



Impact of Plant Growth Regulators on Post Harvest Life of Cut Flowers of Gerbera (*Gerbera jamesonii*.B) cv. Goliath

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJECC/2021/v11i830468

Editor(s):

(1) Dr. Anthony R. Lupo, University of Missouri, USA.

Reviewers:

(1) Wajid Ali Jatoy, Sindh Agriculture University, Pakistan.

(2) S. Maheswari, Indian Academy Degree College – Autonomous, India.

Complete Peer review History: <https://www.sdiarticle4.com/review-history/74824>

Received 18 July 2021

Accepted 28 September 2021

Published 01 October 2021

Original Research Article

ABSTRACT

The present investigation was carried out in premises of Biotechnology cum Tissue Culture Centre, Odisha University of Agriculture and Technology, Bhubaneswar during 2015-16 and 2016-17. The objective of the study was to standardize suitable bio regulators on post harvest life of gerbera cut flowers. Apart from control, eight treatments of growth regulators like Gibberellins (GA₃) @ 100ppm and 150ppm; cycocel @ 700 ppm and 800 ppm with and without amino acid were used as foliar spray. In winter season percentage gain weight of flower stalk (19.95%), percentage gain in flower diameter (4.95%), solution uptake (33.17 ml) and vase life (13.83 days) were maximum with application of cycocel @ 700 ppm + Amino Acid while percentage gain in stalk length (1.28%) of flower in vase was maximum in Gibberellin @ 150ppm + Amino Acid. Similar trends in change in above post harvest parameters were also observed in summer and rainy season.

Keywords: Gibberellin; cycocel; amino acid; growth regulators; gerbera.

1. INTRODUCTION

Gerbera (*Gerbera jamesonii* B.) also known as Transvaal daisy, Barbeton daisy or African daisy

belonging to family Asteraceae occupies 5th place as cut flower in international flower trade [1]. It is popular because of its attractive colour, long vase life and suitability for long distant

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transport [2 and 3]. It is used for fresh and dry flower arrangement, exhibition, decoration, bouquet preparation [4]. Local and improved cultivar are grown in garden, flower bed, pots, borders, dish garden and rock garden. Flowers are of different colour like white cream, yellow, pink, orange, brick red, scarlet, salmon, maroon and bicolor and are available in single, semi-double or double form [5].

Application of plant growth regulators is important for growth, flowering and post harvest life of cut flowers of gerbera. Flowering can be manipulated by checking vegetative growth of plant, encouraging more number of side suckers by application of growth regulators which increase number of flowers and yield per m² (Lal and Mishra, 1986). Growth regulators are broadly two type. Auxin, Gibberellins, Cytokinin are known to accelerate growth of plant and are called growth promoter. Abscisic acid, Ethrel and Malic Hydrazide are known to inhibit plant growth and are called growth retardant. The plant bio regulators modify growth, flowering and post harvest life of gerbera. GA₃ promotes vegetative growth and flowering parameters. Cycocel increases number of ray floret, flower number, flower diameter and post harvest life by increasing number of leaves, suckers and chlorophyll content. However the available information regarding use of growth regulator in gerbera is scanty. In such situation it is essential to determine the most effective treatment of growth regulator in gerbera for maximizing yield and quality of flowers. Maximum vegetative growth, flower yield and quality was observed in gerbera by application of GA₃ @ 100 ppm. [4]. Post harvest quality and physiology of gerbera flowers can be manipulated by application of growth regulators [6].

However the available information regarding use of growth regulator in gerbera is scanty. In such situation it is essential to determine the most effective treatment of growth regulators in gerbera for maximizing yield and quality of flowers. The present investigation entitled "Impact of plant growth regulators on post harvest life of cut flowers of gerbera (*Gerbera jamesonii*. B) cv. Goliath" needs further understanding for recommendation to gerbera growers of the state and country as well. Therefore, the research project has been proposed to study the impact of plant growth regulators on post harvest life of cut flowers of gerbera hybrid cv. Goliath.

2. MATERIALS AND METHODS

The experiment was carried out in campus of Bio technology cum Tissue Culture Centre, Odisha University of Agriculture Technology, Bhubaneswar, Odisha State, India from Nov. to Oct. 2015-16 and 2016-17 in open field condition.

