



# Effect of PGR and Micronutrient on Growth, Yield and Quality of Cauliflower (*Brassica oleracea* var. *botrytis* L.) Cv Pusa Deepali

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## Authors' contributions

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

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## ABSTRACT

A field experiment was conducted during rabi season of 2024 at the Horticulture Research Farm, Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur (U.P.), Kanpur, to study the effect of plant growth regulators (PGRs) and micronutrients on the growth, yield and quality of cauliflower (*Brassica oleracea* var. *botrytis* L.) cv Pusa Deepali. The experiment was laid out in a Randomized Block Design (RBD) with nine treatments, each replicated thrice. The treatments include T1 (control), T2 GA3 @ 60 PPM, T3 GA3 @100 PPM, T4 NAA @100 PPM, T5 NAA @150 PPM, T6 Boron @ 2%, T7 GA3 @ 60 PPM + Boron 2%, T8 GA3 @ 100 PPM + Boron

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@ 2% and T9 NAA @ 100 PPM + Boron @ 2% and T1 Control No PGR and no micronutrient (Control) are used. The results showed that the treatment involving use of T8 GA3 @ 100 PPM + Boron @ 2% was recorded highest plant growth, yield and quality of cauliflower as compared to other treatments.

**Keywords:** PGR; micronutrient; growth; yield; quality and cauliflower.

## 1. INTRODUCTION

Cauliflower (*Brassica oleracea* var. *botrytis* L.) is the most widely cultivated cruciferous vegetable among the cole crops in India. This crop is indigenous to Southern Europe in the Mediterranean region and was introduced to India from England in 1822 by Dr. Jemson (Chatterjee and Swarup, 1972). The edible portion of the cauliflower is known as the 'Curd', which represents the 'prefloral fleshy apical meristem'. An analysis of the production trends for cauliflower reveals a commendable increase in both area and productivity over the past five years. China ranks first in production, yielding 10,263,746 tons annually, while India ranks second with an annual output of 8,199,000 tons. The highest cauliflower production in India is recorded in West Bengal, followed by Madhya Pradesh, Bihar, Gujarat, Haryana, Orissa, Chhattisgarh, Punjab, Uttar Pradesh, and Assam (NHB 2021-22). In Uttar Pradesh, cauliflower production reached 436.77 MT, accounting for 4.71 percent of India's total cauliflower production (NHB 2021-22). This crop is cultivated annually and is significant for its edible component known as the 'curd,' which represents the pre-floral apical meristem of the plant. The fresh curd is highly nutritious, containing 90.8 g of moisture, 2.6 g of protein, 0.4 g of fat, 1.0 g of minerals, 1.2 g of fiber, 4.0 g of carbohydrates, 33.0 mg of calcium, 57.0 mg of phosphorus, 1.5 mg of iron, 30.0 mg of carotene, 0.04 mg of thiamine, 0.10 mg of riboflavin, 1.0 mg of niacin, and 56.0 mg of vitamin C per 100 g of the edible portion (Jood and Neelam, 2011). Plant growth regulators (PGRs) such as Naphthalene Acetic Acid (NAA), Gibberellic Acid (GA3), and Indole-3-butyric acid (IBA) are crucial for enhancing the growth, yield, and Quality of cauliflower. NAA facilitates vegetative growth and flowering, while GA3 promotes cell division, stem elongation, and overall plant development. IBA enhances root formation, resulting in healthier plants and increased yields. Studies have indicated that PGRs can significantly boost cauliflower productivity, leading to greater plant height, root weight, and fresh weight (Kotecha et al., 2011), (Colebrook et al., 2014), (Swamy et al., 2021),

and (Rawat et al., 2002). Although there is existing research on sowing times and plant geometry in Chhattisgarh, further investigation into plant growth regulators (PGRs) could enhance cauliflower cultivation. Micronutrients are crucial for the growth and development of plants, even though they are needed in minimal quantities. Their absence can lead to physiological disorders that negatively impact both the yield and quality of cauliflower. Micronutrients contribute to the chemical composition of the curd and the overall health of the plant. They facilitate the uptake of macronutrients, boost production and quality by enhancing photosynthetic activity, and increase the metabolite content in leaves. Additionally, they help decrease the prevalence of diseases, pests, and disorders, thereby improving the post-harvest quality of the curd (Ranjan et al., 2020).

