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Effect of foliar application of GA_3 and NAA on yield of Broccoli (*Brassica oleracea var. italica L.*) under Walk-in-tunnel

Susmitha Kottapu[1]* and Annu Verma[2]

Department of Horticulture, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur 492 012, C.G., India

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ABSTRACT

An experiment was conducted to evaluate the possible effect of foliar application of plant growth regulators with different concentration levels on yield of broccoli. It was consisted of ten treatments including T_0: Control (without spray of PGRs), T_1: GA_3@ 40 ppm, T_2: GA_3@ 60 ppm, T_3: GA_3 @ 80 ppm, T_4: NAA @ 60 ppm, T_5: NAA @ 120 ppm, T_6: NAA @ 180 ppm, T_7: GA_3 @ 40 ppm + NAA @ 60 ppm, T_8: GA_3 @ 60 ppm + NAA @ 120 ppm and T_9: GA_3 @ 80 ppm + NAA @ 180 ppm" were undertaken randomized block design (RBD) with three replications at "Centre of Excellence on Protected Cultivation, College of Agriculture, IGKV, Raipur (C.G)". Two foliar applications were performed at 20 days after transplanting and 40 days after transplanting. The important parameters encompassed in the study were Curd diameter (cm), primary curd weight (g), secondary curd weight (g), curd yield per plant, curd yield per plot and curd yield per hectare. Data was recorded three times during investigation that is 30 DAT, 60 DAT and at the time of harvest. Although all treatments showed a positive effect on yield among all the treatments, T_9 was showed better performance which may be due to the elongation of cells and cell division, increased dry matter accumulation in plants. Therefore, foliar application of GA_3 80 ppm + NAA 180 was optimum among all treatments for getting higher yield in broccoli crop.

Key word: *Broccoli, GA_3, NAA, Foliar application, Yield*

Introduction

Broccoli (*Brassica oleracea var. italica* L.) is the importantcrop among cole crops belonging to the family Cruciferae and it is originated in Mediterranean region. Chromosome number of broccoli is 2n = 18. It is resemblance to cauliflower, but flower stalks are longer than cauliflower. Usually, green type broccoli is being cultivated in India which knowns as 'Calabrese'. Green types are more nutritive compared to white, yellow and purple types. Purple types are hardier and withstand extremely lower temperatures. Broccoli is so precious vegetable as it's having anticarcinogenic and antioxidant properties. It is rich source of "sulphoraphane" as an anticancer property which helps to fight with breast and lung cancer. It is nutritionally higher-ranking vegetable than cabbage and cauliflower because it has 130 times more vitamin A than cauliflower and 22 times more than cabbage. It contains protein (3.3 g), Vitamin A (3500 IU), 0.14 mg Vitamin-B_1, 0.3 mg B_2, 1.2 mg niacin, Vitamin-C 137 mg, Calcium (0.80 mg) and Iron (205 mg) per 100 g.

Phytohormones are the signal molecules, pro-

(*Research Scholar, [2]Associate Professor)

duced within the plants, that occurs in extremely low concentrations which promote, modifyor inhibit the physiological process of the plant. These may be natural and synthetic. Now-a-days people are much interested in production of quality produce and earning profits by using plant growth regulators during crop cultivation. Among all the growth regulators, auxins and gibberellins plays important role in cell division and cell enlargement or both (Nickell, 1982). Gibberellic acid (GA_3) and Naphthalene acetic acid (NAA) showed beneficial effect in several vegetable crops. NAA is a synthetic plant hormone in auxin family. It will be used as a rooting agent in vegetative propagation of plants to induce roots for stem and leaf cuttings. Generally, it can beused to induce flowering, preventing shedding of flower buds and immature fruits. It helps in enlargement of size, to increasing the yield and quality improvement of the produce. Gibberellins are essential in regulating major aspects of plant growth and developmental processes like seed germination (by breaking of dormancy), stem elongation, leaf expansion, trichome development, pollen maturation, induction of flowering.

Mazumdar (2013) designed and carried out a research experiment regarding the response of GA_3 and potash on growth and yield ofin cabbage. The results clearly indicated that GA_3 120 ppm showed highest marketable yield (65.1 t/ha) among all the treatments. Chanwala *et al.* (2019) conducted an experiment on effect of foliar application of growth and quality of broccoli consisted of 16 combinations of GA_3 (control, 25, 50 and 75) and NAA (Control, 80, 120 and 180). $GA_3$75 ppm + NAA @ 180 PPM showed best results over the rest of the treatment combinations. Kumar and Ray (2000) conducted an experiment with GA_3 50 mg^{-1} and 100 mg^{-1} in cauliflower cv. Pant Subhra and recorded maximum curd circumference and significant increase in curd yields.In the view of all above facts, the research was undertaken to study the effect of foliar application of GA_3 and NAA on growth parameters and yield attributes of broccoli.

