International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(5): 1372-1375

Received: 28-06-2020
Accepted: 12-08-2020

KB Barad
Department of Horticulture, College of Agriculture, Anand Agricultural University, Vaso, Gujarat, India

KM Patel
Department of Horticulture, College of Agriculture, Anand Agricultural University, Vaso, Gujarat, India

BA Jethava
Department of Horticulture, College of Agriculture, Anand Agricultural University, Vaso, Gujarat, India

Corresponding Author:
KB Barad
Department of Horticulture, College of Agriculture, Anand Agricultural University, Vaso, Gujarat, India

Effect of GA_3 and NAA on growth and yield parameters of broccoli (*Brassica oleracea var. italica*) var. Pusa KTS-1

KB Barad, KM Patel and BA Jethava

DOI: https://doi.org/10.22271/chemi.2020.v8.i5s.10492

Abstract
The present investigation was carried out on "Effect of GA_3 and NAA on growth and yield parameters of broccoli (*Brassica oleracea var. italica*) var. Pusa KTS -1" at Horticultural Research Farm, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand during *Rabi* season of the year 2019-20. The experiment was laid out in Randomized Block Design replicated thrice with nine treatments. Among all the different treatments foliar application of GA_3 50 mg/l recorded significantly, maximum plant height (52.65 cm) at 45 days ATP, plant height (67.20 cm) at harvesting time, number of leaves (27.30) at harvest, diameter of stem at harvest (46.11 mm), leaf length (33.77 cm), leaf width (24.41 cm), early curd initiation (40 days), significantly the highest curd diameter (18.93 cm), maximum main curd weight (626 g), maximum volume of curd (466 cm^3), minimum days to final harvesting (49.67), highest yield 671.67 g/plant, 19.31 kg/plot and 22.35 t/ha was found in treatment GA_3 50 mg/l.

Keywords: Broccoli, GA_3, NAA, growth and yield parameters

Introduction
Broccoli (*Brassica oleracea* L. *var. italica*), is a member of cole group originates from the Mediterranean region commonly known as Hari ghobi in Hindi. The term cole has originated from the word "Colewart'' which means wild cabbage. It is biennial and herbaceous winter vegetable crop of *Brassicacae* family and is considered as commercial crop in India (Hossain *et al*., 2011) [4]. Broccoli is related to cabbage, kale, cauliflower, and Brussels sprouts. Brassica vegetables possess both antioxidant and anti carcinogenic properties. Broccoli is known as the "Crown of Jewel Nutrition" as it is rich in vitamins and minerals. Eating large portion may also have additional benefits, since broccoli is also a rich source of many vitamins and minerals such as vitamin A and C, carotenoides, fiber, calcium and folic acid. It has about 130 times more vitamin A contents than cauliflower and 22 times than cabbage (Meena *et al.*, 2017) [7]. Among the cole crops, the sprouting broccoli is highly nutritious as compared to others. It contains carbohydrates (5.5%), protein (3.3%), VitaminA (3500 IU), Vitamin-C (137 mg), calcium (0.80 mg) and phosphorus (0.79 mg) and 0.12 mg in Vitamin-B2 (Hazra and Som, 1999) [3]. In India, Cauliflower and Broccoli is cultivated in an area of 5.69 lakh ha with an annual production of 70.60 MT and productivity of 19.05 t ha^{-1} (FAO, 2018) [2].
Plant growth regulators (PGR's) are organic compounds, other than nutrients that modify the plant physiological processes. They normally are active in low concentrations in plants (Bisht *et al.*, 2018) [1]. GA_3 exhibited beneficial effect in several cole crops by stimulating cell division or cell enlargement or both and foliar application of GA_3 provide more yield (Reza *et al*., 2015) [9-10]. The application to NAA affected the physiological processes particularly respiration and photosynthesis, which ultimately lead to accumulation of dry matter, minerals and carbohydrates (Vishwakarma *et al*., 2017) [12].

Methods and Materials
The present investigation was carried out on "Effect of GA_3 and NAA on growth and yield of broccoli (*Brassica oleracea var. italica*) var. Pusa KTS -1" at Horticultural Research Farm,

Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand during *Rabi* season of the year 2019-20.

