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Efficacy of Growth Regulators on Flowering of Gerbera (*Gerbera jamesonii* B.) cv. Goliath in Open Field Condition

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ABSTRACT

Background: Application of plant bioregulators at specific concentration modify growth, flowering, flower yield and post harvest quality of flowers. Growth promoters like auxin, gibberellins and cytokinin modify physiological process by accelerating plant growth while growth retardant like cycocel and abscisic acid inhibit plant growth. But in open field cultivation of gerbera, little is known about use of growth regulators on flowering regulation. A good knowledge on use of growth regulators in gerbera is required before going to any recommendations. The current study aimed to standardize suitable bioregulators on flower production in gerbera in open field condition.

Methods: The study was carried out in premises of Biotechnology cum Tissue Culture Centre, Odisha University of Agriculture and Technology, Bhubaneswar during 2015-16 and 2016-17. Apart from control eight treatments of growth regulators were used like GA_3 @ 100 ppm and 150 ppm, cycocel @ 700 ppm and 800 ppm with or without amino acids as foliar spray. The observation were recorded from 5 randomly selected plant within each replication of treatment for different floral parameters.

Result: The result revealed that days taken to flower bud initiation and days taken to flowering was minimum in GA_3 @ 100 ppm + amino acid. The stalk length of flower was maximum in treatment GA_3 @ 150 ppm + amino acid while largest flower diameter, maximum number of flowers and longest bloom life was observed in treatment with cycocel @ 700 ppm + amino acid. Maximum stalk thickness was found in treatment with cycocel @ 800 ppm + amino acid. The present work will be a complementary contribution to the researchers and gerbera growers in increasing productivity of this flower crops.

Key words: Amino acid, Cycocel, Gibberellins.

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 (Sujatha *et al.,* 2002). It is popular because of its attractive colour, long vase life and suitability for long distant transport (Bose *et al*., 2003). It is used for fresh and dry flower arrangement, exhibition, decoration, bouquet preparation (Patra *et al*., 2015). 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.

Application of plant bio regulators at specific concentration modify growth, flowering, flower yield and post harvest quality of flowers. Growth promoters like auxin, gibberellin and cytokinin modify physiological process by accelerating plant growth while growth retardant like cycocel and abscisic acid inhibit plant growth. Maximum vegetative growth, flower yield and quality was observed in gerbera by application of GA_3 @ 150 ppm (Dalal *et al.,* 2009).

Similarly, application of growth retardant like paclobutrazole @ 25 to 100 ppm in gerbera reduce plant spread, increase leaf number/plant, increase chlorophyll content, decrease in stalk length, increase in stalk thickness, number of flowers and flower quality parameters (Bekheta *et al*., 2008).

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MATERIALS AND METHOD

The present study was conducted in premises of Biotechnology cum Tissue Culture Centre, Odisha University of Agriculture Technology, Bhubaneswar from Nov. to Oct. 2015-16 and 2016-17 in open condition.

The experimental site is situated 63 km away from Bay of Bengal at an altitude of 25 m above MSL and extended 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 experimental soil was sandy loam with pH 5.83, EC 0.64 ds/m, OC 0.475%, N 125 kg/ha, P_2O_5

67.1 kg/ha, K_2O 166.6 kg/ha. The growing media was composed of soil, FYM and coco peat in 1: 1: 1 proportion.

Earthen pots with a hole at the bottom were used for planting. The pots were filled with soil mixture. Four leaved tissue culture plantlet of gerbera cv. Goliath a variety suitable for protected cultivation was used for planting. A basal dose of NPK @ 10:15:20 g per m^2 was applied. The experiment was laid down in completely randomized design (CRD) with nine treatments and three replication per treatments. There were 10 plants per replication and 30 plants per treatment making a total population of 270 plants.