Materials and Methods

The research was conducted at Centre of Excellence on Protected Cultivation and Precision Farming, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during *rabi,* 2020-21. The experiment was performedin a "Randomized block design" with three replications comprising of tentreatments*viz.*,T_0: Control (without any spray), T_1: GA_3 40 ppm, GA_3T_2: 60 ppm, T_3: GA_3 80 ppm, T_4: NAA 60 ppm, T_5: NAA 120 ppm, T_6: NAA 180 ppm, T_7: GA_3 40 ppm + NAA 60 ppm, T_8: GA_3 60 ppm + NAA 120 ppm and T_9: GA_3 80 ppm + NAA 180 ppm. Green Magic (F1 hybrid) seeds of broccoli were sown in the pro trays and monitored regularly by keeping them in nursery.Four weeks (28-30 days) old healthy seedlings having 12-15 cm height and 3-4 leaves were transplanted in beds having drip irrigation system which covered with mulch under the walk-in-tunnel. The area of walk-in-tunnel (Covered with polythene) was 696 sq. m. (72.5 Length X 9.6 Breadth) which fixed with an exhaust fan to maintain optimum temperature and relative humidity.10 kgs FYM was applied to each bed. Water soluble fertilizers were given to the crop in the form of drenching and fertigation for fertilizer use efficiency.

Preparation of GA_3 solutions

To prepare 40 ppm, 60 ppm and 80 ppm of GA_3 solutions, 40 mg, 60 mg and 80 mg was measured by using electrical balance and taken into a glass container (100 ml) individually. The containers were mixed with 99% ethyl alcohol (10-15 ml) for dilution of GA_3. and continuously stirred with glass rod for proper dilution. Then the solution was transferred into a volumetric flask (1000 ml) and make up the solution to 1 litre by adding normal water. The containers which contain solution were kept away from the light as GA_3 is photosensitive.

Preparation of NAA solutions

Plano fix 4.5 SL was taken as a source of Naphthalene acetic acid to prepare different doses of NAA solution. Plano fix will be containing 4.5 % of active ingredient (Alpha napthyl acetic acid). So, 1 ml of Plano fix should be dilute in 4.5 litres of water to prepare 10 ppm of NAA solution. In the similar way 60 ppm, 120 ppm and 180 ppm were prepared.

Preparation combined solutions of GA_3 and NAA

To prepare the combinations of GA_3 and NAA solutions, first required quantity of $GA_3$was diluted in 99 % ethyl alcohol (10-15 ml) and made up to 500 ml by adding water. In other hand NAA solutions (according to the requirement) also prepared in 500 ml. Finally, these two solutions were mixed to make a uniform combined solution of GA_3 and NAA. The

fresh solution was prepared each time of foliar application.

Two foliar applications were performed at 20 days after transplanting and 40 days after transplanting only in the morning or evening hours. The uniform spraying was carried out with the help of knapsack sprayer carefully to ensure that the leaves on both sides were completely wet with the spray solution.

The important parameters encompassed in the study wereplant height (cm), no. of leaves/plant, leaf area (cm^2), canopy spread (cm^2), days to curd initiation, days to harvest, curd yield per plant, curd yield per plot and curd yield per hectare. The data was collected from five randomly selected plants for parameters mentioned above. The data was subjected to analysis of variance technique (ANOVA) and least significance difference test was applied to separate different treatment means (Panse and Sukhatme, 1967).

Results and Discussion

Yield attributes

It is revealed from Table 1 that, yield attributing characters were significantly affected by foliar application of GA_3 and NAA. Treatment T_9: GA_3 80 ppm + NAA 180 ppm was showed the maximum diameter of the curd (12.84 cm). The maximum weight of the primary curd (210.05 g/plant) and secondary curd (110.3 g/plant) was obtained from the treatment T_9: GA_3 80 ppm + NAA 180. It might be due to the GA_3 and NAA which sprayed at higher concentrations leads to accumulation of photosynthates in the economic part and quick cell division and cell elongation which helps in enhancement of circumference of the curd which ultimately leads to increase in the diameter and weight of the curd. The results agree with Saravaiya *et al.* (2010), Sawant *et al.* (2010), Moniruzzaman *et al.* (2019) in cabbage, Chanwala *et al.* (2019) in broccoli, Dev *et al.* (2020) in cabbage.