## 2. MATERIALS AND METHODS

The present study, titled "Effect of PGR and micronutrient on growth yield and quality of cauliflower (*Brassica oleracea* L. var. *Botrytis*) Cv Pusa Deepali" was conducted at the Horticulture Research Farm, Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur (U.P.), Kanpur during the rabi season 2024-2025. Positioned approximately 25 km from the district headquarters of Uttar Pradesh 208024. The farm is situated at 20°16' North latitude and 80°08' East longitude in the southwestern plains of Uttar Pradesh. It sits at an altitude of 180 meters above sea level, falling within the subtropical zone. The field was effectively leveled, equipped with adequate irrigation and drainage facilities. Prior to the current study, any stubble from the previous crop and weeds were manually removed from the field. The experiment was laid out Randomized block design (RBD) with three replications. With the variety Pusa Deepali. The size of each plot was 2.5 x 1.8m (4.5m<sup>2</sup>) with a spacing of 60 x 45 cm counting 16 plants per plot. The treatment combinations are T<sub>1</sub>: Control No PGR and no micronutrient (Control), T<sub>2</sub>: GA3 @ 60 PPM, T<sub>3</sub>: GA3 @100 PPM, T<sub>4</sub>: NAA @100 PPM, T<sub>5</sub>: NAA @150 PPM, T<sub>6</sub>: @ 0.2%, T<sub>7</sub>: GA3 @ 60 PPM +

2%, T<sub>8</sub>: GA3 @ 100 PPM + @ 2% and T<sub>9</sub>: NAA @ 100PPM + @ 2%. The data were taken from randomly selected five plants from each plot on various characters viz., plant height (cm), number of leaves per plant, length of leaves (cm), width of leaves (cm), stem diameter (cm), stem length (cm), days to curd formation stage, days to marketable curd maturity, curd diameter (cm), total biomass production per plant (g), curd weight (g), curd yield per plot (kg plot<sup>-1</sup>), curd yield (q ha<sup>-1</sup>) and TSS (°Brix). The data gathered from five randomly chosen plants regarding the aforementioned parameters were analyzed using the analysis of variance (ANOVA) method, and the least significant difference test was employed to distinguish between the various treatment means (Panse and Sukhatme, 1967).

### 3. RESULTS AND DISCUSSION

The findings of the present study as depicted in Table 1 revealed significant effect of plant growth regulators and micronutrients on vegetative growth parameters of cauliflower. Application of T<sub>8</sub> GA3 @ 100 PPM + @ 2% recorded maximum plant height (59.20cm) followed by T<sub>7</sub> GA3 @ 60 PPM + 2%, T<sub>9</sub> NAA @ 100PPM + @ 2%, T<sub>3</sub> GA3 @100 PPM and T<sub>2</sub> GA3 @ 60 PPM, Whereas the minimum plant height (38.79cm) was recorded in treatment T<sub>1</sub>Control No PGR and no micronutrient (Control). Application of T<sub>8</sub> GA3 @ 100 PPM + @ 2% recorded maximum number of leaves per plant (18.64) which was statistically at par with treatment T<sub>7</sub> GA3 @ 60 PPM + 2% and T<sub>9</sub> NAA @ 100PPM + @ 2%. Whereas the minimum number of leaves per plant (10.18) was recorded in treatment T<sub>1</sub>Control No PGR and no micronutrient (Control). This result was might be due to increase the cell division and elongation of cells in sub apical meristem. GA3 stimulate growth and cell expansion of cells through increasing the plasticity of cells. Similar results also obtained by Dhengle and Bhosle (2007) and Mishra et al. (1986). Application of T<sub>8</sub> GA3 @ 100 PPM + @ 2% recorded maximum length of leaves (cm) (38.47) followed by T<sub>9</sub> NAA @ 100PPM + @ 2%, T<sub>7</sub> GA3 @ 60 PPM + 2% and T<sub>3</sub> GA3 @100 PPM. Whereas the minimum length of leaves (cm) (25.47) was recorded in treatment T<sub>1</sub>Control No PGR and no micronutrient (Control). Application of T<sub>8</sub> GA3 @ 100 PPM + @ 2% recorded maximum width of leaves (cm) (23.74) which was statistically at par with treatment T<sub>7</sub> GA3 @ 60 PPM + 2%. Whereas the minimum width of leaves (cm) (13.62) was recorded in treatment T<sub>1</sub>Control No