The investigation site is located 63 km away from Bay of Bengal at an altitude of 25 m above MSL (Mean Sea Level). The site extends between 20° 15' North latitude and 85° 50' East longitude. The average rainfall of the site is 1646 mm. The maximum temperature during the experimental period was 38.8 °C to 40.8 °C and minimum temperature was 14.1°C to 15.2 °C. The relative humidity during the experimental period was 37 % to 94 %. The soil was sandy loam with pH 5.83; electrical conductivity (EC) 0.64 ds/m; organic carbon (OC) 0.47 %; Nitrogen(N) 125 kg/ha; phosphate (P₂O₅) 67.1 kg/ha and potash (K₂O) 166.6 kg/ha. The soil mixture is prepared of sandy loam soil, Farm Yard Manure and coco peat in 1: 1: 1 proportion.

Earthen pots with a hole at the bottom were filled with soil mixture and four leaved tissue culture plantlets of gerbera cv. Goliath, a variety suitable for protected cultivation were planted in these pots. Experiment was laid down in Completely Randomized Design (CRD) with nine treatments combination and three replications per treatment. There were 30 plants per treatment making a total population of 270 plants.

For application of treatments to the plants following concentrations of plant bio regulators solution were prepared. With help of precision balance 100 mg and 150 mg of GA₃ were measured and taken in two beakers separately. Little quantity of sodium hydroxide was added to the beaker for easy solubility. Then the volume was made to 1 litre by adding water in to the beaker thus preparing 100 ppm and 150 ppm of GA₃ solution. Similarly, 700 mg and 800 mg of cycocel were measured and taken in two beakers separately. Little quantity of alcohol was added to the beaker for easy solubility and then the volume was made to 1 litre by adding water into the beaker. Thus, 700 ppm and 800 ppm cycocel solution were prepared. As per treatment combinations growth regulators and amino acid were sprayed on plants.

The observation were recorded from 5 randomly selected plant within each replication of

treatment for different post harvest life parameters like percentage gain in flower weight in vase, percentage gain in stalk length in vase, percentage gain in flower diameter in vase, solution uptake in vase and vase life in winter, summer and rainy season of two consecutive years and the pooled mean data of both the years were given in following tables.

The data collected were analysed statistically following the method of Gomez and Gomez [7] using one way ANOVA in CRD. A comparison of treatment means were done at 5% level of significance ($P=0.05$).

3. RESULTS AND DISCUSSION

The data obtained from both the year 2015-16 and 2016-17 on percentage gain in flower weight in vase, percentage gain in stalk length in vase, percentage gain in diameter in vase, solution uptake in vase and vase life were pooled and presented under following headings.

3.1 Percentage Gain in Flower Weight

In winter season maximum percentage gain in weight of cut flower was observed in T_8 (19.95%) receiving cycocel @ 700 ppm + Amino Acid which was at par with T_9 (17.83%) treated with Cycocel 800 ppm + Amino Acid, T_6 (17%) treated with GA @ 100ppm + Amino Acid, T_4 (18.89%) treated with Cycocel @ 700 ppm and T_5 (17.03) treated with Cycocel @ 800ppm while minimum percentage gain in weight was recorded in T_1 (9.16%, Control). Increase in percentage gain in weight of cut flower in T_8 , T_9 , T_4 and T_5 might be due to application of cycocel with or without amino acid. As a growth retardant cycocel delay senescence by maintaining food reserve in

flower and thus increasing weight of cut flower by absorbing more amount of water from vase. Besides, cycocel another treatment T_6 (GA @ 100ppm + Amino Acid) recorded more percentage gain in weight which was very close to cycocel treatment. Similar findings of increase in percentage gain in weight in vase was observed in Gerbera cut flower by Danaee *et al.* [5] by application of GA/BA @ 500ppm. Sajid *et al.* [8] and Aier *et al.* [9] in gladiolus found that GA recorded maximum fresh weight of spike. Sahare and Singh [10] in Anthurium observed that pulsing with GA 10 ppm increase spike weight. Increase flower weight was observed in China aster by GA application as reported by Vijayakumar *et al.* [11]. Similar result of maximum flower weight in vase was obtained in gladiolus by treatment with 200 ppm GA_3 +20% sucrose + 300 ppm Al_2SO_4 in vase solution as reported by Kumar [12]. Similar trend in increase in percentage gain in fresh weight of flower was observed in summer and rainy season. Minimum percentage gain in fresh weight of flower in control might be due to no application of growth regulators.

