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The Implications of Growth-Regulating Substances on Growth and Yield Traits of Cauliflower

Dhara Gadhiya [a], Dushyant D. Champaneri [a] and Naren K. Patel [a*]

[a] Department of Vegetable Science, ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Gujarat - 396 450, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Background: Present investigation was carried out to evaluate the performance of the different levels of GA_3 and NAA as foliar spray on growth and yield attributes of cauliflower cv. Pusa Snowball KT-25 at Vegetable Research Farm, Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat.
Methods: The experiment was framed in Randomized Block Design with three replications, which included nine treatments.
Results: The results revealed that the application of GA_3 @ 150 mg l^{-1} (T_5) recorded higher values for growth character *viz.,* plant height (69.26 cm), number of leaves $plant^{-1}$ (29.67), length of stalk (6.54 cm) as well as plant spread in N-S (69.48 cm) and E-W (71.70 cm). In case of yield attributes, the same treatment GA_3 @ 150 mg l^{-1} (T_5) at 40 and 60 DATP exhibited maximum curd diameter (17.80 cm), gross weight of curd (2.88 kg $plant^{-1}$), net weight of curd (789.59 g $plant^{-1}$), yield $plot^{-1}$ (20.23 kg) and yield $hectare^{-1}$ (31.22 t) followed by NAA @ 80 mg l^{-1} (T_7). Whereas, days to 50 % curd initiation and days to first marketable curd did not show any significant differences.

**Corresponding author: E-mail: naren_horti@yahoo.co.in;*

Keywords: Cauliflower; foliar spray; GA_3; NAA; PGR; quantitative characters.

1. INTRODUCTION

India is predominantly a farming nation and vegetables contribute significantly in Indian farming. Vegetable production has influenced the most (59-61%) of all horticulture crops over the past five years. Vegetable production ascended from 101.2 million tonnes in 2004-05 to 184.40 million tonnes in 2017-18 [1]. Vegetables are regarded as protective foods given that they provide important nutrients, vitamins, and minerals to the human body and are the finest resource for overcoming micronutrient shortages. These crops, which are considered perishable commodities, are essential components of the human diet [2]. Cauliflower (*Brassica oleracea* var. *botrytis* L.) is the most popular cruciferous vegetable among the cole crop grown in India. It is an important winter vegetable crop grown as annual plant and can be grown without branching. The name cauliflower originated from Latin word '*Caulis*' means cabbage and '*Floris'* means flower. The edible part of cauliflower is called as 'curd'. It is a highly nutritious and delicious vegetable. It supplies 50 mg Vitamin C, 40 IU carotene, 31 kcal energy, 8 g carbohydrate, protein 1.9 g, calcium 22 mg, thiamine 0.2 mg, riboflavin 0.1 mg, niacin 0.57 mg and 90 % water per 100 g edible part [3]. The leading cauliflower growing states are West Bengal, Bihar, Uttar Pradesh, Punjab and some parts of Gujarat.

Due to the diversified use of productive land, it is necessary to increase food production, for that the growth regulators may a contributor in achieving the desired goal. Now a day's plant growth regulators have been tried to improve the growth and ultimately crop yield. Growth regulators are organic compounds other than nutrients; a small amount of which are capable of modifying growth [4]. Among the growth regulators, auxin causes enlargement of plant cell and gibberellins stimulate cell division, cell enlargement, or both [5]. The foliar application of GA_3 and NAA exhibited beneficial effects in several crops including cauliflower. The concentration of the chemicals, environmental conditions and method of application are most essential factors for determining their practical utility. Therefore, considering the above factors, the present study was undertaken to find out the effect of the appropriate concentration of GA_3 and NAA for better vegetative growth and yield of cauliflower under the South Gujarat condition.