The data presented in the Table 2 clearly indicate that total curd yield per plant was recorded in T_9: $GA_3$80 ppm + NAA 180 ppm (320.35 g/plant) which was significantly superior over other treatments followed by T_8: GA_3 60 ppm + NAA 120 ppm (300.26 g), T_7: GA_3 40 ppm + NAA 80 ppm (283.86 g), T_6: NAA 180 ppm (275.83 g), T_5: NAA 120 ppm (264 g). While T_0: control plot was recorded with minimum curd yield (148.59 g) per plant. It might be due to the increase in cell division and cell elongation, accumulation of carbohydrates owing to greater photosynthesis which leads to more weight of the curd compared to the other treatments which treated with the respective lower concentrations. Estimated yield/hectare was calculated based on the data collected earlier. Estimated yield was ranging from 55.03 q/ha to 118.64 q/ha. The highest yield (118.64 q/ha) was recorded in the treatment T_9: GA_3 80 ppm + NAA 180 ppm which on par with T_8: GA_3 60 ppm + NAA 120 ppm (111.2 q). Similar results were found by Saravaiya *et al.* (2010), Sawant *et al.* (2010), Dev *et al.* (2020) in cabbage, Moniruzzaman *et al.* (2019) in cauliflower, Patel *et al.* (2011) in cauliflower,

Table 1. Effect of different concentration levels of GA_3 and NAA on curd diameter (cm), primary curd weight (g), secondary curd weight (g) in broccoli.

T. No.	Treatments	Curd diameter (cm)	Primary curd weight of plant(g)	Secondary curd weight of plant (g)
T_0	Control	9.027	99.26	49.33
T_1	GA_3 40 ppm	10.57	139.40	86.7
T_2	GA_3 60 ppm	10.82	147.10	88.7
T_3	GA_3 80 ppm	11.23	154.40	90.1
T_4	NAA 60 ppm	11.47	165.90	92.3
T_5	NAA 120 ppm	11.97	169.80	94.2
T_6	NAA 180 ppm	12.05	179.13	96.7
T_7	GA_3 40 ppm + NAA 80 ppm	12.22	186.46	97.4
T_8	GA_3 60 ppm + NAA 120 ppm	12.43	195.46	104.8
T_9	GA_3 80 ppm + NAA 180 ppm	12.84	210.05	110.3
	S E(m) ±	0.565	4.892	2.672
	CD at 5%	1.68	14.535	7.938

Note: ppm- Parts Per Million, GA_3 - Gibberellic acid & NAA-Naphthalene acetic acid

Table 2. Effect of different concentration levels of GA_3 and NAA on Total curd yield (g/ plant), Curd yield (kg/ plot) and Estimated curd yield (q/ha)

T. No.	Treatments	Total curd yield (g/plant)	Curd yield (kg/ plot)	Estimated curd yield (q/ha)
T_0	Control	148.59	7.42	55.03
T_1	GA_3 40 ppm	226.1	11.3	83.74
T_2	GA_3 60 ppm	235.8	11.79	87.33
T_3	GA_3 80 ppm	244.5	12.22	90.55
T_4	NAA 60 ppm	258.2	12.91	95.62
T_5	NAA 120 ppm	264.0	13.2	97.77
T_6	NAA 180 ppm	275.83	13.79	102.15
T_7	GA_3 40 ppm + NAA 80 ppm	283.86	14.19	105.13
T_8	GA_3 60 ppm + NAA 120 ppm	300.26	15.01	111.20
T_9	GA_3 80 ppm + NAA 180 ppm	320.35	16.01	118.64
	S E (m) (±)	3.818	0.58	3.096
	CD at 5 %	11.343	1.724	9.198

Note: ppm- Parts Per Million, GA_3 - Gibberellic acid and NAA-Naphthalene acetic acid

Chanwala *et al.* (2019) in broccoli.

Conclusion

The foliar application of GA_3 and NAA (at optimum concentration) showed significant effect towards the yield attributes of broccoli. In this context, the combined effect of GA_3 and NAA found to be effective than the individual effect of GA_3 or NAA. The plants sprayed with GA_3 80 ppm + NAA 180 ppm found to be superior in yield attributing characters which was at par with T_8 GA_3 60 ppm + NAA 120 ppm. Based on the results obtained from this research revealed that GA_3 80 ppm + NAA 180 was optimum dosage for getting higher yield in broccoli crop. However, further detailed investigation is needed to get some concrete findings.

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