



Growth and Flowering of Liliium (*Lilium longiflorum*) cv. Eremo as Affected by CCC and GA₃ under Naturally Ventilated Polyhouse Conditions of Prayagraj

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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

The present investigation was carried out under naturally ventilated polyhouse conditions, Department of Horticulture, SHUATS, Prayagraj, during November, 2023 to March, 2024. The experiment was laid out in Randomized Block Design (RBD) with three replications. There were nine treatments comprising of Cycocel (CCC) and Gibberellic Acid (GA₃) at different concentrations viz., GA₃ (100, 200, 300 and 400 ppm) and CCC (100, 200, 300 and 400 ppm) along with Water spray. The results revealed foliar application of 300 ppm GA₃ for Liliium significantly enhanced the number of leaves (71.83), plant height (76.47 cm), plant spread (15.44 cm), leaf area (9.73 cm²), number of buds (3.40), at 300 ppm of GA₃ it takes lesser days taken for bud initiation (40.40), and also less days taken for first flower opening from planting (68.53), flower bud

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length (8.83 cm), flower stalk length (12.43 cm), stalk length (78.10 cm), self-life (12.97 days), flower yield per plant (3.40) and flower yield for 250 m²(6296.29) . Among the different treatments, the highest Gross return is 188888.7 Rs/250 m², Net return is 120870.75 Rs/250 m² and Benefit cost ratio is 2.77, obtained by the application of 300 ppm of GA₃.Whereas in terms of only Bulb parameters, foliar application of 200 ppm of CCC for Liliium reported maximum number of bulblets per plant (4.11) and gives maximum weight of bulb per plant (74.07g).

Keywords: *Lilium*; *Eremo*; GA₃; CCC; polyhouse.

1. INTRODUCTION

Lilium (*Lilium longiflorum*) is one of the most important bulbous flower, belongs to Liliaceae family, commercially grown for cut flowers. They add some excitement to any bouquet with their exotic vibes and their colour palette. They are one of the world's most easily recognisable flowers. These flowers look beautiful in bouquets of cut flowers and they are long lasting. Lilies are the genus of bulbous flowering plant with its basic chromosome number 12. Most of the liliium species are originated from the northern hemisphere [Lim and Van, 2011]. *Lilium* is a species of more economic importance in the production and commercialization of cut flowers in the international market [1] liliium as cut flowers occupies 4 th position in the world cut flower trade. They are extensively grown in green houses as a cut flower in the global flower trade due to a wider choice of the growing periods, attractive colours and due to its everlasting quality.

These flowers are propagated by bulbs. The Netherlands, Japan and U.S.A. are the prime producers of both cut flowers and bulbs. The commercial cultivation of *Lilium* in India [2] has been restricted to the states; Tamil Nadu, Kerala, Karnataka, Himachal Pradesh, Uttar Pradesh and Maharashtra. *Lilium* has been known for its aesthetic beauty and has been depicted as a symbol of purity and kingship. *Lilium* is one of the important geophytes, endowed with showy and attractive flowers, appealing colour pattern and durable flowers. Flower colour varies from orange, red, yellow, pink, white etc. These are late flowering in nature, plants are tall with large and broad leaves. Flowers are large, fragrant and they tend to be outward facing. They are also compact, with plant height of 60-150 cm that bears 4-5 flowers per stalk. Flowers are of 15-20 cm diameter that may point up, out or down and stalk length may vary from 50 to 100 cm.

Large and attractive flowers with the capacity to rehydrate after long distance transportation have

made Lilies gain popularity fast in India. The cultivars are highly appreciated for their outstanding range of colours, fragrances, and adaptability to many of the environmental conditions" [3]. However, nearly all the cut flowers of *Lilium* available in the florists' shop are being acquired from Bengaluru, Pune and hilly areas like Himachal Pradesh, Uttarakhand and North Eastern regions. However, Asiatic lily varieties/hybrids grown by amateurs in the state of Uttar Pradesh are coming up well and blooming in a wide range of colours, sizes, and shapes.