2. MATERIALS AND METHODS

The present experiment was conducted on cauliflower cv. Pusa Snowball KT- 25 during *Rabi* season 2017-2018 at Vegetable Research Scheme, Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat. The trial was laid out in Randomized Block Design with nine treatments and three replications. The plant growth regulators *viz.*, GA_3 @ 50, 75, 100, 125, 150 mg l^{-1} and NAA @ 60, 80, 100 were tried and compared with control. Four weeks old healthy seedlings were transplanted at the spacing of 60 × 45 cm. The recommended dose of fertilizers *i.e.,* FYM 15 t/ha at the time of land preparation and N: P: K at the rate of 125: 80: 60 kg/ha at the time of planting was incorporated in the experiment plot. Different concentration of GA_3 and NAA were sprayed twice at 40 and 60 days after transplanting. Control plots were treated with ordinary water only. All the standard package of practices were followed. Five plants were randomly selected in each plot area, tagged and labelled for observations. Various vegetative character like plant height (cm), number of leaves, length of stalk (cm), plant spread in N-S & E-W (cm) at harvesting stage and days to 50 % curd initiation as well as yield attributes *viz.,* days to first marketable curd, curd diameter (cm), gross weight of curd (kg $plant^{-1}$), net weight of curd (g $plant^{-1}$), curd yield per plot (kg $plot^{-1}$) and curd yield per hectare (t ha^{-1}) were recorded. The collected data on various parameters were statistically analysed by appropriate procedure as described by Panse and Sukhatme [6].

3. RESULTS AND DISCUSSION

The findings that were obtained from the execution of the experiment "Influence of growth regulators on growth and yield attributes of cauliflower cv. Pusa Snowball KT-25" as well as relevant discussion has been summarized below.

Growth attributes like plant height (cm), number of leaves, length of stalk (cm) and plant spread (cm) at harvest stage are important parameters to assess the vigour of the plant. The results obtained under these growth attributes were significantly influenced by the different concentrations of plant growth regulators are presented in Table 1. Maximum plant height (69.26 cm) was obtained in GA_3 @ 150 mg l^{-1}

(T_5) which was at par with treatments T_7, T_4 and T_2 and minimum plant height was recorded in control (T_9). This might be due to increasing cell wall extensibility by GA_3. Gibberellins increasing cell elongation as well as division and decreased the minimum force in tissue levels that will cause cell wall extension. It was also reported that GA_3 increasing plasticity of the cell wall followed by hydrolysis of starch to sugars which lowers the water potential of cell, resulting in the entry of water into cell causing elongation. These results are in accordance with other researchers *viz.,* [7,8] in cauliflower; [9,10,11] in cabbage in cluster bean and [12] in Indian bean.

Higher number of leaves per plant (29.67) was found in GA_3 @ 150 mg l^{-1} (T_5) that might be due to the activity of gibberellic acid at the apical meristem resulting in more nucleoprotein synthesis responsible for increasing leaf initiation and expansion. It is well known fact that GA_3 has significant role in enhancing the growth of the plant through cell division and cell elongation, hence it enhanced the number of leaves $plant^{-1}$. The similar trend was also reported by Kumar et al. [7] in cauliflower, [13,14,15] in cabbage and [16] in broccoli.

The foliar application of GA_3 @ 150 mg l^{-1} (T_5) found beneficial in increasing of length of stalk (6.54 cm) at harvest stage. This might be due to the gibberellic acid which stimulate vegetative growth and involved in the initiation of cell division in cambium. Enhance in the auxin content of tissue also increase cell elongation. These findings are in close agreements with [17] in cauliflower, [18] Roy and Nusiruddin [15] in cabbage and [19] in broccoli.

It is evident from data that plant spread was found significant under various treatments. At harvesting, the maximum plant spread in N-S (69.48 cm) and E-W (71.70 cm) was resulted in GA_3 @ 150 mg l^{-1} (T_5) compared to control (T_9). The increase in plant spread by GA_3 @ 150 mg l^{-1} might be due to increased rate of photosynthetic activity accelerated transport of food material and efficiency of utilizing photosynthetic products resulting in the cell elongation and rapid cell division in the growing portion. The results are in conformity with the findings of [13] Saravaiya et al. [10]. Dhengle and Bhosale [20] Yadav et al. [11] in cabbage and Sudha et al. (2018) in broccoli. The foliar application of growth regulators found to be non-significant for the days to 50% curd initiation. Though, numerically minimum days to 50% curd initiation was obtained with GA_3 @ 125 mg l^{-1} (T_4) as compared to other growth regulators treatments.

