Seed Res., Vol. 41(1): 56-62 June 2015

Effect of head decapitation and planting density on seed production in sprouting broccoli

D.K. MEHTA*, TARUN SINGH, H.S. KANWAR, SEEMA THAKUR[1] AND K.S. THAKUR[2]

Seed Technology and Production Centre, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh 173 230

devinder1971@gmail.com

ABSTRACT A study was carried out during Rabi 2010-11 to evaluate the effect of head decapitation and planting density on growth, seed yield and quality of sprouting broccoli (*Brassica oleracea*) cultivar 'Green Head'. The twenty treatments comprised of combinations of four head decapitation methods *viz.*, D_1 (decapitation of primary head at appearance and harvesting seeds from secondary heads), D_2 (decapitation of primary head at marketable stage and harvesting seeds from secondary heads), D_3 (removal of secondary heads at appearance and harvesting seeds primary head) and 'D_4' (No decapitation- control) and five planting densities *viz.*, S_1 (60x60 cm), S_2 (60x45 cm), S_3 (45x45 cm), S_4 (60x30 cm), and S_5 (45x30 cm). Decapitation of primary head at appearance and harvesting seeds from secondary heads (D_1) and planting density S_3 (45x45 cm) independently as well as in combination has given highest seed yield per hectare. This combination was also found to be comparable with best combination for other characters like days to 50% flowering, days to harvesting, plant height at maturity (cm), number of branches per plant, number of siliqua per plant, siliqua length (cm), number of seeds per siliqua and seed quality parameters. Therefore, it is suggested that decapitation of primary head at appearance and harvesting seeds from secondary heads (D_1) in combination with plant spacing of 45x45 cm *i.e.* D_1S_3 should be recommended for seed production of sprouting broccoli.

Key words: Head decapitation, planting density, seed yield, quality

Sprouting broccoli (*Brassica oleracea* L. var. italica) is one of the important crop among this cole crops. It has not gained popularity with Indian farmers till early nineties despite having nutritional importance and high demand in super market. It is an excellent source of vitamin C, folic acid, sulforaphane glucosinolate (SGS) which is considered as anticancerous. Broccoli requires cool climate tolerate frost conditions. However, the best quality sprouts are produced in the sunny weather and light frost during night. A period of comparatively low temperature chilling is not essential for the seed production of sprouting broccoli as in case of cabbage. The process of flowering in sprouting broccoli starts at low temperature but pollination and seed setting will not occur until the average daily temperature goes above 15°C [1]. Hence, quality seed production of broccoli can be done at an elevation of 1000 - 1200 m above mean sea level *i.e.* Srinagar valley (Jammu and Kashmir), upper part of Kullu valley, Kalpa valley, Kinnaur, Saproon valley of Solan in Himachal Pradesh; Kumaon hills of Uttrakhand, Kalimpong and Darjeeling hills of West Bengal.

Methods of seed production and planting density are two important factors which affect the quantity of seed and quality produced. In broccoli *in situ* method of seed production is followed like in cauliflower as transplanting method is not successful in these crops unlike in cabbage where mostly transplanting method is performed. In cauliflower to facilitate bolting, different curd cutting methods like scooping, half curd cutting and curd pruning are recommended. These practices have impact on branching, seed yield and quality [4]. However in sprouting broccoli no such practices is to improve the availability seed quality.

*Corresponding author

Presently working as Asstt. Scientist, Vegetable Research Station, Kalpa, Kinnaur (HP)

Received: October 2012 Revised: April 2013 Accepted: June 2013

Planting density also play an important role in quantity and quality of seed produced, thereby affecting the economics of seed production. Thus, keeping in view the above facts the present study was planned with the objective to study the individual and combined effect of head decapitation and planting density on seed yield and quality in sprouting broccoli.