Research work on the use of gibberellins and cycocels improving bulb and corm multiplication rate as well as bulb and corm enlargement. The plant growth regulators can also enhance, hasten, or delay the flowering time in some plant species. Gibberellic acids play a great role in regulation of bulb production and breaking dormancy of bulb. Gibberellic acid application has resulted increased percentage of germination rate. Gibberellins, a plant growth promoter has the effect of prevention of genetic dwarfism, induction of bolting and flowering by stimulating cell division and cell elongation in the sub-apical meristem. It enhances flowering in short day plants under inductive conditions. Cycocels helps in bulb production, stem elongation and retards the vegetative growth of the plant which enables for early commencement of flowering. Plant growth promoters like CCC and GA₃ known to increase plant growth, flower yield, bulb production and extending the self-life of flowers. According to some other reports, gibberellins induced early flowering and prolonged flower life. Growth and yield were enhanced by application of Gibberellic acid (GA₃) [4, 5], and Cycocel (CCC) [6].

2. MATERIALS AND METHODS

The present investigation was carried out under naturally ventilated polyhouse, Department of Horticulture, SHUATS, Prayagraj, during November, 2023 to March, 2024. The *Lilium* bulbs

of Eremo variety were planted on raised bed, containing a mixture of soil, farm yard manure and vermicompost of ratio 2:1:1. Before planting the bulbs treated with fungicide solution of Bavistin @2g/l for 1 hr. The treated bulbs were planted at a spacing of 30 cm x 45 cm on the bed and light irrigation was given after planting. And at the time of planting vermicompost applied along with the bulbs. Immediate irrigation was given after planting of bulbs. Whenever, the soils show low moisture content, we can do watering. Mostly I watered in the morning hours. The experiment was conducted in Randomized Block Design (RBD) with nine treatments and three replications. Also, in this experiment, plant was sprayed with Gibberellic acid (GA₃) (at 100, 200, 300, 400 ppm), and Cycocel (CCC) (at 100, 200, 300, and 400 ppm) and water spray after planting of Liliun bulbs. The treatments were sprayed at 20, 40, 60 days of intervals. Three plants were selected randomly from each treatment per replication and their observations were recorded at 20 days interval.

Table 1. Treatment details

Sl. No.	Symbol	Treatment
1	T ₀	WATER SPRAY
2	T ₁	GA ₃ @ 100 ppm
3	T ₂	GA ₃ @ 200 ppm
4	T ₃	GA ₃ @ 300 ppm
5	T ₄	GA ₃ @ 400 ppm
6	T ₅	CCC @ 100 ppm
7	T ₆	CCC @ 200 ppm
8	T ₇	CCC @ 300 ppm
9	T ₈	CCC @ 400 ppm

3. RESULTS AND DISCUSSION

Effect of different concentrations of CCC and GA₃ on Vegetative, Flowering, Yield, Bulb and economic parameters of Liliun are presented in Tables 2, 3, 4 and 5 respectively.

3.1 Vegetative Parameters

3.1.1 Number of leaves

Among all the treatments, the maximum number of leaves was observed in T₃ - GA₃ @ 300 ppm (71.83) which was found to be at par with T₂ - GA₃ @ 200 ppm (64.07) while, minimum was reported in T₀ - water spray (56.43).

Pal and Das [7] reported GA₃ influencing the increased vegetative growth by increasing cell division and cell elongation is the reason behind

the production of more number of leaves per plant.

3.1.2 Plant height (cm)

As mentioned in Table 1, the plant height were the plants treated with GA₃ at 300 ppm is (76.47) which was found to be at par with T₂- GA₃ @ 200 ppm (72.83) while, minimum was reported in T₀- water spray (61.00).

Nariya et al. [8], Aparna et al. [9] reported GA₃ induce m-RNA synthesis pertaining to hydrolytic enzymes, which promotes mitotic activity in apical meristem and increase cell division and cell elongation, leading to increased length of internodes, in turn increases the plant height. Providing conducive environment inside the naturally ventilated polyhouse at night time helped in better plant height also.

3.1.3 Plant spread (cm)

Plant spread is the way of plant grows and develops over a flat surface; here among all the treatments, the maximum Plant spread (cm) was observed with T₃- GA₃ @ 300 ppm (15.44) which was found to be at par with T₂- GA₃ @ 200 ppm (14.13) while, minimum was reported in T₀- water spray (11.30).