The yield attributes *viz.,* curd diameter, gross weight of curd, net weight of curd, yield per plot and yield per hectare in cauliflower were influenced by foliar application of growth regulators at a different concentration as compared to control. The foliar spray of GA_3 @ 150 mg l^{-1} (T_5) had maximum curd diameter (17.80 cm) which was on same bar with T_7, T_4, T_6, T_8 and T_2. This result may be due to the profound effect of gibberellic acid on cell enlargement, cell elongation and cambial activity. Another possible explanation for increase

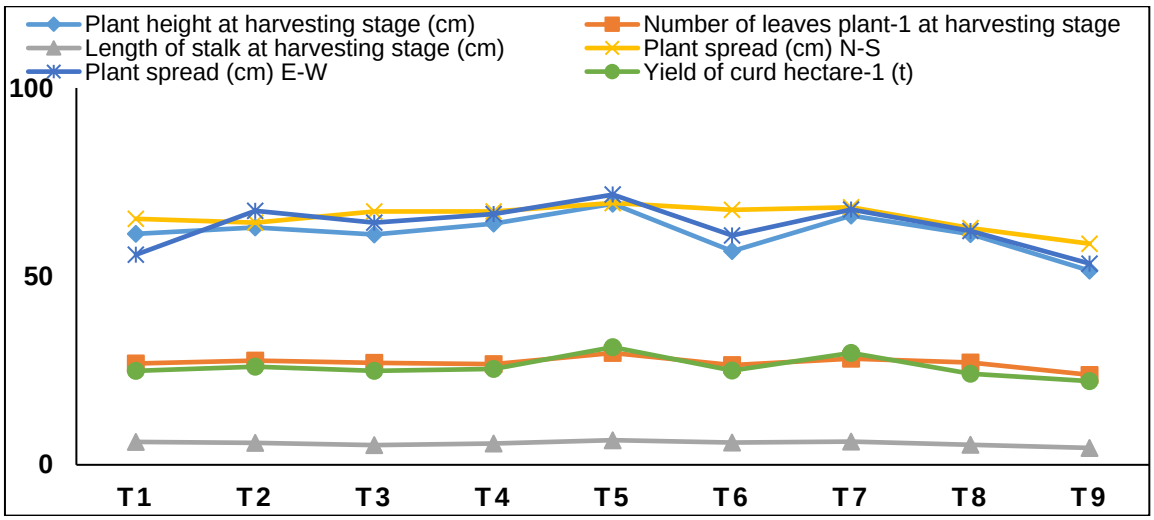

Fig. 1. Impact of various treatments on important growth and yield attributes of cauliflower

Table 1. Influence of growth regulators on growth attributes of cauliflower

Treatments	Plant height at harvesting stage (cm)	Number of leaves plant^{-1} at harvesting stage	Length of stalk at harvesting stage (cm)	Plant spread (cm)		Days to 50% curd initiation
				N-S	E-W	
T_1: GA_3 (50 mg l^{-1})	61.31	(26.93) 5.24	6.09	65.24	55.77	63.33
T_2: GA_3 (75 mg l^{-1})	63.01	(27.67) 5.31	5.83	64.22	67.41	63.33
T_3: GA_3 (100 mg l^{-1})	61.10	(27.07) 5.25	5.23	67.24	64.29	62.67
T_4: GA_3 (125mg l^{-1})	64.00	(26.73) 5.21	5.64	67.23	66.53	61.00
T_5: GA_3 (150 mg l^{-1})	69.26	(29.67) 5.49	6.54	69.48	71.70	61.67
T_6: NAA (60 mg l^{-1})	56.69	(26.47) 5.19	5.89	67.63	60.83	63.67
T_7: NAA (80 mg l^{-1})	66.12	(28.20) 5.36	6.20	68.35	67.78	64.33
T_8: NAA (100 mg l^{-1})	61.23	(27.13) 5.26	5.31	62.84	62.05	62.00
T_9: No spray(Control)	51.51	(23.87) 4.94	4.49	58.67	53.40	63.67
S.Em±	2.16	0.09	0.32	1.38	1.40	0.71
C.D. (5%)	6.48	0.27	0.96	4.13	4.20	NS
C.V.%	6.07	2.95	9.78	3.63	3.84	1.96

