Effect of application of GA$_3$ and NAA on yield, quality and economics of broccoli (Brassica oleracea var. italica) var. Pusa KTS-1

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Abstract
The present investigation was carried out on “Effect of application of GA$_3$ and NAA on yield, quality and economics 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, highest yield 671.67 g/plant, 19.31 kg/plot and 22.35 t/ha. The highest chlorophyll content (0.20 mg/100g) and the maximum shelf life (3.83 days) was also recorded in treatment T3 (GA$_3$ 50 mg/l). The highest net realization (263760 ₹/ha) and benefit cost ratio (3.6) was observed in foliar application of GA$_3$ 50 mg/l.

Keywords: Broccoli, GA$_3$, NAA, yield, quality and economics

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 Brassicaceae 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) [6-7]. Among the cole crops, the sprouting broccoli is highly nutritious as compared to others. It contains carbohydrates (5.5%), protein (3.3%), Vitamin A (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) [14].

Methods and Materials
The present investigation was carried out on “Effect of application of GA$_3$ and NAA on yield, quality and economics 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
The chlorophyll content of curd was significantly affected by foliar application of GA3 and NAA. The highest chlorophyll content (0.20 mg/100g) was found in treatment T3, i.e. GA3 50 mg/l as compared to rest of the treatments, whereas minimum chlorophyll content (0.13 mg/100g) was recorded in absolute control. The above results were also in accordance with the findings of Reza et al. (2015) [9-10] in broccoli; Kumar et al. (2017) [6] in cauliflower and Kaur and Mal (2018) [5] in cauliflower.

Result and Discussion
Effect on yield parameters

Curd yield (g/plot)
The curd yield per plot was significantly affected by foliar application of GA3 and NAA. The maximum curd yield (671.67 g/plot) was recorded in treatment T3 (GA3 50 mg/l) which was statistically at par with treatment T4 i.e. GA3 75 mg/l (595.31 g), whereas minimum curd yield per plot (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 GA3 and NAA treatment. The maximum curd yield (19.31 kg/plot) was found in treatment T3 (GA3 50 mg/l) which was statistically at par with treatment T4 i.e. GA3 75 mg/l (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 GA3 and NAA. The highest curd yield (22.35 t/ha) was found in treatment T3 (GA3 50 mg/l), which turned superior over rest of the treatments. Which was statistically at par with treatment T4 (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.

Effect on quality parameters
Chlorophyll content in curd (mg/100g)
The chlorophyll content of curd was significantly affected by foliar application of GA3 and NAA. The highest chlorophyll content (0.20 mg/100g) was found in treatment T3 i.e. GA3 50 mg/l as compared to rest of the treatments, whereas minimum chlorophyll content (0.13 mg/100g) was recorded in absolute control. The above results were also in accordance with the findings of Reza et al. (2015) [9-10] in broccoli; Kumar et al. (2017) [6] in cauliflower and Kaur and Mal (2018) [5] in cauliflower.

Total cost of cultivation
Total expenditure of each treatment was divided into two parts viz., fixed expenditure and treatments wise extra cost. Fixed expenditure includes cost of field preparation seed, sowing expenses, transplanting expenses, fertilizers application, weeding and use of insecticide spraying, watching, irrigation, harvesting and general expenses. The cost of cultivation of Rs 60291 was common for all the treatments but the cost of different treatments of plant growth regulators varied from treatment to treatment. The highest total cost of cultivation (Rs 73809 /ha) was incurred in GA3 @ 75 mg/l (T3) against the total cost of Rs 64691/ha involved in control (T1).

Gross income
Data embodied in Table 2 revealed that the maximum gross income of Rs 335250/ha was obtained with the GA3 @ 50 mg/l (T1) followed by in order resulting are T3 (317550), T6 (Rs 286800), T3 (Rs 280650) against T1 control (Rs 229200).

Net income
The net return obtained by foliar application of GA3 and NAA treatment to broccoli crop was ranging from Rs 164507 to Rs 263750 per hectare, maximum net return of 263750/ha was obtained with treatment T3 followed by T4 (Rs 243741), T5 (Rs 219740), T6 (219533) against T1 (Rs 164507).