MATERIALS AND METHODS

The experiment was laid out in Randomized Block Design (factorial) with three replications at experimental farm and laboratory of the Seed Technology and Production Centre, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, HP during winter season of 2010-11. The twenty treatments comprised of combinations of four head decapitation methods *viz.*, D_1 (decapitation of primary head at appearance and harvesting seeds from secondary heads), D_2 (decapitation of primary head at marketable stage and harvesting seeds from secondary heads), D_3 (removal of secondary heads at appearance and harvesting seeds from primary head) and D_4 (No decapitation as control) and five planting densities *viz.*, S_1 (60x60 cm), S_2 (60x45 cm), S_3 (45x45 cm), S_4 (60x30 cm), and S_5 (45x30 cm). The observations were recorded on days to 50% flowering, days to harvesting, plant height at maturity (cm), number of branches per plant, number of siliqua per plant, siliqua length (cm), number of seeds per siliqua, seed yield per plant (g), seed yield per hectare (q), 1000 seed weight (g), germination (%), seedling length (cm), seedling dry weight (mg), seed vigour index-I and II.

RESULTS AND DISCUSSION

Growth parameters

Days to 50% flowering and days to maturity are important indicators of early maturity where as taller plants are considered to be desirable because they lead to more number of branches which ultimately bear more number of siliqua resulting in increased seed productivity in sprouting broccoli. In the present study most of these traits were significantly affected by different head decapitation methods, planting densities and their interaction (Table 1). The individual effects showed that removal of secondary heads at appearance resulted in early flowering and subsequently early maturity where as pinching of main head at formation or at full marketable stage resulted in delay in flowering and seed harvesting. Scharawat *et al.* [5] obtained similar results in marigold. They reported that pinching increased the number of days to 50% flowering and flowering duration. Removal of secondary heads at appearance also resulted in more plant height where as control *i.e.*, no decapitation gave maximum number of branches per plant. As compared to other decapitation the main effect of planting density showed that the wider spacing resulted in early flowering, early seed harvesting and more number of branches per plant, whereas, its effect on plant height was found to be non-significant. This might be due to the fact that at wider spacing had more penetration of light and less competition for nutrients and moisture among the plants thereby increasing the chances of early flowering and seed maturity as well as more number of branches per plant. These results are in line with findings of Chatterjee [6] in cauliflower. The interaction effects of head decapitation and planting density was found to be non- significant for days to 50% flowering and days to seed harvesting where as tallest plants were obtained in D_3S_2 (removal of secondary heads at appearance with spacing 60 x 45 cm) which was at par with D_3S_4, D_2S_1, D_3S_5, D_3S_3 and D_3S_1. Maximum number of branches per plant was obtained in D_4S_2 (control with spacing 60 x 45 cm) which was at par with D_4S_4 and D_4S_3.

Seed yield and contributing parameters

Seed yield and yield contributing characters play an important role in the profitability and

Table 1. Effect of head decapitation and planting density on growth characters in sprouting broccoli cv. Green Head.

Treatments	Characters			
	Days to 50% flowering	Days to seed maturity	Plant height at maturity	No. branches per plant
Head Decapitation methods (D)				
D_1 (Decapitation of primary head at appearance)	145.40	205.53	67.25	11.57
D_2 (Decapitation of primary head at marketable stage)	152.67	209.13	70.16	11.91
D_3 (Removal of secondary heads at appearance)	141.73	200.13	76.13	7.81
D_4 (Control - Untreated)	144.47	20.6.07	69.32	13.85
CD at 5%	**1.21**	**0.81**	2.34	0.99
Planting Density (S)				
S_1 (60x60)	144.17	203.92	70.18	12.26
S_2 (60x45)	144.75	204.75	70.35	12.27
S_3 (45x45)	145.25	204.92	69.66	11.28
S_4 (60x30)	146.67	205.67	71.43	10.70
S_5 (45x30)	149.50	206.84	71.95	9.92
CD at 5%	**1.36**	**0.90**	**NS**	**1.11**
Interaction (DxS)				
$D_1 S_1$	144.00	204.00	60.07	12.03
$D_1 S_2$	144.33	205.00	64.00	12.00
$D_1 S_3$	145.00	205.00	70.13	11.87
$D_1 S_4$	146.00	206.00	72.00	11.06
$D_1 S_5$	147.67	207.67	70.07	10.90
$D_2 S_1$	150.00	208.00	76.40	13.20
$D_2 S_2$	150.67	208.67	70.47	13.03
$D_2 S_3$	152.67	209.00	66.33	11.80
$D_2 S_4$	153.67	209.33	67.47	11.53
$D_2 S_5$	156.33	210.67	70.13	9.97
$D_3 S_1$	140.00	198.00	74.60	8.93
$D_3 S_2$	140.33	199.33	78.73	8.47
$D_3 S_3$	139.67	200.33	74.87	7.87
$D_3 S_4$	143.33	201.00	76.73	6.93
$D_3 S_5$	145.33	202.00	75.73	6.87
$D_4 S_1$	142.67	205.67	69.67	14.87
$D_4 S_2$	143.67	206.00	68.20	15.60
$D_4 S_3$	143.67	205.33	67.33	13.60
$D_4 S_4$	143.67	206.33	69.53	13.27
$D_4 S_5$	148.67	207.00	71.87	11.93
CD at 5%	**NS**	**NS**	**5.24**	**2.21**