Patel et al. [10] and Mishra et al. [11] reported that the application of plant growth regulators enhance cell division with rapid internode elongation and is confined in the sub-apical meristem, which increases the plant spread.

3.1.4 Leaf area (cm²)

Among all the treatments, the maximum Leaf area (cm²) was observed with T₃- GA₃ @ 300 ppm (9.73) which was found to be at par with T₂- GA₃ @ 200 ppm (9.17) while, minimum was reported in T₀- water spray (6.57).

Kumar et al. [12] and koley et al. [13] reported that GA₃ promotes cell division and cell elongation, thereby increase the leaf length and leaf area and enhance sugar translocation.

3.2 Floral Parameters

3.2.1 Number of flower buds per plant

The effect of different growth regulators showed significant influence on the number of buds per plant. It was spotted that number of buds per

plant was more (3.40) in T₃ GA₃ at 300 ppm. Which had fewer bud per plant with GA₃ 200 ppm T₂ (2.73) while, less number of buds are reported in T₀- water spray (1.44).

Khan and Tiwari [14] in Dahlia reported that at proper concentration, the plant growth hormones are known to manipulate growth and flowering in desirable direction. The reason behind this effect may be due to the stimulation and enhancement of vegetative growth. In this study, number of

flower buds per plant significantly increased with levels of GA₃ at 300 ppm.

3.2.2 Days to bud initiation

Among all treatments, the minimum Days to bud initiation was observed with T₃-GA₃ @ 300 ppm (40.40) which was found to be at par with T₂ -GA₃ @ 200 ppm (41.10) while, maximum was reported in T₀- water spray (44.50).

Table 2. Effect of different concentrations of CCC and GA₃ on Vegetative parameters of Lilium

Treatments	Number of leaves	Plant height (cm)	Plant spread (cm)	Leaf area (cm ²)
T ₀ -WATER SPRAY	56.43	61.00	11.30	6.57
T ₁ -GA ₃ @ 100 ppm	63.20	71.43	14.11	7.70
T ₂ -GA ₃ @ 200 ppm	64.07	72.83	14.13	9.17
T ₃ -GA ₃ @ 300 ppm	71.83	76.47	15.44	9.73
T ₄ -GA ₃ @ 400 ppm	61.73	69.60	13.30	8.80
T ₅ -CCC @ 100 ppm	63.63	69.07	13.81	8.03
T ₆ -CCC @ 200 ppm	59.73	64.93	13.70	7.63
T ₇ -CCC @ 300 ppm	62.50	67.37	12.30	8.29
T ₈ -CCC @ 400 ppm	63.50	67.97	13.00	7.93
F-TEST	S	S	S	S
SEd (±)	2.61	2.65	0.64	0.77
CD (5%)	5.53	5.62	1.29	1.62
CV%	5.07	4.71	5.64	11.42

Table 3. Effect of different concentrations of CCC and GA₃ on Floral parameters of Lilium

Treatments	Number of buds per plant	Days to bud initiation	Days taken for first flower opening from planting	Flower bud length (cm)	Flower stalk length (cm)	Stalk length (cm)	Self-life (days)
T ₀ -WATER SPRAY	1.44	44.50	75.30	6.11	6.83	63.00	9.98
T ₁ -GA ₃ @ 100 ppm	2.43	41.87	71.40	7.33	9.43	72.10	11.17
T ₂ -GA ₃ @ 200 ppm	2.73	41.10	69.33	8.06	10.52	73.67	10.87
T ₃ -GA ₃ @ 300 ppm	3.40	40.40	68.53	8.83	12.43	78.10	12.97
T ₄ -GA ₃ @ 400 ppm	2.30	43.63	70.63	7.40	11.30	71.47	12.63
T ₅ -CCC @ 100 ppm	2.40	44.20	73.20	6.78	7.72	70.33	10.40
T ₆ -CCC @ 200 ppm	2.53	43.77	73.50	6.85	8.78	65.33	11.33
T ₇ -CCC @ 300 ppm	2.50	42.50	73.77	7.25	8.22	68.27	12.43
T ₈ -CCC @ 400 ppm	2.17	42.33	74.83	7.30	8.44	70.10	11.40
F-TEST	S	S	S	S	S	S	S
SEd (±)	0.26	1.20	1.03	0.61	0.92	2.10	0.52
CD (5%)	0.55	2.55	2.19	1.30	1.96	4.45	1.09
CV%	13.04	3.44	1.75	10.22	12.17	3.66	5.51