PGR and no micronutrient (Control). The increase in length of leaves might be due to increase in meristematic activity of the apical tissue on GA3 application. Also, GA3 was involved in increasing photosynthetic activity, efficient translocation and utilization of photosynthates causing rapid cell division, cell elongation and cell differentiation at growing region of the plant leaves leading to stimulation of growth. Similar findings were observed by Prakash et al. (2023) and Sonam et al. (2020). Application of T<sub>8</sub> GA3 @ 100 PPM + @ 2% recorded maximum stem diameter (cm) (3.93) which was statistically at par with treatment T<sub>7</sub> GA3 @ 60 PPM + 2% and T<sub>9</sub> NAA @ 100PPM + @ 2%. Whereas the minimum stem diameter (cm) (2.44) was recorded in treatment T<sub>1</sub>Control No PGR and no micronutrient (Control). The highest stem diameter recorded by GA3 application it might be due to that GA3 plays an important role in stem or internode elongation. It stimulates cell division and cell expansion. Similar result obtained by Mandingbam et al. (2020) and Prakash et al. (2023). Application of T<sub>8</sub> GA3 @ 100 PPM + @ 2% recorded maximum stem length (cm) (16.79) which was statistically at par with treatment T<sub>7</sub> GA3 @ 60 PPM + 2% and T<sub>9</sub> NAA @ 100PPM + @ 2%. Whereas the minimum stem length (cm) (12.36) was recorded in treatment T<sub>1</sub>Control No PGR and no micronutrient (Control). The highest stem length recorded by GA3 application it might be due to that GA3 plays an important role in stem or internode elongation. It stimulates cell division and cell expansion. Similar result obtained by Meena et al. (2018). Minimum days to curd formation i.e. 53.86 was found with treatment T<sub>8</sub> GA3 @ 100 PPM + @ 2% which was statistically at par with treatment T<sub>7</sub> GA3 @ 60 PPM + 2% and T<sub>9</sub> NAA @ 100 PPM + @ 2%. Whereas the maximum Days to curd formation stage (63.99) was found in Control No PGR and no micronutrient (Control). Minimum Days to marketable curd maturity i.e. 72.08 days were taken under treatment T<sub>8</sub> GA3 @ 100 PPM + @ 2%. It was followed by T<sub>7</sub> GA3 @ 60 PPM + 2%, T<sub>9</sub> NAA @ 100PPM + @ 2% and T<sub>3</sub> GA3 @100 PPM. Whereas the maximum Days to marketable curd maturity (87.51) were taken under treatment T<sub>1</sub> Control No PGR and no micronutrient (Control). Maximum curd diameter (17.65 cm) was recorded with treatment T<sub>8</sub> GA3 @ 100 PPM + @ 2% which is significantly superior over all the treatment. It was followed by T<sub>7</sub> GA3 @ 60 PPM + 2% and T<sub>9</sub> NAA @ 100 PPM + @ 2% respectively.

**Table 1. Effect of PGR and micronutrient on growth, yield and quality of cauliflower (*Brassica oleracea* L. var. *Botrytis*) Cv Pusa Deepali**

S. N.	No. of Treatments	Plant height (cm)	Number of leaves per plant	Length of leaves (cm)	Width of leaves (cm)	Stem diameter (cm)	Days to curd formation stage	Days to marketable curd maturity	Curd diameter (cm)	Total biomass production per plant (g)	Curd weight (g)	Curd yield per plot (kg plot <sup>-1</sup> )	Curd yield (q ha <sup>-1</sup> )	TSS (°Brix)
2	T <sub>2</sub>	38.79	10.18	25.47	13.62	12.36	63.99	87.51	12.70	688.17	368.51	5.90	131.03	3.20
3	T <sub>3</sub>	52.68	17.20	32.37	18.93	16.15	58.72	78.50	14.72	875.53	500.76	8.01	178.05	4.64
4	T <sub>4</sub>	53.77	17.56	35.33	20.40	15.84	58.44	77.88	15.25	893.56	489.53	7.83	174.05	5.07
5	T <sub>5</sub>	51.26	16.28	30.93	18.37	15.42	58.86	78.97	14.19	861.39	432.19	6.91	153.67	5.28
6	T <sub>6</sub>	50.50	14.40	29.71	16.49	15.17	60.04	81.49	13.32	838.26	468.23	7.49	166.48	4.51
7	T <sub>7</sub>	48.82	14.52	28.27	15.29	14.15	61.37	82.03	13.09	814.52	428.02	6.85	152.18	4.16
8	T <sub>8</sub>	57.68	18.43	36.42	23.52	16.58	55.61	74.39	17.26	965.47	569.50	9.11	202.49	5.30
9	T <sub>9</sub>	59.20	18.64	38.47	23.74	16.79	53.86	72.08	17.65	971.54	632.07	10.11	224.74	5.46
		55.88	18.20	34.70	22.89	16.42	56.25	75.36	15.81	953.54	608.79	9.74	216.46	5.12
	<b>F-Test</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>
	<b>C.D. at 0.5%</b>	<b>1.431</b>	<b>0.771</b>	<b>1.494</b>	<b>0.573</b>	<b>0.242</b>	<b>0.744</b>	<b>0.790</b>	<b>0.396</b>	<b>6.796</b>	<b>6.864</b>	<b>0.109</b>	<b>2.416</b>	<b>0.162</b>
	<b>S.Ed. (+)</b>	<b>0.675</b>	<b>0.364</b>	<b>0.705</b>	<b>0.270</b>	<b>0.114</b>	<b>0.351</b>	<b>0.373</b>	<b>0.187</b>	<b>3.206</b>	<b>3.238</b>	<b>0.051</b>	<b>1.140</b>	<b>0.076</b>

