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THE IMPACT OF GIBERELLIC ACID AND DIFFERENT DECAPITATION METHODS ON SEED YIELD OF BROCCOLI

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ABSTRACT

The present investigation was conducted during the *rabi* season of 2021-22 and 2022-23 in the Experimental farm, Department of Horticulture, College of Agriculture, Assam Agricultural University, Jorhat. The experiment was laid out in a Randomized Block Design (factorial) with three replications. The sixteen treatments comprised combinations of four different concentrations of GA_3 *viz*., G_0 (0 ppm), G_1 (25 ppm), G_2 (50 ppm) and G_3 (75 ppm) and four different head decapitation methods *viz*., D_1 (decapitation of the primary head at appearance), D_2 (decapitation of the primary head at the marketable stage), D_3 (decapitation of the secondary heads at appearance) and D_0 (control). Among GA_3 treatments, GA_3@50ppm GA_3 was applied as seedling root dip treatment for 24 hours before transplanting was found to be the best in producing highest seed yield per plant (4.24 g/plant) and seed yield per hectare (1.59 q/ha). While among different decapitation methods, D_1 (Decapitation of primary head at appearance resulted the highest seed yield per plant (4.19 g) and seed yield per hectare (1.98 q ha^{-1}). Therefore, it is suggested that decapitation of the primary head at appearance (D_1) can be recommended for commercial seed production of broccoli. Moreover, the interaction effect of G_2D_1 (GA_3 @50 ppm and decapitation of the primary heads at appearance) recorded highest seed yield per plant (5.42 g) and seed yield per hectare (235.49 kg). Therefore, it can be concluded that root dip treatment of broccoli seedlings with 50ppm GA_3 and with decapitation of broccoli head at appearance was found to be the best for producing highest seed yield of broccoli.

Keywords **:** Broccoli, seed production, decapitation, GA_3

Introduction

Broccoli (*Brassica oleracea* var. *italica* L) is a nutritious vegetable that belongs to the family Brassicaceae. Broccoli is mostly cultivated in hilly areas of Himachal Pradesh, Uttar Pradesh, Jammu and Kashmir, the Nilgiri Hills, and the Northern Plains of India. (Chadha, 2001). For seed purposes, the head is allowed to mature, which turns from green to yellow flowers with four sepals, four petals, six stamens, and a bilocular superior ovary. The fruit of broccoli is called siliqua, also called a pod, which contains the seeds. Broccoli is a cross-pollinated crop, and honeybees are the primary pollinators. It is propagated through seeds; hence, quality seed is the basic need for increasing the production of the crop. With the increasing global demand for broccoli, there is a growing need to ensure a consistent supply of high-quality seeds to support its cultivation. However, the main production problems are the lack of availability of high-quality seeds, the low yield, and the short shelf life of the crop. The adoption of high-quality seeds is imperative since the evidence shows that low seed quality affects the vigour of the plantlets, reducing productivity. Methods of decapitation for seed production and the application of an optimum concentration of GA_3 are two important factors that affect the quality and quantity of seed produced in cole crops. GA_3 application encounters the worst effect of high temperature and increases the pod set per cent and other seed yield attributes, including seed quality. In broccoli, not much research has been

done on the effect of decapitation and the application of GA_3 on seed production. So, keeping in view the above points, the present study was undertaken.

Materials and Methods

The present investigation entitled "Effect of decapitation and Gibberellic acid on seed production of broccoli (*Brassica oleracea* var. *italica* L.)" was conducted at Experimental Farm, Department of Horticulture, College of Agriculture, Assam Agricultural University, Jorhat during 2021-22 and 2022-23. The field experiment plot was laid out in a factorial randomized block design and consisted of three replications. There were 16 treatment combinations.

Factor 1: Gibberellic acid application (ppm)

G_0 (Control), G_1 (25 ppm), G_2 (50 ppm) and G_3(75 ppm) Seedling root dip treatment was done in above mentioned different concentrations of GA_3 for 24 hours before transplanting.