quality of seed production in sprouting broccoli. In the present study most of these characters were significantly affected by head decapitation methods and different planting densities (Table 2). Number of siliqua per plant, which contributes directly towards the higher seed yield in sprouting broccoli, was maximum in D_1 *i.e.*, decapitation of primary head at appearance. The pinching is known to accumulate more photo-synthates which are utilized for production of more number of flower bearing branches and more number of flowers per plant [7]. The maximum siliqua length and number of seeds per siliqua was obtained in D_3 due to the removal of secondary heads at appearance which was at par with D_1 for both the characters. However, D_3 had significantly lowest number siliqua per plant. The results showed that number of siliqua per plant and siliqua length is inversely related to each other, whereas siliqua length and number of seeds per siliqua are positively related to each other. The main effect of head decapitation also revealed that highest seed yield per plant or per hectare was significantly highest in D_1 as compared to all other decapitation methods. The increase in yield over control *i.e.*, no decapitation D_4 was 18.34 %. Mihov and Antonova [7] concluded that decapitation of central flower head has the strongest effect on the individual plant seed productivity and in this way the seed yield is increased by several times in broccoli. However, these results are opposite with the findings of Elyazied *et al.* [8]. They obtained highest seed yield with pinching the main head at marketable stage. Sukthong [9] also concluded that the best seed production techniques in broccoli were either no thinning or selecting fifteen best inflorescences after a thinning treatment.

The effect of planting density showed that in general number of siliqua per plant, siliqua length and number seeds per siliqua increased with decrease in planting density (Table 2). At wider spacing more pods setting and more number seeds per pod may be there due to better pollination by honey bees and less competition amongst plants for nutrient and light. Das *et al.* [10] also recorded highest seed yield per hectare with 45x45 cm plant spacing in cauliflower. Sharma [11] reported maximum number of siliqua per plant at wider spacing in Chinese cabbage. The highest seed yield per plant was obtained at widest spacing of 60 x 60 cm (S_1) where as spacing of 45 x 45 cm (S_3) closely followed by 60 x 30 cm (S_4) gave highest seed yield per plot and per hectare. The increase in yield over recommended spacing of 60 x 45 cm (S_2) was 23.65 % and 15.66 %, respectively.

The interaction effect of head decapitation and planting density showed that decapitation of primary head at appearance under wider spacing resulted in more number of siliqua per plant, siliqua length, number seeds per siliqua and seed yield per plant.However, the highest seed yield per plot and per hectare was recorded in D_1S_3 (decapitation of primary head at appearance with spacing 45 x 45 cm), which was at par with D_1S_4 (decapitation of primary head at appearance with spacing 60 x 30 cm). The increase in seed yield over control (no decapitation and 60 x 45 cm spacing) was 35.60 % and 31.31%, respectively. The higher seed yield per hectare obtained with of D_1S_3 might be due decapitation of primary head at appearance resulting in more number of productive flowering branches and pod number per plant while planting at optimum spacing contributed to higher seed yield per unit area.

