Plant Archives Vol. 26, No. 2, 2026 pp. 3226-3230 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.no.2.447

GIBBERELLIC ACID-MEDIATED ENHANCEMENT OF GROWTH, YIELD AND QUALITY IN CHILLI (*Capsicum annuum* L.) CV. KASHI ANMOL UNDER VARANASI CONDITIONS

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ABSTRACT

Chilli (*Capsicum annuum* L.) is an economically important spice and vegetable crop valued for its nutritional and medicinal properties. The present study was conducted to evaluate the effect of different concentrations of gibberellic acid (GA_3) on the growth, yield and quality of chilli cv. Kashi Anmol under the agro-climatic conditions of Varanasi. The experiment was carried out during *rabi* 2024–25 at the Vegetable Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. Nine treatments comprising GA_3 concentrations of 15, 30, 45, 60, 75, 90, 105 and 120 ppm, along with a distilled-water control, were evaluated in a Randomized Block Design with three replications. Foliar application of GA_3 was carried out at 30 and 90 days after transplanting. Significant variation was observed among treatments for growth, yield and quality attributes. GA_3 at 75 ppm (T_5) recorded the highest number of primary branches (4.26), plant spread (74.10 cm), stem diameter (1.48 cm), fruit length (7.18 cm), fruit weight (3.30 g), fruit yield (230.50 q ha^{-1}) and ascorbic acid content (95.99 mg 100 g^{-1} fresh weight). Application of GA_3 at 90 ppm (T_6) resulted in maximum plant height at 45 and 90 days after transplanting (40.80 and 74.10 cm, respectively), number of fruits per plant (253.40), fruit width (1.09 cm) and number of seeds per fruit (77.80). The untreated control recorded comparatively lower values for the evaluated traits. The results indicated that foliar application of GA_3 enhanced vegetative growth, fruit development, productivity and nutritional quality of chilli. Among the concentrations evaluated, GA_3 at 75 ppm was found to be the most effective treatment, followed by 90 ppm, for improving the overall performance of chilli cv. Kashi Anmol under Varanasi conditions.

***Key words*:** Chilli, GA_3, Kashi Anmol, growth, yield, quality.

Introduction

Vegetables are vital for food security and nutrition, providing essential vitamins, minerals, antioxidants and dietary fibre that support health and immunity while reducing disease risk. Regular consumption also supports normal physiological functions and contributes to overall well-being (Muduli *et al.*, 2025). Among vegetable crops, the Solanaceae family occupies an important position because of its contribution to food security, nutrition and agricultural economies. It includes major crops such as potato, tomato, brinjal, chilli and capsicum (Madhusudhana, 2023). Among these, chilli has a distinct importance due to its wide culinary, medicinal and industrial uses. It is one of the most extensively cultivated spice crops worldwide and is valued for its pungency, colour and flavour (Padmanabhan *et al.*, 2016). Chilli is valued for its nutritional richness, particularly its vitamins A, C and E, antioxidant properties and capsaicin content (Litoriya *et al.*, 2014). Beyond its culinary and medicinal uses, it serves as an important raw material for sauces, pickles,

powders, oleoresins and natural colour products, contributing significantly to its economic importance in domestic and international markets (Liu *et al.*, 2023). Andhra Pradesh, Telangana, Karnataka, Tamil Nadu and Maharashtra are the major chilli-producing states, with Andhra Pradesh contributing nearly 57% of India's total production (Anonymous, 2025).

Excessive flower and fruit shedding limits chilli yield by reducing fruit set. Plant growth regulators and phytohormones play important roles in regulating plant growth and reproductive development and in modulating source-sink relationships and assimilate partitioning toward developing sink organs such as fruits and seeds (Jegatheeswaran *et al.*, 2026; Rahman *et al.*, 2026). Plant growth regulators, whether natural or synthetic, are widely used in modern horticulture to regulate crop development (Das *et al.*, 2025). Several studies have reported their effectiveness in improving flower retention, fruit set, fruit development and yield in vegetable crops (Kumari *et al.*, 2016). GA_3 has gained considerable attention due to its beneficial effects on crop growth, yield and productivity (Veishnav *et al.*, 2012).