Factor 2: Decapitation methods

D_0 (No decapitation), D_1 (Decapitation of the primary head at appearance and harvesting seeds from secondary heads), D_2 (Decapitation of the primary head at marketable stage and harvesting seeds from secondary heads), D_3 (Removal of the secondary heads at appearance and harvesting of seeds from the primary head)

Treatment includes 16 different combinations viz., G_0D_0 (Control), G_0D_1 (GA_3 0 ppm and decapitation of the primary head at appearance), G_0D_2 (GA_3 0 ppm and decapitation of the primary head at maturity), G_0D_3 (GA_3 0 ppm and decapitation of the secondary head at appearance), G_1D_0 (GA_3 25 ppm and no decapitation), G_1D_1 (GA3 25 ppm and decapitation of the primary head at appearance), G_1D_2 (GA_3 25 ppm and decapitation of the primary head at maturity), G_1D_3 GA_3 25 ppm and decapitation of the secondary head at appearance), G_2D_0 (GA_3 50 ppm and no decapitation), G_2D_1 (GA_3 50 ppm and decapitation of the primary head at appearance), G_2D_2 (GA_3 50 ppm and decapitation of the primary head at maturity), G_2D_3 (GA_3 50 ppm and decapitation of the secondary head at appearance), G_3D_0 (GA_3 75 ppm and no decapitation), G_3D_1 (GA_3 75 ppm and decapitation of the primary head at appearance), G_3D_2 (GA_3 75 ppm and decapitation of the primary head at maturity), G_3D_3 (GA_3 75 ppm and decapitation of the secondary head at appearance).

The experimental plot was ploughed thrice by a tractor-drawn disc plough up to a depth of 20 cm. Then the field was harrowed and leveled. The field was divided into subplots as per the layout of the experiment and then plots were made. Farmyard manure @ 200 quintals per hectare was applied as a basal dose and mixed thoroughly with the soil.

FYM@ 10 tha^{-1} was applied at the time of field preparation. Fertilizer in the form of urea, single super phosphate, and muriate of potash at the rate of 100 kg N, 75 kg P_2O_5, and 50kg K_2O per hectare was applied. The total amount of P and K was applied as a basal dose, nitrogen in two split doses, and the remaining 50 per cent was applied one month after transplanting at the time of earthing up.

Results and Discussion

Seed yield per plant

The effect of GA_3 on seed yield per plant was found to be significant. The maximum seed yield per plant (4.24 g) was obtained in G_2 (GA_3 50 ppm) which was significantly higher than all other treatments. However, the lowest seed yield per plant (3.19 g) was obtained under G_0 (Control). The main effect of head decapitation revealed that the maximum seed yield per plant (4.19 g) was obtained in D_1 *i.e*., decapitation of the primary head at appearance which was found significantly superior to other treatments. However, the lowest seed yield per plant (3.59 g) was obtained in D_2 *i.e*., decapitation of the primary head at full marketable stage. Firoz *et.al.* (2000) and Khanal *et.al*. (2014) reported that head removal produced higher seed yield attributes and seed yield of broccoli as compared to those without head removal. The increase in seed yield and yield parameters of pinched plants was mainly because of the production of more side branches which ultimately resulted in a higher number of pods per plant, seeds per pod, and thus seed yield.

The interaction between G_2D_1 (GA_3 50ppm and decapitation of the primary head at the time of appearance) resulted in the highest seed yield per plant (5.42 g) which was followed by (5.19 g) in G_2D_3 (GA_3 50 ppm and decapitation of secondary head at appearance). More siliquas, more seeds per siliqua and high thousand seed weight etc. contribute to high seed yield per plant. While the lowest (3.61g) was observed under G_0D_2 (GA_3 50 ppm and decapitation of secondary head at appearance). The findings are in line with those of Chauhan and Tandel (2010) in cabbage and Ghoname *et al.* (2011) in carrots.