3.2 Percentage Gain in Flower Stalk Length

In winter season maximum percent gain in stalk length of cut flower was observed in T_7 (3.23%) receiving GA @ 150ppm + amino acid followed by T_6 (2.09%) treated with GA @ 100 ppm + amino acid while minimum percentage gain in stalk length was observed in T_1 (0.66%, control). Similar trend in increase in percentage gain in stalk length was also observed in summer and rainy season. Increase in percentage gain in stalk length in T_7 and T_6 might be due to growth promoting effect of GA_3 which is well known for

Table 1. Treatments details for PBRs application in gerbera cv. Goliath

Code	Treatments Combination
T_1	Control
T_2	Plant growth hormone GA_3 @ 100 ppm
T_3	Plant growth hormone GA_3 @ 150 ppm
T_4	Cycocel @ 700 ppm
T_5	Cycocel @ 800 ppm
T_6	Plant growth hormone GA_3 @ 100 ppm + Amino Acid (2 ml/l)
T_7	Plant growth hormone GA_3 @ 150 ppm + Amino Acid (2 ml/l)
T_8	Cycocel @ 700 ppm + Amino Acid (2 ml/l)
T_9	Cycocel @ 800 ppm + Amino Acid (2 ml/l)

cell elongation and cell enlargement there by increasing stalk length. Similar findings have been obtained by Sajid *et al.*, [8] in gladiolus with respect to increase in spike length by application of GA @ 100 ppm in vase. Akiladevi *et al.* [13] reported that application of BA @ 25ppm increase stalk length in *Anthurium*. Similar trend in increase in percentage gain in stalk length of flower was observed in summer and rainy season.

3.3 Percentage Gain Flower Diameter in Vase

In winter season maximum percentage gain flower diameter was observed in T₈ (4.95%) receiving cycocel @ 700 ppm + amino acid followed by T₄ (4.35%) treated with Cycocel @ 700 ppm, T₉ (4.31%) treated with cycocel @ 800 + amino acid) followed by T₆ (3.67%) treated with GA @ 100 ppm + amino acid while minimum percentage gain in flower diameter was observed in T₁ (2.04%, control). Similar trends in increase in percentage gain in flower diameter was also observed in summer and rainy season.

Increase in percentage gain in flower diameter in T₈, T₄ and T₉ might be due to cycocel application with and without amino acid. Cycocel treated plant exhibited higher chlorophyll content in leaf tissue which resulted higher dry matter production and accumulation in flower which resulted more number florets/flower increasing diameter of flower. Besides, cycocel another treatment gibberellins with amino acid (T₆) recorded more percentage increase in diameter of flower which was very close to cycocel which corroborates with the findings of Kumar [12] where GA in vase solution increased fresh weight of spike of gladiolus. This might be due to growth promoting effect of gibberellins increasing flower diameter. Similar findings was reported by Hamidimoghadam *et al.* [14] in increasing flower diameter of carnation applied with 5 ppm GA₃ and BA @ 80 ppm in vase solution. Being a growth promoter, GA also attribute towards increase in flower diameter due to accumulation of more photosynthates and so also more petals in flower which corroborates with the finding of Sujata *et al.* [1] and Jamaluddin *et al.* [15] in gerbera.

3.4 Solution Uptake in Vase

In winter season, maximum solution was taken by T₈ (33.17 ml) receiving cycocel @ 700 ppm + amino acid followed by T₉ (30.67 ml) treated

with cycocel @ 800 ppm + amino acid, T₄ (30.67 ml) treated with cycocel @ 700 ppm and T₆ (27.17) treated with GA @ 100ppm + amino acid while minimum solution uptake was observed in T₁ (19.50, control). Increase in solution uptake in T₈, T₉ and T₄ might be due to cycocel application. As discussed earlier plant treated with cycocel exhibited more gain in fresh weight which might be due to more uptake of water by cut flower in vase. Besides cycocel, another treatment T₆ receiving GA @ 100 ppm + amino acid recorded high water uptake which corroborates with the finding of Danaee *et al.* [5] in gerbera. Being a growth promoter GA maintain enzyme and proline balance in flowers increasing fresh weight of flowers which might be due to more water uptake by cut flowers. Similar result of more water intake and relative water content in carnation flower was reported by Hamidimoghadam *et al.*, [14] by application of 5 ppm nano silver and 5 ppm GA₃ in combination with BA @ 80 ppm. Similar finding has been obtained by Sahare and Singh [10] in *Anthurium* and Mutui *et al.* [16] in *Alstromeria* who reported that GA @ 10 ppm in vase resulted more water uptake. Lowest water uptake in T₁ (Control) might be due to no application of growth regulator. Similar trend in increased uptake of solution was observed in summer and rainy season.

3.5 Vase Life

In winter season maximum vase life was observed in T₈ (13.83 days) receiving cycocel @ 700 ppm + amino acid which was followed by T₄ (12.33 days) treated with cycocel @ 700 ppm, T₉ (12.33 days) treated with cycocel @ 800 ppm + amino acid while minimum vase life was observed in T₁ (8.33 days, control).