Seed quality parameters

Test weight, germination and vigour are important parameters which determine the physiological quality of seeds. When environmental conditions in the field are close to ideal for a crop, field emergence will correlate well with germination. However, in practice, optimum field conditions are not often encounter and environmental stress can lead to varying field performance depending

Table 2: Effect of head decapitation and planting density on seed yield and contributing characters in sprouting broccoli cv. Green Head

Treatments	Characters				
	No. of Siliqua per plant	Siliqua length (cm)	No. of seeds per siliqua	Seed yield per plant (g)	Seed yield per ha (q)
Head Decapitation methods (D)					
D_1 (Decapitation of primary head at appearance)	994.73	4.82	12.05	35.23	11.42
D_2 (Decapitation of primary head at marketable stage)	771.8	4.04	9.76	21.54	6.90
D_3 (Removal of secondary heads at appearance)	573.27	4.94	12.4	23.97	8.38
D_4 (Control - Untreated)	876.87	4.43	10.68	30.52	9.65
CD at 5%	**119.56**	**0.19**	**0.68**	**3.37**	**0.95**
S_1 (60x60)	964.00	4.61	12.36	37.06	7.67
S_2 (60x45)	856.50	4.78	12.53	33.56	9.26
S_3 (45x45)	911.58	4.65	11.35	31.12	11.45
S_4 (60x30)	869.58	4.58	10.51	25.88	10.71
S_5 (45x30)	419.17	4.15	9.35	11.48	6.34
CD at 5%	**133.67**	**0.21**	**0.75**	**3.76**	**1.06**
Interactions (DxS)					
$D_1 S_1$	1366.33	4.44	11.10	45.63	9.45
$D_1 S_2$	950.00	4.45	14.90	43.27	11.94
$D_1 S_3$	1138.67	4.75	12.18	41.20	15.16
$D_1 S_4$	1155.00	5.80	11.23	35.47	14.68
$D_1 S_5$	363.67	4.66	10.82	10.60	5.85
$D_2 S_1$	866.00	4.71	12.08	30.27	6.27
$D_2 S_2$	857.33	4.53	11.45	27.90	7.70
$D_2 S_3$	977.33	3.49	9.12	24.30	8.94
$D_2 S_4$	728.00	3.87	8.78	17.10	7.08
$D_2 S_5$	430.33	3.61	7.37	8.13	4.49
$D_3 S_1$	701.67	4.58	11.50	28.23	5.84
$D_3 S_2$	586.33	5.38	11.52	22.57	6.23
$D_3 S_3$	615.00	5.23	12.27	25.43	9.36
$D_3 S_4$	528.00	4.89	14.62	26.03	10.78
$D_3 S_5$	435.33	4.63	12.10	17.57	9.70
$D_4 S_1$	922.00	4.73	14.78	44.10	9.13
$D_4 S_2$	1032.33	4.78	12.27	40.50	11.18
$D_4 S_3$	915.33	5.13	11.83	33.53	12.34
$D_4 S_4$	1067.33	3.78	7.40	24.90	10.31
$D_4 S_5$	447.33	3.72	7.13	9.60	5.30
CD at 5%	**267.34**	**0.42**	**1.51**	**7.53**	**2.13**

upon vigour status of the seeds. In the present studies, the head decapitation and planting density individually affected seed quality parameters significantly however their interactions for all these characters were non-significant (Table 3). The individual effect of head decapitation revealed that maximum 1000 seed weight, seed germination, seedling length, seedling dry weight, seed vigour index-I and II were maximum in D_3 (removal of secondary heads at appearance) and it was at par with D_1 for all these parameters. As discussed earlier that in D_3 there were less number of branches and siliqua per plant but siliqua length was more as compare to other decapitation methods because there is a less competition for nutrient uptake and light absorption. Hence, it appeared that weight of individual seed may be stimulated by better availability of nutrients and light. Similar results were also reported by Singh *et al.* [12] in Indian cauliflower. They obtained highest 100 seed weight, germination and vigour with scooping and side cutting of curd at half loose stage. The main effect of planting density indicated that seed quality parameters decreased with increase in planting density. The best seed quality was obtained at widest spacing of 60 x 60 cm,

Table 3. Effect of head decapitation and planting density on seed quality parameters in sprouting broccoli cv. Green Head