Gibberellic acid (GA_3) is a widely used plant growth regulator that promotes vegetative and reproductive growth in horticultural crops. It influences stem elongation, seed germination, dormancy breaking, flowering and fruit development (Sharma *et al.*, 2024; Singh *et al.*, 2017). Foliar application of GA_3 promotes vegetative growth and crop performance in chilli by influencing key growth and reproductive processes. Recent findings also indicate its potential to improve growth and quality attributes of green chilli (Hembram *et al.*, 2026).

However, the response to GA_3 depends on its concentration, application timing and crop growth stage. An appropriate dose is therefore essential, as excessive application may favour vegetative growth over fruit production. Optimizing GA_3 concentration can help maximize growth, yield and quality while avoiding undesirable effects (Swamy, 2023). Therefore, the present study was undertaken to evaluate the effect of different concentrations of foliar-applied GA_3 on growth, yield and quality attributes of chilli cv. Kashi Anmol under the agro-climatic conditions of Varanasi.

Materials and Methods

The experiment was conducted during the *rabi* season of 2024-25 at the Vegetable Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India. Its coordinates are 25°26'4'' North latitude and 83°99'3'' East longitude. During the experiment, the recorded minimum and maximum temperatures ranged from 7.1°C to 26.2°C and from 15.2°C to 40.9°C, respectively. The observed morning relative humidity varied between 49% and 97%, whereas the evening relative humidity ranged from 24% to 80%. Gibberellic acid applied foliar to the crop @ 15 mg/L, 30 mg/L, 45 mg/L, 60 mg/L, 75 mg/L, 90 mg/L, 105 mg/L and 120 mg/L along with the control (Table 1). The study comprised nine treatments along with a control (water spray), laid out in a Randomized Block Design with three replications.

Chilli cv. Kashi Anmol was raised in the nursery and transplanted into the main field at the 60 × 60 cm spacing. The required quantity of GA_3 was dissolved and diluted with water to prepare the respective concentrations for foliar application. Two foliar applications were made at 30 and 90 days after transplanting. Each plot consisted of five rows, with five plants per row. Observations were recorded from five randomly selected competitive plants in each treatment. The study assessed a plant height (cm), number of primary branches per plant, plant spread (cm), stem diameter (cm), number of fruits per plant, fruit length (cm), fruit width (cm), average fruit weight (g) and yield per hectare (q) and ascorbic acid (mg/100 g FW). Data were subjected to Analysis of Variance (ANOVA) and treatment means were compared using the critical difference (CD) at the 5 % level, while Sem ± and Sed ± were computed to assess statistical precision.

Results and Discussion

Growth attributes

The application of gibberellic acid (GA_3) significantly influenced the growth, yield and quality attributes of chilli. Plant height increased progressively with GA_3 application, with the tallest plants recorded under GA_3 90 ppm at both 45 and 90 days after transplanting (DAT), measuring 40.80 and 74.10 cm, respectively, compared with 26.66 and 61.68 cm in the control (Table 2). The increase in

Table 1: Treatment and concentration details of gibberellic acid used in Chilli.

Treat-ment	Quantity of Gibberellic acid (mg/l)	Concentration (ppm)	Growth regulator
T_1	15	15	Gibberellic acid
T_2	30	30	Gibberellic acid
T_3	45	45	Gibberellic acid
T_4	60	60	Gibberellic acid
T_5	75	75	Gibberellic acid
T_6	90	90	Gibberellic acid
T_7	105	105	Gibberellic acid
T_8	120	120	Gibberellic acid
T_9	-	-	Distilled water

Table 2: Influence of GA_3 concentrations on growth attributes of chilli.