The broccoli seeds were sown in raised bed should be prepared by addition of well rotten farmyard manure or vermicompost @ 10 kg/m^2. The field was ploughed thoroughly and then rotavated until the soil was friable and free from perennial weeds. Well-rotten farm yard manure @15-20 t ha^{-1} was incorporated at the time of final ploughing. Plots measuring 37.4 m x 18.5 m were laid out. Healthy seedlings of 30 days old were transplanted in evening hours as per the treatments. After transplanting basal dose of half of the nitrogen @ 50 kg ha^{-1}, full dose of phosphorous @ 50 kg ha^{-1} and potash @ 50 kg ha^{-1} was applied at the time of land preparation. The remaining dose of nitrogen was top dressed in two equal splits, one at 30 days after transplanting and other at curd initiation stage. Hand weeding was done at 15, 30 and 45 days after transplanting.

The experiment was laid out in Randomized Block Design replicated thrice with nine treatments *viz.*, T_1 - Absolute control, T_2 - GA_3 25 mg/l, T_3 - GA_3 50 mg/l, T_4 - GA_3 75 mg/l, T_5 – NAA 60 mg/l, T_6 – NAA 120 mg/l, T_7 – NAA 180 mg/l, T_8 – GA_3 25 mg/l + NAA 60 mg/l, T_9 - GA_3 50 mg/l + NAA 120 mg/l. Five plants were tagged randomly in each treatment of respective replication for recording data on various traits *i.e.*, plant height (cm) at 45days and at harvesting after transplanting, number of leaves per plant, stem diameter (mm), width of middle leaf (cm) and length of middle leaf (cm) at harvesting time, days of curd initiation, curd diameter (cm), average curd weight (g), curd volume (cm^3), days to final harvest, curd yield per plant (g), per plot (kg) and per hectare (t). The data pertaining to all the characters studied were subjected to the statistical analysis of variance technique as described by Panse and Sukhatma (1985) [8].

Result and Discussion

Effect on growth parametrs

Plant height

Plant height at 45 days after transplanting was significantly affected by foliar application of GA_3 and NAA. The maximum plant height (52.65 cm) was found in treatment T_3 (GA_3 50 mg/l) which, was at par with T_4 GA_3 75 mg/l *i.e.* 51.55 cm and T_7 *i.e.* 49.70 cm. The minimum plant height (37.33 cm) was observed in absolute control. Plant height at harvesting time was also significantly affected by different foliar application of GA_3 and NAA. Maximum plant height (67.20 cm) was recorded in treatment T_3 (GA_3 50 mg/l) which, was at par with T_4 *i.e.* 63.70 cm at harvesting time. Similar, results were also reported by Roy and Nasiruddin (2011) [11] in cabbage, Reza *et al.* (2015) [9-10] in broccoli, Kumar *et al.* (2017) [12] in cauliflower and Kaur and Mal (2018) [5] in cauliflower.

Number of leaves plant^{-1}

The maximum number of leaves per plant (27.30) at harvest were recorded in treatment T_3 (GA_3 50 mg/l) which was statistically at par with treatment T_4 (GA_3 75 mg/l) 25.05. While, minimum number of leaves per plant (15.87) were found in control at harvest stage. Higher number of leaves per plant produce might be due to invigoration of physiological process of plants and stimulatory effects with GA_3 to form new leaves at faster rates and thus increased vegetative growth that could have attributed to higher metabolic activities, enhanced growth and higher carbohydrates production. Similar, results were also reported by Lendve *et al.* (2010), Roy and Nasiruddin (2011) [11] in cabbage; Reza *et al.* (2015) [9-10] in broccoli, Kumar *et al.* (2017) [12] and Kaur and Mal (2018) [5] in cauliflower.