Table 1 : Seed yield per plant (g)

GA_3 treatment	21-22	22-23	Pooled
G_0	4.05	2.33	3.19
G_1	4.21	2.98	3.60
G_2	5.09	3.40	4.24

G_3	4.83	2.64	3.73
S Ed (±)	0.12	0.11	0.13
C.D.at 5%	0.26	0.22	0.27
Decapitation treatment	**21-22**	**22-23**	**Pooled**
D_0	4.94	2.81	3.88
D_1	5.02	3.37	4.19
D_2	4.32	2.82	3.57
D_3	4.38	3.21	3.79
S Ed (±)	0.25	0.37	0.26
C.D.at 5%	0.52	0.76	0.53
GA_3 x Decapitation	**21-22**	**22-23**	**Pooled**
G_0D_0	4.38	3.91	4.14
G_0D_1	4.22	3.70	3.96
G_0D_2	4.22	3.01	3.61
G_0D_3	4.32	3.87	4.09
G_1D_0	4.12	3.33	3.72
G_1D_1	4.18	3.83	4.01
G_1D_2	4.81	3.09	3.95
G_1D_3	5.17	3.51	4.34
G_2D_0	5.12	3.73	4.42
G_2D_1	6.07	4.77	5.42
G_2D_2	4.52	2.86	3.69
G_2D_3	5.67	4.70	5.19
G_3D_0	4.09	4.06	4.07
G_3D_1	4.34	4.38	4.36
G_3D_2	4.95	4.72	4.84
G_3D_3	4.60	4.36	4.48
S Ed (±)	0.25	0.23	0.24
C.D at 5%	0.51	0.47	0.49

Seed yield per hectare (q)

The maximum seed yield per hectare (1.58 q/ha) was obtained in G_2(GA_3 50 ppm) while the lowest (1.10 q/ha) was obtained in G_0(control). The main effect of head decapitation revealed that the maximum seed yield per hectare (1.98 q/ha) was obtained in D_1 i.e., decapitation of the primary head at appearance. However, the minimum seed yield per hectare (1.02 q/ha) was obtained in D_2 (Decapitation of the primary head at marketable stage). Emongor (2007) conducted an experiment on the effects of GA_3 on cowpeas. The results revealed that exogenous application of GA_3 @ 60 mg per litre and 90 mg per litre was found effective in increasing vegetative growth and nodulation in cowpeas. GA_3 @ 90 mg per litre recorded the maximum pod per plant, seeds per pod, 100 seed weight, and seed yield per hectare. The increased growth rate of plants and total seed yield in onions using GA_3 have also been reported by Passam *et al.* (2008).

The combined effect of head decapitation and GA_3 was also found significant on seed yield per hectare. The combination of G_2D_1 (GA_3 50ppm and decapitation of the primary head at appearance) resulted in the maximum seed yield per hectare (2.35 q/ha). Whereas the combination G_0D_2 (GA_3 0 ppm and decapitation of the primary head at the marketable stage) gave the lowest seed yield per hectare (1.06 q/ha).

Verma and Sharma, 2000 reported that the decapitation methods significantly affect the quantity and quality of seed produced. Similarly in the cauliflower to facilitate bolting, different curd-cutting methods are recommended which have an impact on branching, seed yield, and seed quality. Rahman *et.al.,* (1996) revealed that curd scooping had positive effects on the yield and the quality of cauliflower seeds. This might be because flower stalks produced from the scooped curd were not as compact as the no scooping and got more space which decreased competition among the flower stalks resulting in more seed yield. Monirruzaman *et al.* (2020) concluded that spraying of GA_3 at 60 ppm and main head removal at the marketable stage was found suitable for maximizing broccoli seed yield with quality seed attributes and net return.