Treat-ments	PH 45 DAT	PH 90 DAT	NPBP	PS	SD
T_1	30.90	62.05	3.15	62.80	0.83
T_2	31.60	62.28	3.35	63.36	0.86
T_3	32.80	67.99	3.68	67.70	0.95
T_4	36.59	71.98	4.10	71.58	1.13
T_5	39.64	72.65	4.26	74.10	1.48
T_6	40.80	74.10	4.18	72.22	1.44
T_7	34.10	68.85	3.64	69.66	0.99
T_8	31.79	66.90	3.45	66.90	0.92
T_9	26.66	61.68	2.74	60.80	0.77

PH: Plant height; NPBP: Number of primary branches per plant; PS: Plant spread (cm); SD: Stem diameter (cm)

plant height may be attributed to the stimulatory role of gibberellic acid in cell division and cell elongation, which promotes internodal elongation and overall vegetative growth. Similar effects of GA_3 application on plant height in chilli were reported by Choudhary *et al.*, (2023) and Tripathi *et al.*, (2025). The number of primary branches per plant was also significantly affected by GA_3 application. The maximum number of primary branches (4.26) was recorded with GA_3 75 ppm, compared with 2.74 in the control. Enhanced branching under GA_3 application may be associated with increased cell division and elongation, resulting in vigorous vegetative growth and greater lateral shoot development. Similar observations were reported by Das and Sheikh (2023) in chilli and Eissa *et al.*, (2025) in tomato. Plant spread also responded significantly to GA_3 application, with the maximum spread of 74.10 cm recorded under GA_3 75 ppm compared with 60.80 cm in the control. The greater canopy development may be attributed to the stimulatory effect of GA_3 on cell division and elongation, thereby promoting vigorous vegetative growth and lateral expansion. Purba and Siyum (2025) also reported a similar improvement in plant spread in chilli following GA_3 application. Stem diameter was likewise significantly increased by GA_3 treatments. The highest stem diameter (1.48 cm) was observed with GA_3 75 ppm, whereas the control recorded only 0.77 cm. The increase in stem thickness may be related to enhanced cell division and enlargement along with greater accumulation and translocation of photosynthates towards stem tissues. Similar findings were reported by Das and Sheikh (2023) in chilli and Sinha *et al.*, (2025) in tomato.

Yield attributes

Gibberellic acid application significantly improved the yield-related attributes of chilli. The maximum number of fruits per plant (253.40) was recorded with GA_3 90 ppm, compared with 194.00 fruits per plant in the control (Table 3). The increase in fruit number may be associated with improved flowering, fruit set and efficient translocation of assimilates towards developing fruits. Comparable results were reported by Tripathi *et al.*, (2025) in chilli and Nayak *et al.*, (2024) in tomato. Fruit width was also enhanced by GA_3 application, with the widest fruits (1.09 cm) recorded under GA_3 90 ppm compared with 0.80 cm in the control, representing a 36.25% increase. The improvement in fruit width may be attributed to enhanced cell division and elongation during fruit development, resulting in greater fruit expansion. Similar responses have been reported by Pandey *et al.*, (2025) and Nayak *et al.*, (2024) in tomato. Fruit length was significantly influenced by GA_3 application, with the maximum length of 7.18 cm recorded under GA_3 75 ppm, compared with 4.98 cm in the control, representing a 44.18% increase over the control. The greater fruit length may be explained by the stimulatory effect of GA_3 on cell division and elongation during fruit development. Misu *et al.*, (2023) in brinjal and Choudhary *et al.*, (2023) in chilli reported similar improvements in fruit growth following growth regulator application. Fruit weight also increased with GA_3 application, reaching a maximum of 3.30 g under GA_3 75 ppm compared with 2.60 g in the control. The increase in fruit weight may be attributed to enhanced cell division and enlargement and efficient translocation of photosynthates towards developing fruits. Similar findings were reported by Tripathi *et al.*, (2025) in chilli and Rehman and Yadav (2022) in capsicum. The improvement in individual yield components was reflected in overall productivity. The highest yield of 230.50 q ha^{-1} was recorded under GA_3 75 ppm, compared with 185.13 q ha^{-1} in the control. The higher productivity under GA_3 application may be associated with improved vegetative growth, enhanced flowering and fruit set, better fruit retention and increased

Table 3: Effect of GA_3 application on yield characteristics of chilli.