The present experiment comprised with 9 treatments *i.e.* T_1 (Control), T_2 (GA_3 @ 100 ppm), T_3 (GA_3 @ 150 ppm), T_4 (Cycocel @ 700 ppm), T_5 (Cycocel @ 800 ppm), T_6 (GA_3 @ 100 ppm + amino acid @ 2 ml/l), T_7 (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). For application of treatments to the plants following concentrations of plant bio regulators solution were prepared. With help of a precision balance 100 mg and 150 mg of GA_3 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 beakers thus preparing 100 ppm and 150 ppm of GA_3 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.

The observation were recorded from 5 randomly selected plant within each replication of treatment for different floral parameters like days taken to flower bud initiation after disbudding, days taken to flowering, stalk length, stalk thickness, number of flower/plant, flower diameter and bloom life. The data collected were analysed statistically following the method of Gomez and Gomez (1984) using one way ANOVA in CRD. A comparison of treatment means were done at 5% level of significance (P=0.05).

RESULTS AND DISCUSSION

The result of the experiment obtained in the year 2015-16 and 2016-17 were pooled and presented under following headings.

Days to flower bud initiation after disbudding

After disbudding of all plants, the days taken to flower bud initiation was counted. The pooled data from both the years showed that the days taken to flower bud initiation (8.83 days) was minimum in T_6 (GA @ 100 ppm+ amino acid) which was at par with T_2 (GA @ 100 ppm), T_7 (GA @ 150 ppm+ amino acid) and T_3 (GA @ 150 ppm) (Table 1). The earliness in flower bud initiation might be attributed to the fact that GA helps in auxin synthesis and enhance metabolism. Phengphachanh (2012) reported that GA application reduce ABA level in plant resulting early bud emergence. The maximum delay in flower bud initiation (22.08 days) was observed in treatment T_1 (control) where no growth regulator was applied. Similar finding was also observed by Dalal *et al.* (2009), Emongor *et al.* (2004) who reported early flower bud emergence by GA application.

Days to flowering

The days taken to flowering from flower bud emergence was counted. The earliest flowering (15.83 days) was recorded in T_6 (GA @ 100 ppm+ amino acid) which was at par with T_7 (GA @ 150 ppm + amino acid), T_2 (GA @ 100 ppm) (Table 1). The earliness in flowering might be due to GA application at optimum concentration (100 ppm). Phengphachanh (2012) reported that application of GA reduce level of growth retardant (ABA) in gerbera resulting early flowering. Similar findings have been obtained by Awan *et al.* (1999); Nair *et al.* (2002); Rana *et al.* (2005); Matsumoto *et al.* (2006); Dalal *et al.* (2009) with respect to early flowering in gerbera. The maximum delay in flowering

Table 1: Impact of plant bio regulators on flowering characters *i.e.* days taken to flower bud initiation after disbudding, days taken to flowering, length of flower stalk and thickness of flower stalk in gerbera cv. Goliath.

Treatments number	Characters / Treatments	Days to flower bud initiation after disbudding	Days taken to flowering	Length of flower stalk (cm)			Thickness of flower stalk (mm)		
				Winter	Summer	Rainy	Winter	Summer	Rainy
T_1	Control	22.08	23.50	49.25	46.94	49.17	5.69	5.17	5.58
T_2	GA @ 100 ppm	9.58	16.33	52.77	48.81	52.00	6.45	6.01	6.20
T_3	GA @ 150 ppm	10.58	17.42	59.28	51.97	53.99	6.28	5.86	6.02
T_4	Cycocel @ 700 ppm	17.08	19.83	47.42	45.55	47.29	6.61	6.22	6.45
T_5	Cycocel @ 800 ppm	19.83	20.83	45.68	43.96	45.52	6.74	6.42	6.65
T_6	GA @ 100 ppm + AA	8.83	15.83	54.68	51.33	53.92	6.62	6.24	6.43
T_7	GA @ 150 ppm + AA	9.83	16.67	61.84	54.23	55.98	6.58	6.08	6.19
T_8	Cycocel @ 700 ppm + AA	16.00	18.67	50.14	47.71	49.71	6.80	6.44	6.67
T_9	Cycocel @ 800 ppm + AA	18.67	19.75	47.85	46.08	47.76	6.99	6.64	6.94
	SE (m) ±	0.941	0.491	1.819	0.653	0.512	0.067	0.189	0.150
	CD (0.05)	3.07	1.4	5.93	1.86	1.46	0.19	0.62	0.49

(23.50 days) was observed in treatment T_1 (control) due to no application of growth regulators.