Table 2 : Seed yield per hectare (q)

GA_3 treatment	**21-22**	**22-23**	**Pooled**
G_0	1.12	1.07	1.10
G_1	1.35	1.20	1.27
G_2	1.61	1.56	1.59
G_3	1.49	1.34	1.42
S Ed (±)	0.01	0.01	0.01
C.D at 5%	0.03	0.02	0.03
Decapitation treatment	**21-22**	**22-23**	**Pooled**
D_0	1.90	1.55	1.63
D_1	2.06	1.90	1.98
D_2	1.04	1.01	1.02
D_3	1.18	1.03	1.10
S Ed (±)	0.01	0.01	0.01
C.D at 5%	0.03	0.02	0.03
GA_3 x Decapitation	**21-22**	**22-23**	**Pooled**
G_0D_0	1.13	1.08	1.11
G_0D_1	1.44	1.29	1.37
G_0D_2	1.12	1.00	1.06
G_0D_3	1.27	1.06	1.17
G_1D_0	1.28	1.13	1.20
G_1D_1	1.69	1.55	1.62
G_1D_2	1.20	1.05	1.13
G_1D_3	1.37	1.21	1.29
G_2D_0	1.26	1.11	1.19
G_2D_1	2.43	2.28	2.35
G_2D_2	1.27	1.19	1.23
G_2D_3	1.41	1.36	1.39
G_3D_0	1.24	1.20	1.22
G_3D_1	2.27	2.12	2.19
G_3D_2	1.28	1.09	1.18
G_3D_3	1.91	1.75	1.83
S Ed (±)	0.02	0.03	0.02
C.D at 5%	0.05	0.05	0.05

Conclusion

From the present investigation, it can be concluded that the highest seed yield per plant (4.24 g) was observed in G_2 (GA_3 50ppm) and the lowest seed yield per plant (3.19 g) was recorded under G_0 (Control). The highest seed yield per plant (4.19 g) was obtained in D_1(Decapitation of the primary head at appearance) and the lowest seed yield per plant (3.57 g) was obtained in D_2 (Decapitation of the primary head at maturity). Moreover, the interaction effect showed that the maximum seed yield per plant (5.42 g) was recorded in G_2D_1 (GA_3 50ppm and decapitation of primary head at the time of appearance) and the minimum seed yield per plant (3.61g) was obtained under G_0D_2 (GA_3 0ppm and decapitation of the primary head at maturity). The highest seed yield per hectare (158.61 kg/ha) was observed in G_2 (GA_3 50ppm) and the lowest seed yield per hectare (109.53 kg/ha) was recorded under G_0 (Control). The highest seed yield per hectare (197.86 kg/ha) was obtained in D_1(Decapitation of the primary head at appearance) and the lowest seed yield per hectare (102.45 kg/ha) was obtained in D_2(Decapitation of the primary head at maturity). Moreover, the interaction effect showed that the maximum seed yield per hectare (235.49 kg/ha) was recorded in G_2D_1 (GA_3 50ppm and decapitation of the primary head at the time of appearance) and the minimum seed yield per hectare (105.90 kg/ha) was obtained under G_0D_2 (GA_3 0ppm and decapitation of the primary head at maturity). Therefore, it can be concluded that G_2 (GA_3 50ppm) and D_1(Decapitation of the primary head at appearance) individually and with interaction *viz.*, G_2D_1 (GA_3 50ppm and decapitation of the primary head at the time of appearance) can be considered as a suitable method for increasing seed production in broccoli.

Fig. 1 : Flowering stage during 2021-22

Fig. 2 : Flowering stage during 2022-23

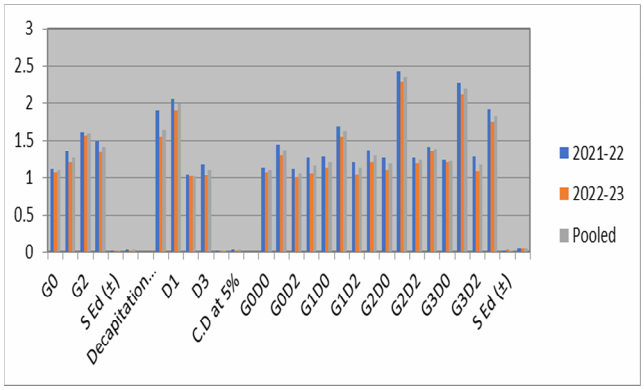

Fig. 3: Seed yield per hectare (q)

Fig. 4 : Harvested pods after drying

Fig. 5 : Seed storage in glass bottles

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