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Effect of plant bio-regulators on vegetative growth and flowering of gerbera (*Gerbera jamesonii* B.) cv. Goliath in open field condition

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Abstract

The present investigation entitled “Impact of Plant Bio-regulator on growth and flowering of gerbera (*Gerbera jamesonii* B.) cv. Goliath” was carried out in premises of Bio-technology 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 flower production in gerbera in open field condition. Apart from control eight treatments of growth regulators were used like GA₃ @ 100 ppm, and 150 ppm; Cycocel @ 700 ppm and 800 ppm with or without amino acids as foliar spray. Among vegetative parameters maximum plant spread, leaf length, petiole length, leaf width and leaf area was found in GA₃ @ 150 ppm + Amino Acid while maximum leaf number/plant, number of suckers/plant and chlorophyll content in leaf was found in treatment with cycocel @ 700 ppm+ Amino acid. In flowering parameters maximum number of flowers/plant/m² in a year was found in treatment with cycocel @ 700 ppm + Amino acid.

Keywords: Gibberellin, cycocel, amino acid

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) [20]. It is popular because of its attractive colour, long vase life and suitability for long distant transport (Bose *et al.* 2003 and Chauhan, 2005) [1, 4]. It is used for fresh and dry flower arrangement, exhibition, decoration, bouquet preparation (Patra *et al.*, 2015) [17]. 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 Absciscic acid inhibit plant growth. Maximum vegetative growth, flower yield and quality was observed in gerbera by application of GA₃ @ 150 ppm. (Dalal *et al.* 2009) [5]. 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) [2].

Materials and Method

The present study was conducted in premises of Bio-technology 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 was 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 was 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,

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P₂O₅ 67.1 kg/ha, K₂O 166.6 kg/ha. The growing media was composed of soil, FYM and coco peat in 1: 1: 1 proportion. Earthen pot with a hole at the bottom were used for planting. The pot were filled with soil mixture. Four leaved tissue culture plantlet of gerbera cv. Goliath a variety suitable for protected cultivation were used for planting in open field condition. A basal dose of NPK @ 10: 15:20 g per m² 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. T₁ (Control), T₂ (GA₃ @ 100 ppm), T₃ (GA₃ @ 150 ppm), T₄ (Cycocel @ 700 ppm), T₅ (Cycocel @ 800 ppm), T₆ (GA₃ @ 100 ppm + Amino Acid @ 2 ml/l), T₇ (GA₃ @ 150 ppm + Amino Acid @ 2 ml/l), T₈ (Cycocel @ 700 ppm + Amino Acid @ 2 ml/l), T₉ (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 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 liter 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 liter 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 vegetative parameter like plant spread, number of leaves, leaf length, leaf width, length of petiole, number of suckers/plant, chlorophyll content and floral parameters like number of flower/plant. The data collected were analyzed statistically following the method of Gomez and Gomez (1984) [9] 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 to 2016-17 were pooled and presented under following headings.

(A) Effect of PBR application on Vegetative parameters

1. Plant Spread

Pooled data from both the years revealed that in winter season maximum plant spread (69.82 cm) was found in T₇ receiving GA @ 150 ppm+ Amino Acid which was closely followed by T₆ (GA @ 100 ppm+ Amino Acid). The minimum plant spread (56.81 cm) was recorded in T₅ (Cycocel @ 800 ppm). Increase in plant spread in T₇ and T₆ might be due to growth promotive effect of GA₃ resulting cell enlargement and cell elongation (Ei Shafe and Hassan, 1978) [7] while minimum plant spread in T₅ might be due to retardation of growth due to application of growth retardant like cycocel. Similar finding have been reported by Nair *et al.* (2002) [15], Sujatha *et al.* (2002) [20], Dalal *et al.* (2009) [5] and Jamal *et al.* (2013) [10] who proved that GA₃ @100 ppm/150 ppm increased plant spread in gerbera while application of growth retardant like ethrel reduced plant height in gerbera. Similar trends in change in plant spread was also observed in summer and rainy season.

