GROWTH AND FLOWERING OF LILIUM *(Lilium longiflorum)* cv. EREMO AS AFFECTED BY CCC AND GA_3 UNDER NATURALLY VENTILATED POLYHOUSE CONDITIONS OF PRAYAGRAJ

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 ofcycocel(CCC) andGibberellic Acid (GA_3) at different concentrations viz., GA_3(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 GA_3 for Lilium significantly enhanced the number of leaves (71.83), plant height (76.47 cm), plant spread (15.44 cm), leaf area (9.73 cm^2),number of buds (3.40),at 300 ppm of GA_3 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 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 m^2(6296.29) . Among the different treatments, the highest Gross return is 188888.7 Rs/250 m^2, Net return is 120870.75 Rs/250 m^2 and Benefit cost ratio is 2.77, obtained by the application of 300 ppm of GA_3.Whereas in terms of only Bulb parameters, foliar application of 200 ppm of CCC for Lilium reported maximum number of bulblets per plant (4.11) and gives maximum weight of bulb per plant (74.07g).

Keywords*: Lilium, Eremo, GA_3, CCC, Polyhouse.*

1. INTRODUCTION

Lilium is one of the most important bulbous flower, belongs to Liliaceaefamily, commercially grown for cut flowers. Lilies add some excitement to any bouquet with their exotic vibes and their colour palette. Lilies are one of the world's most easily recognisable flowers. These flowers look beautiful in bouquets of cut flowers and they are long lasting. Lilium is the genus of bulbous flowering plant with its basic chromosome number 12. Most of the lilium 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] lilium as cut flowers occupies 4 th position in the world cut flower trade. Lilies 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.

Lilies 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 Lilium gain popularity fast in our country. 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 colors, sizes, and shapes.

Research work on the use of traditional plant growth promoters like gibberellins and cycocels improving bulb and corm multiplication rate as well as bulb and corm enlargement was carried out in different parts of the country but artificial application of 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 GA_3 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 (GA_3) [4, 5], and cycocel (CCC) [6].

2. MATERIALS AND METHODS

A field experiment entitled "Growth and flowering of Lilium (*Lilium longiflorum) cv.*EREMO as affected by CCC and GA_3 under naturally ventilated polyhouse conditions of Prayagraj" was carried out in the Horticulture Research Field, Department of Horticulture,

Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences during November 2023- 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 under shade net condition. The experiment was conducted in Randomized Block Design (RBD) with nine treatments and three replication. Also, in this experiment plant was sprayed with Gibberellic Acid (GA_3) (at 100, 200, 300, 400 ppm), and Cycocel (CCC) (at 100, 200, 300, and 400 ppm) with water spray after planting of Lilium bulbs. The observations were recorded with respect to 20 days after planting to know the response of Lilium to different regulators at different concentrations.

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 GA_3 on Vegetative, Flowering, Yield, Bulb and Economic parameters of Lilium are presented in Tables 2, 3, 4 and 5 respectively.

3.1Vegetative Parameters

3.1.1 Number of leaves – At 60 days after transplanting (DAT), among all the treatments,the maximum Number of leaves was observed in T_3- GA_3 @ 300 ppm (71.83) which was found to be at par with T_2 - GA_3 @ 200 ppm (64.07) while, minimum was reported in T_0- water spray (56.43).

GA_3 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.

These results are supported by the findings of Pal and Das [7] in lilium.

3.1.2 Plant height (cm) - At 60 days after transplanting (DAT), among all the treatments,the maximum Plant height (cm) was observed with T_3- GA_3 @ 300 ppm (76.47) which was found to be at par with T_2- GA_3 @ 200 ppm (72.83) while, minimum was reported in T_0- water spray (61.00).

GA_3 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 conductive environment inside the naturally ventilated polyhouse at night time helped in better plant height also.

These results are supported by the findings of Nariya et al. [8], Aparna et al. [9] and kuri et al [10].

3.1.3 Plant spread (cm) – At 60 days after transplanting (DAT), among all the treatments,the maximum Plant spread (cm) was observed with T_3- GA_3 @ 300 ppm (15.44) which was found to be at par with T_2- GA_3 @ 200 ppm (14.13) while, minimum was reported in T_0- water spray (11.30).

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.

These results are supported by the findings of Patel et al. [11] and Mishra et al. [12]

3.1.4 Leaf area (cm^2) -At 60 days after transplanting (DAT),among all the treatments,the maximumLeaf area (cm^2) was observed with T_3- GA_3 @ 300 ppm (9.73) which was found to be at par with T_2- GA_3 @ 200 ppm (9.17) while, minimum was reported in T_0- water spray (6.57).

GA_3 promotes cell division and cell elongation, thereby increase the leaf length and leaf area and enhance sugar translocation

These results are supported by the findings of Kumar et al. [13] and koley et al. [14]

3.2Floral Parameters

3.2.1 Number of flower buds per plant- At 60 days after transplanting (DAT),among all treatments, the maximum Number of flower buds per plant was observed with T_3- GA_3 @

300 ppm (3.40) which was found to be at par with T_2- GA_3 @ 200 ppm (2.73) while, minimum was reported in T_0- water spray (1.44).

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 GA_3 at 300 ppm.