While minimum curd diameter (12.70) was observed under treatment T<sub>1</sub> Control No PGR and no micronutrient (Control). Maximum curd diameter was recorded in GA3 this might be due to the effect of GA3 on enlargement of cells, elongation of cells and cambial activity. Also increase in accumulation of carbohydrates may due to GA3 which give better photosynthesis in plant Satya et al., (2025). Maximum total biomass production per plant (g) (971.54) was recorded with treatment T<sub>8</sub> GA3 @ 100 PPM + Boron @ 2% which is significantly superior over all the treatment. It was followed by T<sub>7</sub> GA3 @ 60 PPM + 2% and T<sub>9</sub> NAA @ 100PPM + @ 2% respectively. While minimum total biomass production per plant (g) (688.17) was observed under treatment T<sub>1</sub> Control No PGR and no micronutrient (Control). Maximum curd weight (g) (632.07) was recorded with treatment T<sub>8</sub> GA3 @ 100 PPM + Boron @ 2% which is significantly superior over all the treatment. It was followed by T<sub>7</sub> GA3 @ 60 PPM + 2% and T<sub>9</sub> NAA @ 100PPM + @ 2% respectively. While minimum curd weight (g) (368.51) was observed under treatment T<sub>1</sub> Control No PGR and no micronutrient (Control). Maximum Curd yield per plot (kg plot<sup>-1</sup>) (10.11) was recorded with treatment T<sub>8</sub> GA3 @ 100 PPM + Boron @ 2% which is significantly superior over all the treatment. It was followed by T<sub>7</sub> GA3 @ 60 PPM + 2% and T<sub>9</sub> NAA @ 100PPM + @ 2% respectively. While minimum Curd yield per plot (kg plot<sup>-1</sup>) (5.90) was observed under treatment T<sub>1</sub> Control No PGR and no micronutrient (Control). Maximum Curd yield (q ha<sup>-1</sup>) (224.74) was recorded with treatment T<sub>8</sub> GA3 @ 100 PPM + @ 2% which is significantly superior over all the treatment. It was followed by T<sub>7</sub> GA3 @ 60 PPM + 2% and T<sub>9</sub> NAA @ 100PPM + @ 2% respectively. While minimum Curd yield (q ha<sup>-1</sup>) (131.03) was observed under treatment T<sub>1</sub> Control No PGR and no micronutrient (Control). Highest yield parameters were recorded in treatments GA3 this might be due to more accumulation of carbohydrates by maximum rate of photosynthesis and accumulation of storage food and increasing cell elongation, cell division and cell expansion which directly led to increase in yield. Highest yield parameters were recorded in treatments GA3 this might be due to more accumulation of carbohydrates by maximum rate of photosynthesis and accumulation of storage food and increasing cell elongation, cell division and cell expansion which directly led to increase in yield. Similar findings were also observed by Mandingbam et al. (2020), Thapa et al. (2013), Jakhar et al. (2018) and Prakash et al. (2023).

Maximum Total soluble solid (<sup>o</sup>Brix) (5.46) was recorded with treatment T<sub>8</sub> GA3 @ 100 PPM + @ 2% which is significantly superior over all the treatment. It was followed by T<sub>7</sub> GA3 @ 60 PPM + 2% and T<sub>9</sub> NAA @ 100PPM + @ 2% respectively. While minimum Total soluble solid (<sup>o</sup>Brix) (3.20) was observed under treatment T<sub>1</sub> Control No PGR and no micronutrient (Control).

#### 4. CONCLUSION

It may be concluded from the finding of the present study that among the foliar application of PGR and micronutrient, treatment T<sub>8</sub> GA3 @ 100 PPM + @ 2% was recorded superior performance for growth, yield and quality attributes of cauliflower.

#### DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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