2. Number of leaves/plant

The pooled data from both the year revealed that in winter season maximum number of leaves (34.84) were found in T₈ receiving cycocel @ 700 ppm+ Amino Acid which was closely followed by T₉ (Cycocel @ 800 ppm + Amino Acid), T₄ (Cycocel @ 700 ppm) and T₅ (Cycocel @ 800 ppm) while minimum number of leaves (24.63) were observed in T₁ (Control). Increase in leaf number in T₈, T₉, T₄ and T₅ might be due to cycocel application with or without amino acid. When cycocel is applied in optimum concentration as in T₈, it result dwarfness and bushiness of plants producing more number of leaves while least number of leaves in T₁ (Control) was due to no application of no growth regulators. Similar finding of increased leaves number has been found in tuberose by dipping bulbs in cycocel @ 5000 ppm for 1 hour which was reported by Ganesh *et al.* (2013) [8]. Similar trends in change in leaves number was also observed in summer and rainy season.

3. Leaf length

Pooled data from both the years revealed that in winter season maximum leaf length (35.65 cm) was observed in T₇ receiving GA @ 150 ppm + Amino acid which was at par with T₆ (GA @ 100 ppm + Amino acid) and T₃ (GA @ 150 ppm). The minimum leaf length (29.42 cm) was found in T₅ (cycocel @ 700 ppm). Increase in leaf length in T₇, T₆ and T₃ might be due to growth promotive effect of GA₃ resulting cell enlargement and cell elongation (Eishafe and Hassan, 1978) [7]. Similar finding have been obtained by Cardoso *et al.* (2012) [3], Patel *et al.* (2013) [16] by application of gibberellin in gerbera.

The minimum leaf length recorded in T₅ (cycocel @ 800 ppm) which might be due to application of growth retardant like cycocel. Similar finding have been obtained by Lin (1991) with respect to application of growth retardant like ethrel in gerbera. Similar trends in change in leaf length was also observed in summer and rainy season.

4. Leaf width

In winter season the maximum leaf width (11.69 cm) was observed in T₇ (GA @ 150 ppm + Amino Acid) which was at par with T₆ (GA @ 150 ppm+ Amino Acid) followed by T₃ (GA @ 150 ppm + Amino Acid) while minimum leaf width (9.78 cm) was observed in T₅ (cycocel @ 800 ppm). The increase in leaf width might be due to growth promotive effect of Gibberellin i.e. cell elongation and cell expansion. Similar finding have been obtained by Dogra *et al.* (2012) [6] with respect to application gibberellin @ 200 ppm in gerbera. The minimum leaf width in T₅ might be due to retardation of growth due to cycocel application resulting small, reduced size leaves. Similar finding have been obtained by Kumar *et al.* (2008) [12] who reported that application of growth retardant ethrel in gerbera reduced leaf width. Similar trends in change in leaf width was also observed in summer and rainy season.

5. Length of petiole

In winter season the maximum length of petiole (9.95 cm) was observed in T₇ (GA @ 150 ppm + Amino Acid) which was at par with T₆ (GA @100 ppm+ amino acid) and T₃ (GA @150 ppm) while minimum length of petiole (7.49 cm) was observed in T₅ (cycocel @ 800 ppm). The increase in length of petiole might be due to growth promotive effect of GA₃ like cell elongation resulting longer petiole while decrease in length of petiole might be due to application of cycocel.

Similar finding have been obtained by Khan and Chaudhury (2006) ^[11] with respect to application of gibberellin in gerbera. Similar trends in change in length of petiole was also observed in summer and rainy season.

6. Number of suckers/plant/month

In winter season maximum number of suckers (3.33) were found in T₈ which was closely followed by T₉ (cycocel @ 800 ppm + amino acid) and T₄ (cycocel @ 700 ppm) while minimum number of suckers (1.42) were found in T₁ (control). The increase in number of suckers in T₈, T₉ and T₄ might be due to break of apical dominance and bushy nature of gerbera when applied with growth retardant like cycocel while lowest number of suckers in T₄ might be due to no application of PBR. Similar trends in change in number of suckers/plant was also observed in summer and rainy season.

7. Leaf Area

In winter season maximum leaf area (265.10 cm²) was found in T₇ (GA @ 150 ppm + amino acid) followed by T₃ (GA @ 100 ppm) and minimum leaf area (161.46 cm²) was observed in T₅ (cycocel @ 800 ppm). The increase in leaf area might be due to application of GA which help in cell expansion and cell elongation resulting increase in leaf area. Similar finding have been obtained by Nair *et al.* (2002) ^[15], Khan and Chaudhury (2006) ^[11], Jamal *et al.* (2013) ^[10] and Patel *et al.* (2013) ^[16] with respect to application of Gibberellin in gerbera. Decrease in leaf area in T₅ might be due to application of growth retardant like cycocel. Growth retardant inhibit vegetative growth, cell elongation, cell enlargement thereby reducing leaf area. Similar trends in change in leaf area was also observed in summer and rainy season.