Stem diameter (mm)

The stem diameter at harvest stage was also significantly influenced by foliar application of GA_3 and NAA. The maximum stem diameter at harvest (46.11 mm) was found with GA_3 50 mg/l (T_3) which, remain at par with treatment T_4 (GA_3 75 mg/l) at harvest time (44.33 mm), T_6 (NAA120mg/l) recorded 43.71 mm and treatment T_7 (NAA 180 mg/l) stem diameter were recorded at harvest time (43.20 mm). The mean increase in stem diameter under the treatment T_3 was found higher as compared to absolute control (31.99 mm). These results were in conformity with the results reported by Roy and Nasiruddin (2011) [11] in cabbage, Reza *et al.* (2015) [9-10] in broccoli and Kaur and Mal (2018) [5] in cauliflower.

Leaf length (cm)

The effect of GA_3 and NAA significantly differed on leaf length of broccoli. Maximum leaf length (33.77 cm) was observed in treatment T_3 (GA_3 50 mg/l) which, was statistically at par with treatment T_4 (GA_3 75 mg/l) being 32.27 cm. whereas, significantly minimum leaf length (25.25 cm) was observed in absolute control.

Leaf width (cm)

The effect of GA_3 and NAA showed significant effect on leaf width. Among all the, treatments T_3 (GA_3 50 mg/l) produced maximum leaf width (24.41 cm) which, remained at par with treatment T_4 (75 mg/l) *i.e.* 23.94 cm. However, minimum leaf width (15.18 cm) was recorded absolute control. These results are closely related with Roy and Nasiruddin (2011) [11] in cabbage and Reza *et al.* (2015) [9-10] in broccoli as well as Kaur and Mal (2018) [5] in cauliflower.

Effect on yield parameters

Days to curd initiation

The days to curd initiation was significantly influenced by the foliar application of GA_3 and NAA. Although, early curd initiation (40 days) was noted in treatment T_3 (GA_3 50 mg/l) which, was at par with treatment T_4 *i.e.* 43.12 days and T_5 (44.67 days). While late curd initiation (56 days) was observed in absolute control. These result are closely match with Roy and Nasiruddin (2011) [11] in cabbage, Reza *et al.* (2015) [9-10] in broccoli and Kaur and Mal (2018) [5] in cauliflower.

Curd diameter (cm)

Curd diameter as significantly influenced by the foliar application of GA_3 and NAA. Among the different PGR's treatment significantly the highest curd diameter (18.93 cm) was observed in treatment T_3 (GA_3 50 mg/l) as compared to rest of the treatments. However, minimum curd diameter was recorded in absolute control (12.90 cm). These results are closely related with Roy and Nasiruddin (2011) [11] in cabbage, Reza *et al.* (2015) [9-10] in broccoli and Kaur and Mal (2018) [5] in cauliflower.

Average weight of curd (g)

The main curd weight showed significant variation among all the treatments. However, the maximum curd weight was found in treatment T_3 *i.e.* 626 g (GA_3 50 mg/l), which was at par with treatment T_4 *i.e.* 580.17 g (GA_3 75mg/l) and minimum was found in absolute control (230.01 g). These

results are near with the findings of Roy and Nasiruddin (2011) [11] in cabbage, Reza *et al*. (2015) [9-10] in broccoli and Kaur and Mal (2018) [5] in cauliflower.

Curd volume (cm^3)

The curd volume of main curd was significantly affected by foliar application GA_3 and NAA. The maximum curd volume (466 cm^3) was found with GA_3 50 mg/l (T_3) treatment, which was statistically at par (437.13 cm^3) with treatment T_4 *i.e.* GA_3 75 mg/l. However, the minimum curd volume found was in absolute control (228.53 cm^3). These results are accordance with Roy and Nasiruddin (2011) [11] in cabbage, Reza *et al*. (2015) [9-10] in broccoli and Kaur and Mal (2018) [5] in cauliflower.

Days to final harvest

Days to final harvest of curd was significantly affected by foliar application GA_3 and NAA. The significantly earliest days to final harvest of curd (49.67) was found in treatment T_3 *i.e.* GA_3 50 mg/l. While, maximum harvest days were recorded in absolute control (65.33). The results are in close conformity with the findings of Roy and Nasiruddin (2011) [11] in cabbage, Reza *et al*. (2015) [9-10] in broccoli and Kaur and Mal (2018) [5] in cauliflower.