Note: Square root transformation X+0.5. Digit outside the parenthesis indicates transformed values

Table 2. Effect of GA_3 and NAA on yield attributes of cauliflower

Treatments	Days to first marketable curd	Curd diameter (cm)	Gross weight of curd (kg plant^{-1})	Net weight of curd (g plant^{-1})	Yield of curd plot^{-1} (kg)	Yield of curd hectare^{-1} (t)
T_1: GA_3 (50 mg l^{-1})	81.67	15.13	2.10	633.73	16.16	24.94
T_2: GA_3 (75 mg l^{-1})	82.00	15.50	2.18	665.78	16.90	26.07
T_3: GA_3 (100 mg l^{-1})	81.33	14.34	2.07	605.95	16.18	24.97
T_4: GA_3 (125mg l^{-1})	79.67	16.13	2.42	683.67	16.49	25.44
T_5: GA_3 (150 mg l^{-1})	78.67	17.80	2.88	789.59	20.23	31.22
T_6: NAA (60 mg l^{-1})	82.67	15.95	2.32	625.02	16.22	25.03
T_7: NAA (80 mg l^{-1})	82.33	16.81	2.58	733.04	19.23	29.68
T_8: NAA (100 mg l^{-1})	82.67	15.53	2.39	623.54	15.68	24.20
T_9: No spray(Control)	84.33	12.74	1.77	545.49	14.39	22.20
S.Em±	2.02	0.81	0.12	37.02	0.77	1.19
C.D. (5%)	NS	2.43	0.37	110.99	2.32	3.58
C.V.%	4.28	9.03	9.18	9.77	7.96	7.96

in curd diameter due to gibberellic acid may be because of larger accumulation of carbohydrates owing to greater photosynthesis by the plant Alvin, [21] resulting in greater curd diameter. The results are in accordance with the earlier findings of Kaur and Mal [22] Patel et al. [17] Sitapara et al. [8] in cauliflower; Singh et al. [14] Roy and Nasiruddin [15] in cabbage.

It is evident from the data that gross weight of curd and net weight of curd were found to be significant under various treatments. Among various treatments, GA_3 @ 150 mg l^{-1} (T_5) recorded maximum gross weight of curd (2.88 kg plant^{-1}) and net weight of curd (789.59 g plant^{-1}). The treatment T_7 (NAA @ 80 mg l^{-1}) in case of gross weight of curd while T_7 (NAA @ 80 mg l^{-1}) and T_4 (GA_3 @ 125 mg l^{-1}) in case of net weight of curd were found at par with T_5. The possible reason for the increasing gross weight and net weight of curd by gibberellic acid might be due to rapid and better nutrient translocation from roots to their aerial parts of the plant [23]. Similar trends were earlier observed by Kaur and Mal [22] Patel et al. [17] Sitapara et al. [8] in cauliflower.

Curd yield per plot and curd yield per hectare showed significant variation due to the foliar application of GA_3 and NAA at different concentration. However, the maximum yield per plot (20.23 kg) and yield per hectare (31.22 t) were obtained with GA_3 @ 150 mg l^{-1} (T_5), which was statistically identical with NAA @ 80 mg l^{-1}

(T_7). The curd weight might be due to greater synthesis of carbohydrates which leads to the formation of amino acids, proteins, chlorophyll, alkaloids and amides. These complex compounds are responsible for building up of new tissues. They are associated in a number of metabolic processes, which leads to better growth and development of crops and eventually there was significant increase in curd yield. Another probable reason for increasing growth characters might be due to the effect of GA_3 on cell division, cell elongation and cell expansion which ultimately improved the curd yield. These findings were in line with the findings of [22] Patel et al. [17]and Sitapara et al. [8] in cauliflower. According to the data, none of the sources were found to be significant for days to first marketable curd.

4. CONCLUSION

According to the findings of the experiment, the usage of growth regulators enhanced the growth and yield performance of cauliflower. The majority of growth and yield characteristics were best seen when GA_3 was sprayed at 150 mg l^{-1}. Thus, we can draw the conclusion that the considerable impact of GA3 @ 150 mg l^{-1} at 40 and 60 DATP on a number of growth characteristics is caused by foliar application.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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