558.56
CV (%)	23.72

Note: Treatment means followed by common letter (s) are not significantly different from each other based on DMRT at 5% level of significance

Table 2: Interactive effect of Nitrogen and Boron Seed yield of broccoli in the plain areas of Chitwan 2011/2012

Treatments	Seed yield (kg ha^{-1})	
	Boron levels	
Nitrogen levels	B0	B1
N1 (100 kg ha^{-1})	235.4e	660.8c
N2 (150 kg ha^{-1})	263.2e	834.3b
N3(200 kg ha^{-1})	446.9d	1054a
N4(250 kg ha^{-1})	284.1e	690bc
sEm	54.093	
LSD	156.2**	
Grand mean	558.569	
CV%	23.72	

Note: Treatment means followed by common letter (s) are not significantly different from each other based on DMRT at 5% level of significance B0: No borax B1: Borax @ 15 kg ha^{-1}

Table 3: Interactive effect of Nitrogen and Main head harvesting at marketable stage on Seed yield of broccoli in the plain areas of Chitwan 2011/2012

Treatments	Seed yield (kg ha^{-1})	
	Harvesting levels	
Nitrogen levels	H0	H1
N1 (100 kg ha^{-1})	309.6d	586.5b
N2 (150 kg ha^{-1})	471.0bcd	626.5b
N3 (200 kg ha^{-1})	486.5bc	1014.0a
N4 (250 kg ha^{-1})	395.0cd	579.5b
sEm	54.09	
LSD	156.2**	
Grand mean	558.56	
CV%	23.72	

Note: Treatment means followed by common letter (s) are not significantly different from each other based on DMRT at 5% level of significance H0: No main head harvesting H1: Main head harvesting B0: No borax B1: Borax @ 15 kg ha^{-1}

Table 4: Interactive effect of Boron and Main head harvesting at marketable stage on Seed yield of broccoli in the plain areas of Chitwan 2011/2012

Treatments	Seed yield (kg ha^{-1})	
	Boron levels	
Harvesting levels	B0	B1
H0	138.4d	476.3c
H1	692.6b	926.9a
sEm	38.25	
LSD	110.5**	
Grand mean	558.56	
CV%	23.72	

Note: Treatment means followed by common letter (s) are not significantly different from each other based on DMRT at 5% level of significance H0: No main head harvesting H1: Main head harvesting B0: No borax B1: Borax @ 15 kg ha^{-1}

Table 5: Interactive effect of Nitrogen, Boron and Main head harvesting at marketable stage on Seed yield of broccoli in the plain areas of Chitwan, 2011/2012

Treatments	Seed yield (kg ha^{-1})			
	Boron levels			
	B0		B1	
	Harvesting Levels			
Nitrogen levels	H0	H1	H0	H1
N1 (100 kg ha^{-1})	95.90g	347.8ef	523.4cde	798.2b
N2 (150 kg ha^{-1})	154.9fg	371.5ef	787.0b	881.6b
N3(200 kg ha^{-1})	162.2fg	731.5bc	810.8b	1296.0a
N4(250 kg ha^{-1})	140.7fg	427.5de	649.3bcd	731.5bc
sEm	76.50			
LSD	220.9**			
Grand Mean	558.569			
CV%	23.72			

Note: Treatment means followed by common letter (s) are not significantly different from each other based on DMRT at 5% level of significance H0: No main head harvesting H1: Main head harvesting B0: No borax B1: Borax @ 15 kg ha^{-1}

Table 6: Interactive effect of Nitrogen and Boron Germination % of broccoli in the plain areas of Chitwan 2011/2012

Treatments	Germination %	
	Boron levels	
Nitrogen levels	B0	B1
N1 (100 kg ha^{-1})	52.72d	76.83b
N2 (150 kg ha^{-1})	68.17c	78.50b
N3(200 kg ha^{-1})	64.00b	86.50a
N4(250 kg ha^{-1})	49.83d	79.33b
sEm	1.80	
LSD	5.19**	
Grand mean	69.48	
CV%	6.36	

Note: Treatment means followed by common letter (s) are not significantly different from each other based on DMRT at 5% level of significance B0: No borax B1: Borax @ 15 kg ha^{-1}

Table 7: Interactive effect of Nitrogen and Boron on Vigor index of broccoli in the plain areas of Chitwan 2011/2012

Treatments	Vigor index	
	Boron levels	
Nitrogen levels	B0	B1
N1 (100 kg ha^{-1})	551.1d	809.8b
N2 (150 kg ha^{-1})	711.4bc	827.5b
N3(200 kg ha^{-1})	619.6cd	1003.0a
N4(250 kg ha^{-1})	512.6d	782.5b
sEm	37.71	
LSD	108.6*	
Grand mean	727.24	
CV%	12.70	

Note: Treatment means followed by common letter (s) are not significantly different from each other based on DMRT at 5% level of significance B0: No borax B1: Borax @ 15 kg ha^{-1}