Length of flower stalk

The pooled data from both the year revealed that in winter season longest stalk length (61.84 cm) was observed in T_7 (GA @ 150 ppm+ amino acid) which was at par with T_3 (GA @ 150 ppm) while minimum stalk length (45.68 cm) was observed in T_5 (Cycocel @ 800 ppm) (Table 1). Increase in stalk length in T_7 and T_3 might be due to application of GA @ 150 ppm with or without amino acid. Being a growth promoter Gibberellin induce cell elongation and cell enlargement increasing stalk length. Similar finding was obtained by Pobudkiewicz and Nowak (1992), Sujatha *et al.* (2009), Dalal *et al.* (2009), Dogra *et al.* (2012), Mehraj *et al.* (2013) and Jamaluddin *et al.* (2014) by application GA in gerbera. Decrease in flower stalk length in T_5 (Cycocel @ 800 ppm) may be due to inhibitory effect of cycocel on cell elongation and cell enlargement which corroborates with the findings of Mohamed (1992) who reported that growth retardant like ethrel decreased stalk length. Similar trend in increase in length of flower stalk was also observed in summer and rainy season.

Thickness of flower stalk

The pooled data from both the year revealed that in winter season maximum stalk thickness (6.99 mm) was observed in T_9 (Cycocel @ 800 ppm + amino acid) which was at par with T_8 (Cycocel @ 700 ppm+ amino acid). Increase in stalk thickness in T_9 and T_8 might be due to application of cycocel and as a growth retardant it checks apical dominance and stem elongation but increases stem thickness.

Similar findings were also obtained by Lin (1961) and Muthumanickam *et al*. (1999) who stated that application of growth retardant like ethrel increased stalk thickness in gerbera. Thinnest flower stalk (5.17 mm) was observed in T_1 (control) during summer where no growth regulators was applied. Similar trend in increase in stalk thickness was also observed in winter and rainy season.

Number of flowers/plant

Pooled data from both the year revealed that in winter season maximum number of flowers (15.77/plant) was found in T_8 (Cycocel @ 700 ppm+ amino acid) which was at par withT_4 (Cycocel @ 700 ppm), T_6 (GA @ 100 ppm+ amino acid) and closely followed by T_9 (Cycocel @ 800 ppm+ amino acid while lowest number of flower (8.43/plant) was recorded in T_1 (Control).

Increase in flower number in T_8 and T_4 may be due to application optimum concentration of Cycocel @ 700 ppm with or without amino acid. Being a growth retardant cycocel inhibits apical dominance and induce bushiness/ dwarfness which resulted in emergence of more number of suckers. When number of suckers increased, the number of flower/plant increased. Similar finding have been obtained by Mohamed (1992), Muthumanikam *et al.* (1999) and Kumar *et al.* (2008) who reported increase in flower number by application of growth retardant like ethrel in gerbera. Besides, Cycocel application another treatment T_6 (GA @ 100 ppm+ amino acid) produced more number of flowers/plant which was very close to best treatment. Similar finding have been obtained by Nair *et al.* (2002), Sujatha *et al.* (2002), Dalal *et al.* (2009), Jamaluddin *et al.* (2013) in increasing number of flowers/plant in gerbera. The minimum number of flower/plant obtained in T_1 (Control) may be due to no application of growth regulator. Similar trend in increase in number of flowers/plant was also observed in summer and rainy season.