Curd yield (g/plant)

The curd yield per plant was significantly affected by foliar application of GA_3 and NAA. The highest curd yield (671.67 g/plant) was found in treatment T_3 (GA_3 50 mg/l) which was statistically at par with treatment T_4 *i.e.* GA_3 75 mg/l (595.31 g), whereas minimum curd yield per plant (235.35 g) was recorded in absolute control. The above results were in accordance with the findings of Roy and Nasiruddin (2011) [11] in cabbage, Reza *et al*. (2015) [9-10] in broccoli and Kaur and Mal (2018) [5] in cauliflower.

Curd yield (kg/plot)

The curd yield per plot was significantly affected by foliar application GA_3 and NAA treatment. The maximum curd yield (19.31 kg/plot) was found in treatment T_3 (GA_3 50 mg/l) which was statistically at par with treatment T_4 (GA_3 75 mg/l) *i.e.* (18.29 kg/plot). Whereas the least curd yield (13.20 kg/plot) was recorded in absolute control.

Curd yield (t/ha)

The curd yield per hectare as significantly affected by foliar application GA_3 and NAA. The highest curd yield (22.35 t/ha) was found in treatment T_3 (GA_3 50 mg/l), which turned superior over rest of the treatments. Which was statistically at par with treatment T_4 (21.17 t/ha), whereas minimum curd yield (15.28 t/ha) was recorded in absolute control. The above results were in accordance with the findings of Roy and Nasiruddin (2011) [11] in cabbage, Reza *et al*. (2015) [9-10] in broccoli and Kaur and Mal (2018) [5] in cauliflower.

Table 1: Effect of foliar application of GA_3 and NAA on growth parameters

Sr. No.	Treatments	Plant height (cm)		Number of leaves per plant	Stem diameter (mm)	Leaf length (cm)	Leaf width (cm)
		45 days ATP	At harvesting time				
T_1	Absolute control	37.33	47.08	15.87	31.99	25.25	15.18
T_2	GA_3 25 mg/l	40.72	48.78	15.67	35.58	27.39	21.18
T_3	GA_3 50 mg/l	52.65	67.20	27.30	46.11	33.77	24.41
T_4	GA_3 75 mg/l	51.55	63.70	25.05	44.33	32.27	23.94
T_5	NAA 60 mg/l	41.57	53.58	19.17	37.27	27.64	20.13
T_6	NAA 120 mg/l	39.04	53.46	21.18	43.71	26.60	20.66
T_7	NAA 180 mg/l	49.70	53.60	19.93	43.20	26.28	20.10
T_8	GA_3 25 mg/l + NAA 60 mg/l	43.10	54.98	20.08	39.52	28.64	20.86
T_9	GA_3 50 mg/l + NAA 120 mg/l	39.75	55.65	19.99	37.32	28.49	19.38
	S.Em.±	1.13	1.52	0.83	0.99	0.68	0.70
	C.D. at 5%	3.40	4.56	2.48	2.97	2.05	2.1
	C.V.%	4.46	4.76	6.99	4.30	4.15	5.86