Treatments	Characters				
	1000 seed weight (g)	Siliqua length (cm)	No. of seeds per siliqua	Seed yield per plant (g)	Seed yield (q) per hactare
Head Decapitation methods (D)					
D_1 (Decapitation of primary head at appearance)	3.93	91.40 (9.56)	9.62	2.77	253.58
D_2 (Decapitation of primary head at marketable stage)	3.30	82.27 (9.07)	8.66	2.48	203.75
D_3 (Removal of secondary heads at appearance)	4.11	92.67 (9.63)	9.75	2.79	258.52
D_4 (Control - Untreated)	3.48	89.87 (9.48)	9.46	2.71	243.17
CD at 5%	**0.19**	**0.08**	**0.15**	**0.13**	**13.63**
S_1 (60x60)	3.87	92.00 (9.59)	9.68	2.75	252.91
S_2 (60x45)	3.75	90.50 (9.51)	9.53	2.78	252.44
S_3 (45x45)	3.69	89.08 (9.44)	9.38	2.70	240.45
S_4 (60x30)	3.60	89.17 (9.44)	9.39	2.66	237.77
S_5 (45x30)	3.50	84.50 (9.19)	8.90	2.55	215.19
CD at 5%	**0.21**	**0.09**	**0.17**	**NS**	**15.24**

NS - Non - significant
Figures in the parenthesis are transformation value

however at this spacing lowest seed yield per hectare was recorded. These findings are in-conformity to those of Mihov and Antonova [7]. They reported that wider spacing resulted in increased seed quality but gave less seed yield per unit area in broccoli. In the present study, the plant spacing of 45 x 45 cm which gave highest seed yield per unit area was also found to be satisfactory in seed quality parameters as compared to the wider spacing.

Keeping in view of the , it is concluded that head decapitation and planting density individually or in combination significantly affected the growth, seed yield and quality characters in sprouting broccoli. The head decapitation D_1 *i.e.* decapitation of primary head at appearance has strongly influenced all the growth, seed yield and quality characters in positive direction. Wider plant spacing gave better seed quality but seed yield per unit area was low. The interaction effect also revealed that highest seed yield per plot and per hectare was obtained with D_1S_3. Hence, it is suggested that decapitation of primary head at appearance and harvesting seeds from secondary heads in combination with plant spacing of 45 x 45 cm can be recommended for commercial seed production of sprouting broccoli.

REFERENCES

1. RANJAN JK, AHMED N AND PRAGY (2010). Broccoli and Brussels Sprout. In: JP Sharma (*ed.*), *Quality seed production of vegetable crops: Technological Interventions*, Vol-II: crop specific aspect, Kalyani Publishers, Ludhiana, pp: 173-89.

2. KUMAR PR, SINGHAL NC AND SINGH R (2000). Effect of different curd cutting methods on seed production of cauliflower. *Seed Res*, 28: 136-9.

3. SEHRAWAT SK, DAHIYA DS, SINGH S, RANA GS AND SINGH S (2003). Effect of nitrogen and pinching on the growth, flowering and yield of marigold (*Tagetes erecta* L.) cv. African Giant Double orange. *Haryana J Hort Sci*, **32**: 59-61.

4. CHATTERJEE R (2006). Effects of transplanting dates and spacing on seed yield and quality of cauliflower (*Brassica oleracea* var. *botrytis* L.) cv. Pusa Early Synthetic. *Seed Res*, **34**: 104-06.

5. MIHOV K AND ANTONOVA G (2009). Influence of the decapitation and plant density effect on the manifestation of reproductively in breeding broccoli lines. *Acta Horticulturae* **830**: 433-40.

6. ELYAZIED AA, SOLAIMAN MM, ELGIZAWY AM AND ELGAWAD HGMA (2007). Effects of sowing date and pinching on broccoli seed production. *Arab Uni J Agril Sci*, **15**: 123-30.

7. SUKTHONG M (2008). Influence of inflorescence thinning on seed quality and seed yield of broccoli Chinese Kale hybrid in Loei Province, Thailand. *Acta Hort*, **771:** 83-8.

8. DAS J, PHOOKAN DP AND GAUTAM BP (2000). Effect of levels of NPK and plant densities on seed production of early cauliflower (*Brassica oleracea* var. *botrytis*) cv. Pusa Katki. *Haryana J Hort Sci*, **29**: 223-4.

9. SHARMA KC (2001). Response of fertility and spacing on seed production of Chinese cabbage (*Brassica compestris* subsp. *pekinensis*) under North-Western Himalayas. *Ind J Agril Sci*, **71**: 608-09.

10. SINGH B, SINGH AK, PANDEY S AND RAI M (2005). Effect of curd cutting techniques at different curd stages on seed production in Indian cauliflower (*Brassica oleracea* var. *botrytis* L.). *Veg Sci*, **32**: 180-1.