Increase in vase life in T₈, T₉ and T₄ might be due to cycocel application. As discussed earlier cycocel treated flowers increased fresh weight of flower in vase and solution uptake in vase there by maintaining water balance, enzyme and proline in cut flowers increasing longest vase life. Similar findings was obtained by Nair *et al.* [17] and Hongyi *et al.* [18] in gerbera by application of cycocel in gerbera. Other growth retardants like ethrel increase vase life of gerbera as reported by Nair *et al.* and Chiahui *et al.* [19].

Besides cycocel, another treatment T₆ (11 days) receiving GA @ 100ppm+ Amino acid recorded better vase life which was very close to the best treatment. As discussed earlier GA increased fresh weight and water uptake in vase there by

Table 2. Impact of plant bio regulators on post harvest characters i.e. Percentage gain in flower weight and Percentage gain in stalk length (Pooled over years 2015-16 and 2016-17) in hybrid gerbera cv. Goliath

Treatments number	Characters Treatments	Percentage gain in flower weight (g)			Percentage gain in stalk length (cm)		
		Winter	Summer	Rainy	Winter	Summer	Rainy
T ₁	Control	9.16 (17.66)	3.68 (11.09)	4.72 (12.52)	0.66(1.52)	0.43 (3.76)	0.57 (4.33)
T ₂	GA @ 100 ppm	16.23 (23.73)	6.59 (14.89)	9.82(18.24)	1.33(6.55)	0.85 (5.29)	1.14 (6.02)
T ₃	GA @ 150 ppm	14.07 (22.06)	5.21(13.18)	7.48(15.89)	1.61(7.27)	1.09 (6.02)	1.33 (6.55)
T ₄	Cycocel @ 700 ppm	18.89(25.77)	7.51(15.89)	12.09(20.36)	1.09(6.02)	0.71 (4.83)	0.95 (5.59)
T ₅	Cycocel @ 800 ppm	17.03(24.43)	6.71(15.00)	10.60(19.00)	0.85(5.29)	0.62(4.52)	0.76 (5.00)
T ₆	GA @ 100 ppm + AA	17.00(24.35)	7.40(15.79)	10.88(19.28)	2.09(8.33)	1.42(6.80)	1.47 (7.04)
T ₇	GA @ 150 ppm + AA	15.48(23.19)	6.12(14.30)	9.70(18.15)	3.23(10.31)	2.14(8.33)	2.28 (8.72)
T ₈	Cycocel @ 700 ppm + AA	19.95(26.49)	8.21(16.64)	13.55(21.64)	1.28(6.55)	1.14(6.29)	1.23 (6.29)
T ₉	Cycocel @ 800 ppm + AA	17.83(24.95)	7.39(15.79)	11.36(19.73)	1.28(6.55)	0.85(5.29)	1.00 (5.74)
	SE (m) ±	0.715	0.177	0.258	0.107	0.081	0.096
	CD (0.05)	2.33	0.50	0.74	0.30	0.23	0.27

*(Figures in parentheses indicate corresponding angular value)***Table 3. Impact of plant bio regulators on post harvest characters i.e. Percentage gain in flower diameter (Pooled over years 2015-16 and 2016-17) in hybrid gerbera cv. Goliath**

Treatments number	Characters Treatments	Percentage gain in diameter (mm)		
		Winter	Summer	Rainy
T ₁	Control	2.04(8.13)	1.23(6.29)	1.56(7.04)
T ₂	GA @ 100 ppm	3.12(10.14)	2.08(8.33)	2.52(9.10)
T ₃	GA @ 150 ppm	2.48(9.10)	1.84 (7.71)	2.01(8.13)
T ₄	Cycocel @ 700 ppm	4.35(12.11)	3.36(10.63)	3.79(11.24)
T ₅	Cycocel @ 800 ppm	3.63(10.94)	2.65(9.28)	2.99(9.81)
T ₆	GA @ 100 ppm + AA	3.67(10.94)	3.30(10.47)	3.39(10.63)
T ₇	GA @ 150 ppm + AA	2.93(9.81)	1.84(7.71)	2.42(8.91)
T ₈	Cycocel @ 700 ppm + AA	4.95(12.79)	4.08(11.68)	4.49(12.25)
T ₉	Cycocel @ 800 ppm + AA	4.31(11.97)	3.10(10.14)	3.53(10.78)
	SE (m) ±	0.191	0.207	0.226
	CD (0.05)	0.54	0.59	0.64

(Figures in parentheses indicate corresponding angular value)