Benefit cost ratio
The B:C ratio for foliar application of nine GA3 and NAA treatment to broccoli crop was ranging from 2.5 to 3.6 while maximum benefit: cost ratio obtained with T3 (3.6) followed by T4 (3.3), T5 (3.2), T6 (3.2) against T1 (2.5). Similar results were reported by (Singh, B.K. 2015) in cabbage.
Table 1: Effect of foliar application of GA$_3$ and NAA on yield parameters

| Sr. No. | Treatment |
|---------|-----------|
| 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 |

| Curd yield (g/plant) | Curd yield (kg/plot) | Curd yield (t/ha) | Chlorophyll content (mg/100g) | Shelf life (days) |
|----------------------|----------------------|-------------------|-----------------------------|------------------|
| 235.35               | 13.20                | 15.28             | 0.13                        | 1.13             |
| 426.69               | 14.32                | 16.57             | 0.14                        | 1.60             |
| 671.67               | 19.31                | 22.35             | 0.20                        | 3.83             |
| 595.31               | 18.29                | 21.17             | 0.17                        | 3.77             |
| 578.45               | 16.16                | 18.71             | 0.15                        | 2.80             |
| 474.76               | 16.52                | 19.12             | 0.16                        | 1.45             |
| 389.17               | 14.45                | 16.72             | 0.16                        | 2.53             |
| 428.56               | 14.04                | 16.25             | 0.15                        | 2.00             |
| 350.75               | 15.21                | 17.60             | 0.17                        | 1.27             |

Table 2: Economics of broccoli as influenced by different treatments

| Treatment | Treatment detail             | Fixed costs | Curd Yield (t/ha) | Gross realization (₹/ha) | Total cost of cultivation (₹/ha) | Net realization (₹/ha) | BCR |
|-----------|------------------------------|-------------|-------------------|---------------------------|---------------------------------|------------------------|-----|
| T$_1$     | Absolute control             | 60291       | 15.28             | 229200                    | 64693                          | 164507                 | 2.5 |
| T$_2$     | GA$_3$ 25 mg/l               | 60291       | 16.57             | 244050                    | 69172                          | 174878                 | 2.5 |
| T$_3$     | GA$_3$ 50 mg/l               | 60291       | 22.35             | 335250                    | 71490                          | 263760                 | 3.6 |
| T$_4$     | GA$_3$ 75 mg/l               | 60291       | 21.17             | 317550                    | 73809                          | 243741                 | 3.3 |
| T$_5$     | NAA 60 mg/l                  | 60291       | 18.71             | 280650                    | 67060                          | 219740                 | 3.2 |
| T$_6$     | NAA 120 mg/l                 | 60291       | 19.12             | 286800                    | 67267                          | 219533                 | 3.2 |
| T$_7$     | NAA 180 mg/l                 | 60291       | 16.72             | 250800                    | 67470                          | 183330                 | 2.7 |
| T$_8$     | GA$_3$ 25 mg/l + NAA 60 mg/l | 60291       | 16.25             | 243750                    | 69379                          | 174371                 | 2.5 |
| T$_9$     | GA$_3$ 50 mg/l + NAA 120 mg/l| 60291       | 17.60             | 264000                    | 71874                          | 192126                 | 2.6 |

Selling price of curd: - 15/7kg

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 yield and quality parameters as well as economics in broccoli cv. Pusa KTS -1.

References
1. Bisht TS, Rawat L, Chakraborty B, Yadav V. A recent advance 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, Dhyayal M, Singh J, Meena SL. Effect of biofertilizers and growth regulators on growth attributes of cauliflower (Brassica oleracea var. botrytis L.) cv. Pusa Pausha. 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, Mehrjaj H, Uddin AFMJ et al. 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. Singh BK. Influence of growth regulators on growth, yield and economics of cabbage varieties. Annals of Plant and Soil Research. 2015; 17(1):41-44.
13. Verma S, Sengupta S, Agarwal BK, Jha KK, Mishra S, Rajak R et al. Enhanced shelf life of Broccoli (Brassica oleracea var. italica) at ambient condition due to foliar application of boron, urea and GA$_3$. International Journal of Current Microbiology and Applied Sciences. 2018, 926-929.
14. Vishwakarma S, Bala S, Kumar P, Prakash N, Kumar V, Singh SS et al. 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.