Table 4. Effect of different concentrations of CCC and GA₃ on Yield and Bulb parameters of Lilium

Treatments	Flower yield per plant	Flower yield per 250 m ²	Number of bulblets	Weight of bulb per plant (g)
T ₀ -WATER SPRAY	1.44	2666.6	1.88	59.57
T ₁ -GA ₃ @ 100 ppm	2.43	4505.83	2.44	65.77
T ₂ -GA ₃ @ 200 ppm	2.73	5061.72	2.89	64.97
T ₃ -GA ₃ @ 300 ppm	3.40	6296.29	3.22	70.93
T ₄ -GA ₃ @ 400 ppm	2.30	4259.25	2.66	66.07
T ₅ -CCC @ 100 ppm	2.40	4444.44	2.22	66.17
T ₆ -CCC @ 200 ppm	2.53	4691.35	4.11	74.07
T ₇ -CCC @ 300 ppm	2.50	4629.62	2.77	68.30
T ₈ -CCC @ 400 ppm	2.17	4012.34	2.33	66.20
F-TEST	S	S	S	S
SEd (±)	0.26	480.11	0.44	2.77
CD (5%)	0.55	1017.78	0.93	5.88
CV%	13.04	13.05	19.66	5.07

Table 5. Effect of different concentrations of CCC and GA₃ on Economics of Lilium

Treatments	Gross return (Rs/250 m ²)	Net return (Rs/250 m ²)	Benefit cost ratio
T ₀ -WATER SPRAY	79999.8	15569.85	1.24
T ₁ -GA ₃ @ 100 ppm	135174.9	69556.94	2.06
T ₂ -GA ₃ @ 200 ppm	151851.6	85033.65	2.27
T ₃ -GA ₃ @ 300 ppm	188888.7	120870.75	2.77
T ₄ -GA ₃ @ 400 ppm	127777.5	58559.55	1.84
T ₅ -CCC @ 100 ppm	133333.2	64974.25	1.95
T ₆ -CCC @ 200 ppm	140740.5	68412.55	1.94
T ₇ -CCC @ 300 ppm	138888.6	62591.65	1.82
T ₈ -CCC @ 400 ppm	120370.2	40104.25	1.49

Mounika et al. [15] reported that GA₃ application enhances food translocation for the development of floral primordia, which leads to early flowering. This is due to increase in photosynthesis and respiration along with enhanced fixation by GA₃ that led to flower bud initiation.

3.2.3 Days taken for first flower opening from planting

Among all the treatments, the minimum days taken for first flower opening from planting was observed with T₃- GA₃ @ 300 ppm (68.53) which was found to be at par with T₂- GA₃ @ 200 ppm (69.33) while, maximum was reported in T₀ - water spray (75.30).

Patel et al. [10] and Mishra et al. [11] reported that application of GA₃ enhances the translocation of food material for the development of floral primordia which leads to early flowering.

3.2.4 Flower bud length (cm)

Among all treatments, the maximum Flower bud length (cm) was observed with T₃- GA₃ @ 300 ppm (8.83) which was found to be at par with T₂- GA₃ @ 200 ppm (8.06) while, minimum was reported in T₀- water spray (6.11).

Justo et al. [16] in carnation reported that the increase in the length of the flower bud in GA₃ treated plants is due to rapid cell elongation, increased cell divisions and cell enlargement. Foliar application of GA₃ also significantly increased flower bud length.

3.2.5 Flower stalk length (cm)

The effect of different growth regulators showed significant influence on flower stalk length, it was spotted that the maximum flower stalk length (cm) was observed with T₃- GA₃ @ 300 ppm (12.43) followed by T₄- GA₃ @ 400 ppm (11.30).