Flower diameter

The pooled data from both of the years revealed that in winter season largest flower diameter (11.53 cm) was observed in T_8 (Cycocel @ 700 ppm + amino acid) which was at par with T_6 (GA_3 @ 100 ppm + AA), T_9 (Cycocel @ 800 ppm + AA) and T_4 (Cycocel @ 700 ppm) while minimum flower diameter (9.49 cm) was observed in T_1 (control) (Table 2). Increase in flower diameter in T_8 and T_4 might be due to application of optimum concentration of cycocel @ 700 ppm with or without

Table 2: Impact of plant bio regulators on flowering characters *i.e.* total number of flowers/plant, flower diameter and bloom life of hybrid gerbera cv. Goliath.

Treatments number	Characters / Treatments	Total number of flowers /plant			Flower diameter (cm)			Bloom life (days)		
		Winter	Summer	Rainy	Winter	Summer	Rainy	Winter	Summer	Rainy
T_1	Control	8.43	5.59	6.93	9.49	8.40	8.76	11.65	7.52	8.54
T_2	GA @ 100 ppm	13.17	8.75	10.25	10.95	9.57	9.84	16.82	10.57	11.40
T_3	GA @ 150 ppm	11.68	7.59	8.85	10.57	9.07	9.64	15.73	9.90	10.82
T_4	Cycocel @ 700 ppm	14.84	10.59	12.17	11.21	9.91	10.25	19.00	12.02	12.96
T_5	Cycocel @ 800 ppm	12.69	9.51	10.76	10.86	9.53	9.95	17.86	11.27	12.27
T_6	GA @ 100 ppm + AA	14.51	10.01	11.18	11.29	9.90	10.11	18.75	11.40	12.21
T_7	GA @ 150 ppm + AA	13.26	9.09	9.92	10.82	9.40	9.90	17.65	10.75	11.57
T_8	Cycocel @ 700 ppm + AA	15.77	12.09	13.17	11.53	10.19	10.57	21.34	13.11	13.98
T_9	Cycocel @ 800 ppm + AA	14.25	10.43	12.18	11.25	9.80	10.18	19.84	12.19	13.29
	SE (m) ±	0.409	0.279	0.239	0.112	0.197	0.161	0.371	0.573	0.772
	CD (0.05)	1.33	0.79	0.68	0.32	0.64	0.53	1.21	1.87	2.52

amino acid. Being a growth retardant cycocel result delay flowering which help in accumulation of photosynthates in plant resulting larger flower. Highest chlorophyll content in treatment with cycocel is also an evidence of maximum dry matter production resulting large flower. Similar findings have been obtained by Nair *et al.* (2002) by application of cycocel in gerbera. The role of growth retardant in increasing flower diameter was also proved by Mohamed (1992) with application of ethrel in gerbera. The smallest flower diameter was recorded in T_1 (control) which was due to no application of growth regulator in gerbera. Similar trend in increase in flower diameter was also observed in summer and rainy season.

Bloom life

The pooled data from both the years revealed that in winter season maximum bloom life (21.34 days) was observed in T_8 (Cycocel 700 ppm+ amino acid) which was closely followed by T_9 (Cycocel @ 800 ppm+ amino acid) while minimum bloom life (11.65 days) was observed in T_1 (control) (Table 2). Increase in bloom life might be due to application of cycocel. As discussed earlier, due to delay in flowering and more chlorophyll content in treatment with cycocel, there was more reserve of photosynthates in flower which prolong bloom life. Similar finding have been reported by Jamaluddin *et al.* (2014) by application of growth retardant like ethrel in gerbera. The shortest bloom life was observed in T_1 (control) due to no application of growth regulators. Similar trend in increase in bloom life was also observed in summer and rainy season.

CONCLUSION

From the above findings it can be concluded that combination of GA_3 @ 100 ppm and amino acid performed best with respect to days to flower bud initiation and flowering. Maximum stalk length was achieved by application of GA_3 @ 150 ppm+ amino acid while maximum number of flowers/plant, diameters of flower and bloom life were observed by application of CCC @ 700 ppm + amino acid. Maximum stalk thickness was found in treatment with cycocel @ 800 ppm+ amino acid. The result of this study will be torch bearer for the researcher as well as gerbera grower for enhancing flower production under open field condition.

Conflict of interest

The authors have no conflict of interest

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