These results are supported by the findings of Khan and Tiwari[15] in Dahlia.

3.2.2 Days to bud initiation–At 60 days after transplanting (DAT), among all treatments, the minimum Days to bud initiation was observed with T_3- GA_3 @ 300 ppm (40.40) which was found to be at par with T_2- GA_3 @ 200 ppm (41.10) while, maximum was reported in T_0- water spray (44.50).

GA_3 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 GA_3 that led to flower bud initiation.

These results are supported by the findings of Mounika et al. [16].

3.2.3 Days taken for first flower opening from planting–At 60 days after transplanting (DAT), among all the treatments, theminimum Days taken for first flower opening from planting was observed with T_3- GA_3 @ 300 ppm (68.53) which was found to be at par with T_2- GA_3 @ 200 ppm (69.33) while, maximum was reported in T_0- water spray(75.30).

Application of GA_3 enhances the translocation of food material for the development of floral primordia which leads to early flowering.

These results are supported by the findings of Patel et al. [11] and Mishra et al. [12].

3.2.4 Flower bud length (cm) – At 60 days after transplanting (DAT), among all treatments, the maximum Flower bud length (cm) was observed with T_3- GA_3 @ 300 ppm (8.83) which was found to be at par with T_2- GA_3 @ 200 ppm (8.06) while, minimum was reported in T_0- water spray (6.11).

The increase in the length of the flower bud in GA_3 treated plants is due to rapid cell elongation, increased cell divisions and cell enlargement.Foliar application of GA_3 also significantly increased flower bud length.

These results are supported by the findings of Justo et al. [17] in carnation.

3.2.5 Flower Stalk length (cm)– At 60 days after transplanting (DAT), among all treatments, the maximum Flower stalk length (cm) was observed with T_3- GA_3 @ 300 ppm (12.43) which was found to be at par with T_4- GA_3 @ 400 ppm (11.30) while, minimum was reported in T_0- Control (6.83).

Foliar application of GA_3 promotes cell division and cell elongation which results in long flower stalk.

These results are supported by the findings of Mounika et al. [16].

3.2.6 Stalk length (cm)– At 60 days after transplanting (DAT),among all treatments, the maximum Stalk length (cm) was observed with T_3- GA_3 @ 300 ppm (78.10) which was found to be at par with T_2- GA_3 @ 200 ppm (73.67) while, minimum was reported in T_0- water spray (63 .00).

GA_3 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.

These results are supported by the findings of Umrao et al. [4] in Gladiolus.

3.2.7 Self-life (days)– At 60 days after transplanting (DAT), among all treatments, the maximum Self life of flowers was observed with T_3- GA_3 @ 300 ppm (12.97) which was found to be at par with T_4- GA_3 @ 400 ppm (12.63) while, minimum was reported in T_0- water spray (9.98).

3.3 Yield Parameters

3.3.1 Flower yield per plant–At 60 days after transplanting (DAT), among all treatments, the maximum Flower yield per plant was observed with T_3- GA_3 @ 300 ppm (3.40) which was found to be at par with T_2- GA_3 @ 200 ppm (2.73) while, minimum was reported in T_0- water spray (1.44).

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.

These results are supported by the findings of Patel et al. [11], Kuri et al. [10] and Kumar et al. [19].

3.3.2 Flower yield per 250 m^2–At 60 days after transplanting (DAT), among all treatments, the maximum Flower yield for 250 m^2 was observed with T_3- GA_3 @ 300 ppm (6296.29) which was found to be at par with T_2- GA_3 @ 200 ppm (5061.72) while, minimum was reported in T_0- water spray(2666.66).

GA_3 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.

These results are supported by the findings of Mishra et al. [12] and Kumar et al. [18].

3.4 Bulb Parameters

3.4.1 Number of bulblets–At 60 days after transplanting (DAT), among all treatments, the maximum Number of bulblets was observed with T_6- CCC@ 200 ppm (4.11) which was found to be at par with T_3- GA_3 @ 300 ppm (3.22) while, minimum was reported in T_0- water spray (1.88).

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.

These results are supported by the findings ofZheng et al. [6] in lilium.

3.4.2 Weight of bulb per plant (g)–At 60 days after transplanting (DAT), among all treatments, the maximum Weight of bulb per plant was observed with T_6- CCC@ 200 ppm (74.07) which was found to be at par with T_3- GA_3 @ 300 ppm (70.93) while, minimum was reported in T_0- water spray (59.57**).**

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.

These results are supported by the findings of Patel et al. [11], Sudhakar and Kumar [19] in gladiolus.

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 m^2; where the treatment T_3- GA_3@300ppm gained maximum gross return 188888.7 Rs/250 m^2, net return 120870.75 Rs/250 m^2 andthe benefit cost ratio is 2.77 [20-23].

Table 2- Effect of different concentrations of CCC and GA_3 on Vegetative parameters of Lilium

Treatments	Number of leaves	Planth eight (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 GA_3 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)	Spike 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 GA_3 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 GA_3 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

4. CONCLUSION

From the present study, it is concluded that the treatment T_3-GA_3@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 T_6-CCC @200ppm reported maximum number of bulblets per plant and gives maximum weight of bulb per plant.

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