Table 2: Effect of foliar application of GA_3 and NAA on yield parameters

Sr. No.	Treatment	Days to curd initiation	Curd diameter (cm)	Average weight of curd (g)	Curd volume (cm^3)	Days to final harvest	Curd yield (g/plant)	Curd yield (kg/plot)	Curd yield(t/ha)
T_1	Absolute control	56.00	12.90	230.01	228.53	65.33	235.35	13.20	15.28
T_2	GA_3 25 mg/l	49.67	17.16	394.59	322.87	59.67	426.69	14.32	16.57
T_3	GA_3 50 mg/l	40.00	18.93	626.00	466.00	49.67	671.67	19.31	22.35
T_4	GA_3 75 mg/l	43.12	16.45	580.17	437.13	56.00	595.31	18.29	21.17
T_5	NAA 60 mg/l	44.67	15.03	543.33	390.07	57.00	578.45	16.16	18.71
T_6	NAA 120 mg/l	49.00	15.74	394.76	333.33	56.33	474.76	16.52	19.12
T_7	NAA 180 mg/l	49.67	14.95	321.06	239.33	60.67	389.17	14.45	16.72
T_8	GA_3 25 mg/l + NAA 60 mg/l	48.00	14.67	351.89	292.93	55.67	428.56	14.04	16.25
T_9	GA_3 50 mg/l + NAA 120 mg/l	46.67	14.76	353.75	252.20	55.33	350.75	15.21	17.60
	S.Em.±	1.69	0.54	17.20	16.95	1.72	27.6	0.74	0.86
	C.D. at 5%	5.0	1.62	51.58	50.81	4.9	82.7	2.22	2.57
	C.V.%	6.15	6.00	7.07	8.92	5.2	10.4	8.3	8.2

Conclusion

On the basis of the *Rabi* season experiment it can be concluded that foliar application of GA_3 50 mg/l treatment at 20 and 40 days after transplanting found most effective treatment with regards to growth and yield parameters as well as curd yield in broccoli cv. Pusa KTS -1."

References

1. Bisht TS, Rawat L, Chakraborty B and Yadav V. A recent advances in use of Plant Growth Regulators (PGRs) in fruit crops - A Review International Journal of Current Microbiology and Applied Sciences. 2018; 7(5):1307-1336.
2. FAO. Food and Agricultural Organization of the United Nations. Cauliflower and Broccoli Area and Production data, 2018. *http://www.fao stat.org.com.*
3. Hazra P, Som MG. Technology for vegetable production and improvement of nutritive value of different vegetables. Naya Prakash, Calcutta, 1999, 31-35.
4. Hossain MF, Ara N, Uddin MR, Dey S, Islam MR. Effect of time of sowing and plant spacing on broccoli production. Tropical Agricultural and Extension. 2011; 14(4):90-92.
5. Kaur P, Mal D. Effect of foliar spray of NAA and GA_3 on the growth, curd formation and yield of cauliflower (*Brassica oleracea* L. *var. botrytis*). Journal of Pharmacognosy and Phytochemistry. 2018; 7(3):2805-2807.
6. Kumar MM, Aravindakshan K, Dhayal M, Singh J, Meena SL. Effect of biofertilizers and growth regulators on growth attributes of cauliflower (*Brassica oleracea var. botrytis* L.) cv. Pusa Paushja. International Journal of Current Microbiology and Applied Sciences ISSN: 2319-7706 special issue. 2017; 7:885-890.
7. Meena K, Ram RB, Meena ML, Meena JK, Meena DC. Effect of organic manures and bio-fertilizers on growth, yield and quality of broccoli (Brassica oleracea var. italica Plenck) cv. KTS-1. Chemical Science Review. 2017; 6(24):2153-2158.
8. Panse VG, Sukhatme PV. "*Statistical Methods for Agricultural Workers"*. Indian Council of Agricultural Research, New Delhi, India, 1985, 381.
9. Reza M, Islam M, Hoque A, Sikder RK, Mehraj H, Uddin AFMJ. Influence of different GA3 concentration on growth and yield of broccoli. American-Eurasian Journal of Scientific Research. 2015; 10(5):332-335.
10. Reza M, Islam MA, Hoque RK, Sikder H, Uddin AFMJ. Influence of Different GA_3 concentrations on growth and yield of broccoli. American-Eurasian Journal of Scientific Research. 2015; 10(5):332-335.
11. Roy R, Nasiruddin KM. Effect of different level of GA_3 on growth and yield of cabbage. Journal environment Science Natural Resources. 2011; 4(2):79-82.
12. Vishwakarma S, Bala S, Kumar P, Prakash N, Kumar V, Singh SS. Effect of nitrogen, naphthalene acetic acid and gibberellic acid on growth, yield and quality of broccoli (*Brassica oleracea var italica* L.) cv. Sante. Journal of Pharmacognosy and Phytochemistry. 2017; 1:188-194.