Treatments	NFPP	FL	FW	FWG	YP
T_1	30.90	62.05	3.15	62.80	0.83
T_2	31.60	62.28	3.35	63.36	0.86
T_3	32.80	67.99	3.68	67.70	0.95
T_4	36.59	71.98	4.10	71.58	1.13
T_5	39.64	72.65	4.26	74.10	1.48
T_6	40.80	74.10	4.18	72.22	1.44
T_7	34.10	68.85	3.64	69.66	0.99
T_8	31.79	66.90	3.45	66.90	0.92
T_9	26.66	61.68	2.74	60.80	0.77

NFPP: Number of fruits per plant; FL: Fruit length (cm); FW: Fruit width (cm); FWG: Fruit weight (g); YP: Yield per ha (q)

Table 4: Effect of GA_3 application on quality characteristics of chilli.

Treat-ments	Number of seeds per fruit	Ascorbic acid (mg/100 g FW)
T_1	64.40	82.70
T_2	66.40	83.94
T_3	65.20	90.67
T_4	74.54	93.58
T_5	74.13	95.99
T_6	77.80	94.82
T_7	68.90	91.55
T_8	66.80	87.82
T_9	52.30	77.82

fruit weight. Rathod *et al*., (2026) and Sathawane *et al*., (2025) reported similar improvements in chilli yield with GA_3 application.

Quality attributes

GA_3 application also significantly affected the quality attributes of chilli fruits. The maximum number of seeds per fruit (77.80) was recorded under GA_3 90 ppm, whereas the control produced 52.30 seeds per fruit (Table 4). The increase in seed number may be associated with improved flowering, enhanced pollen viability, better fertilization and more efficient fruit development, ultimately resulting in greater seed formation. Similar observations were reported by Sony *et al*., (2022) in chilli and Kumar *et al*., (2014) in tomato. Ascorbic acid content was also enhanced by GA_3 application, with the highest value of 95.99 mg/100 g fresh weight recorded under GA_3 75 ppm compared with 77.82 mg/100 g fresh weight in the control. The improvement in ascorbic acid content may be attributed to enhanced metabolic activity, improved nutrient utilization and increased biosynthesis of quality constituents under GA_3 application. Singh and Singh (2019) in chilli and Kumar *et al*., (2014) in tomato also reported improvement in fruit quality following growth regulator application. Overall, the results indicate that GA_3 application, particularly at 75 ppm, promoted vegetative growth, yield formation and fruit quality in chilli, although certain attributes such as plant height, fruit number and seed number showed their maximum response at 90 ppm.

Conclusion

The study revealed that GA_3 at 75 ppm (T_5) was the most effective treatment followed by 90 ppm (T_6) for improving growth, yield and quality of chilli. GA_3 application promoted vegetative development with greater plant height, branching, plant spread and stem diameter. It also enhanced yield attributes including fruits per plant, fruit length, fruit weight and overall productivity. Fruit quality was improved through higher ascorbic acid content, while 90 ppm GA_3 produced the maximum number of seeds per fruit. Thus, among the concentrations evaluated, GA_3 at 75 ppm produced the highest values for several important growths, yield and quality attributes, while 90 ppm recorded the maximum plant height, number of fruits per plant, fruit width and seeds per fruit.

Disclaimer (Artificial Intelligence)

Author(s) hereby declares 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.

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