Table 4. Impact of plant bio regulators on post harvest characters i.e. solution uptake in vase and vase life (Pooled over years 2015-16 and 2016-17) in hybrid gerbera cv. Goliath

Treatments number	Characters Treatments	Solution uptake (ml)			Vase life (days)		
		Winter	Summer	Rainy	Winter	Summer	Rainy
T ₁	Control	19.50	12.33	16.00	8.33	6.92	7.67
T ₂	GA @ 100 ppm	25.17	18.00	21.50	10.67	9.08	9.83
T ₃	GA @ 150 ppm	22.83	16.83	19.67	9.67	8.58	9.00
T ₄	Cycocel @ 700 ppm	30.67	23.00	26.50	12.33	9.92	11.33
T ₅	Cycocel @ 800 ppm	27.17	20.67	23.83	11.33	9.67	10.83
T ₆	GA @ 100 ppm + AA	27.17	20.00	23.00	11.00	9.67	10.50
T ₇	GA @ 150 ppm + AA	25.17	18.33	21.00	10.33	9.33	9.67
T ₈	Cycocel @ 700 ppm + AA	33.17	24.83	27.33	13.83	10.83	12.50
T ₉	Cycocel @ 800 ppm + AA	30.67	22.33	25.50	12.33	10.00	11.33
	SE (m) ±	0.556	0.462	0.763	0.308	0.267	0.275
	CD (0.05)	1.58	1.32	2.49	0.88	0.76	0.78

Table 5. Monthly mean weather data from November 2015 to October 2016

Sl. No.	Month	Temperature ° C		Rainfall	Relative Humidity %		Rainy days
		Max	Min	Daily (mm)	7 hr	14 hr	
1	November 15	31.3	20.1	3.0	91	55	2
2	December 15	29.3	17.6	14.8	87	53	3
3	January 16	29.9	15.7	0.6	92	39	1
4	February 16	34.5	21.3	3.0	89	41	1
5	March 16	37.1	23.4	1.5	86	40	2
6	April 16	40.8	26.8	7.6	86	37	1
7	May 16	38.8	26.4	114.9	81	47	9
8	June 16	34.8	26.4	264.8	89	68	19
9	July 16	32.2	25.8	222.2	92	79	15
10	August 16	31.8	25.5	247.8	94	79	22
11	September 16	31.4	25.4	238.2	93	80	23
12	October 16	32.2	22.6	132.8	89	68	11

Table 6. Monthly mean weather data from November 2016 to October 2017

Sl. No	Month	Temperature deg C		Rainfall Daily (mm)	Relative Humidity %		Rainy days
		Max	Min		7 hr	14 hr	
1	November 16	31.0	17.4	20.3	92	46	2
2	December 16	30.1	15.2	0.0	87	39	0
3	January 17	29.7	15.0	0.0	90	39	0
4	February 17	33.8	19.3	0.0	94	38	0
5	March 17	34.7	22.8	45.4	91	42	5
6	April 17	36.9	26.1	29.2	88	49	1
7	May 17	38.8	27.2	43.1	82	46	3
8	June17	35.2	26.5	122.0	87	59	15
9	July 17	31.9	25.9	445.9	92	78	24
10	August 17	32.9	25.8	377.0	91	76	24
11	Septeber17	33.6	25.7	245.2	92	70	14
12	October 17	32.2	24.3	204.5	93	69	9



Plate 1. Impact of PBRs application on vase life of hybrid gerbera cv. Goliath (1st year)



Plate 2. Impact of PBRs application on vase life of hybrid gerbera cv. Goliath (2nd year)

maintaining proline, water and enzyme level in flower resulting prolonged vase life. Similar finding have been obtained by Danaee *et al.* [5], Kumar and Gupta[20] in gerbera where GA delay senescence and increase vase life. Similar results of increased vase life have been observed with application of GA by Nouri *et al.* [21] in Alstromeria, Sahare and Singh [10] in Anthurium, Hamidimoghadam *et al.*, [14] in carnation, Abbasi and Hassanpour [22] in tuberose, Janowska and Stanecka [23] in calla lily. In gladiolus, maximum vase life was found by application of GA which was reported by Faraji *et al.* [24], Kumar [12].

4. CONCLUSION

From the above investigation it can be concluded that application of cycocel @ 700 ppm + amino acid increased percentage gain in weight of cut flower, percentage gain in flower diameter, solution uptake in vase and vase life of gerbera while percentage gain in stalk length of cut flower in vase was maximum with application of GA₃ @ 150 ppm + amino acid. This result will be useful for further research and so also for gerbera growers in extending post harvest life of flower.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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