In contrast, the water spray treatment T₀ recorded the minimum flower stalk length (6.83).

Mounika et al. [15]. Foliar application of GA₃ promotes cell division and cell elongation which results in long flower stalk.

3.2.6 Stalk length (cm)

The effect of different growth regulators showed significant influence on stalk length, it was spotted that the maximum stalk length (cm) was observed with T₃- GA₃ @ 300 ppm (78.10) followed by T₂- GA₃ @ 200 ppm (73.67). In contrast, the water spray treatment T₀ recorded the minimum stalk length (63.00).

Umrao et al. [4] in *Gladiolus* reported that GA₃ promotes vegetative growth and increases the photosynthetic and metabolic activities causing more transportation and utilization of photosynthetic products which may be the reason for increased length of the stalk.

3.2.7 Self-life (days)

Self-life means the total life span of flower emergence from bud to the number of days was calculated till the flower dried up in the field from the emergence of bud.

Here among all treatments, the maximum Self life of flowers was observed with T₃- GA₃ @ 300 ppm (12.97) which was found to be at par with T₄- GA₃ @ 400 ppm (12.63) while, minimum was reported in T₀- water spray (9.98).

3.3 Yield Parameters

3.3.1 Flower yield per plant

Among all treatments, the maximum Flower yield per plant was observed with T₃- GA₃ @ 300 ppm (3.40) followed by the treatment T₂- GA₃ @ 200 ppm (2.73) while, minimum was reported in T₀- water spray (1.44).

Patel et al. [10], Kuri et al. [17] reported that Increase in flower yield per plant due to the fact that plant growth regulators stimulate vegetative growth and induced changes in vegetative morphology, and thereby accelerate growth parameters.

3.3.2 Flower yield per 250 m²

Among all treatments, the maximum Flower yield for 250 m² was observed with T₃- GA₃ @

300 ppm (6296.29) followed by the treatment T₂- GA₃ @ 200 ppm (5061.72) while, minimum was reported in T₀- water spray (2666.66).

Mishra et al. [11] and Kumar et al. [18] reported that GA₃ treatment enhance induction of flower bud break i.e., differentiation of floral primordia in the apical region which leads to increase production of flowers per plants and hence increase the flower yield.

3.4 Bulb Parameters

3.4.1 Number of bulblets

Among all treatments, the maximum Number of bulblets was observed with T₆- CCC@ 200 ppm (4.11) followed by the treatment T₃- GA₃ @ 300 ppm (3.22) while, minimum was reported in T₀- water spray (1.88).

Zheng et al. [6] in *Lilium* reported that PGR's have higher level of starch, Sucrose and indole-3-acetic acid in the bulbs, which may stimulate the formation of new scales and bulblets growth. This might be the reason for more number of bulblets as compared to water spray.

3.4.2 Weight of bulb per plant (g)

Among all treatments, the maximum Weight of bulb per plant was observed with T₆- CCC@ 200 ppm (74.07) followed by the treatment T₃- GA₃ @ 300 ppm (70.93) while, minimum was reported in T₀- water spray (59.57).

Patel et al. [10], Sudhakar and Kumar [19] in *gladiolus* reported that application of CCC regulate the source sink ratio by reducing the partitioning of carbohydrates to floral spike which was evident from the reduction in spike length and enhancement of bulb weight as compared to water spray.

3.5 Economic Parameters

The economics of different treatments is depicted in Table 5, The total cost of cultivation for this experiment was 64,429.95 Rs/250 m²; where the treatment T₃- GA₃@300ppm gained maximum gross return 188888.7 Rs/250 m², net return 120870.75 Rs/250 m² and the benefit cost ratio is 2.77 [20-23].

4. CONCLUSION

From the present study, it is concluded that the treatment T₃-GA₃@300ppm proved to be

superior among all other treatments in terms of vegetative, flowering and yield parameters like number of leaves, plant height, plant spread, leaf area, number of flower buds per plant, days to bud initiation, days taken for first flower opening from planting, flower bud length, flower stalk length, stalk length and self-life of flowers. And in case of bulb parameters, the treatment T₆-CCC @200ppm reported maximum number of bulblets per plant and gives maximum weight of bulb per plant.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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