8. Chlorophyll content

In winter season maximum chlorophyll content (3.94 mg/leaf) was observed in T₈ (cycocel @ 700 ppm + Amino acid) which was at par with T₉ (cycocel @ 800 ppm + Amino Acid), T₆ (GA @ 100 ppm + Amino Acid), T₄ (cycocel @ 700 ppm) and T₅ (cycocel @ 800 ppm). The minimum chlorophyll content (3.06 mg/g leaf) was observed in T₁(control). The increase in chlorophyll content in T₈, T₉, T₄ and T₅ might be due to application of growth retardant like cycocel. Growth retardant reduce vegetative growth, promote bushiness,

compactness thereby increasing chlorophyll content per gram leaf. Similar finding have been obtained by Bekheta *et al.* (2008) ^[2] with respect to application of growth retardant like paclobutrazole in gerbera. Besides, another treatment T₆ (GA @ 100 ppm + Amino acid) recorded chlorophyll content which was at par with cycocel treatment which corroborates with the finding of Jamal *et al.* (2013) ^[10] with respect to GA application in gerbera and Sajid *et al.* (2015) ^[18] with respect to application of GA in gladiolus. Gibberellin promote vegetative growth and increase chlorophyll content in leaf. The minimum chlorophyll content was found in T₁ (control) where no growth regulator was applied. Similar trends in change in chlorophyll content was also observed in summer and rainy season.

(B) Effect of PBR application on flowering parameters

Number of flowers/plant/m²/season

Pooled data from both the year revealed that in winter season maximum number of flowers/plant /m² (141.90) was found in T₈ (Cycocel @ 700 ppm+ Amino Acid) which was closely followed by T₄ (Cycocel @ 700 ppm) and T₆ (GA @ 100ppm+ Amino Acid) while lowest number of flower (75.84) was observed in T₁ (Control).

Increase in flower number in T₈ and T₄ 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 result in emergence of more number of suckers. When number of suckers increases, the number of flower/plant increases. Similar finding have been obtained by Mahamed (1992) ^[13], Muthumanikam *et al.* (1999) ^[14] and Kumar *et al.* (2008) ^[12] who reported increasing stalk thickness by application of growth retardant like etrel in gerbera. Besides, Cycocel application another treatment T₆ (GA @ 100 ppm+ Amino Acid) produced more number of flowers/plant which was very close to best treatment. Similar finding have been obtained by Sekar and Sujata (2001) ^[19], Nair *et al.* (2002) ^[15], Sujata *et al.* (2002), Dalal *et al.* (2009) ^[5], Jamal *et al.* (2013) ^[10] in increasing number of flowers/plant in gerbera. The minimum number of flower/plant obtained in T₁ (Control) may be due to no application of growth regulator. Similar trends in change in flower number/m²was also observed in summer and rainy season.

Table 1: Impact of plant bio regulators on vegetative character i.e. Plant spread and Leaf number/plant (Pooled over years 2015-16 and 2016-17) in hybrid gerbera cv. Goliath\

Treatments No.	Characters/Treatments	Plant spread(cm)			Leaf number/plant		
		Winter	Summer	Rainy	Winter	Summer	Rainy
T ₁	Control	60.85	50.53	55.21	24.63	10.28	15.11
T ₂	GA @ 100 ppm	64.25	55.96	57.64	30.42	13.98	19.46
T ₃	GA @ 150 ppm	66.05	58.45	60.06	28.79	12.48	17.67
T ₄	Cycocel @ 700 ppm	59.09	47.34	52.64	33.52	17.15	25.40
T ₅	Cycocel @ 800 ppm	56.81	45.57	50.32	31.73	15.65	24.63
T ₆	GA @ 100 ppm + AA	67.07	58.66	59.99	32.38	15.63	23.32
T ₇	GA @ 150 ppm + AA	69.82	60.58	62.12	30.67	14.42	20.38
T ₈	Cycocel @ 700 ppm + AA	60.22	49.75	54.40	34.84	18.63	27.77
T ₉	Cycocel @ 800 ppm + AA	58.69	48.15	52.50	32.50	17.19	25.84
	SE (m) ±	0.730	2.201	0.663	0.352	0.247	0.656
	CD (0.05)	2.08	7.18	1.89	1.00	0.70	2.14

Table 2: Impact of plant bio regulators on vegetative characters i.e. Leaf length and Leaf width (Pooled over years 2015-16 and 2016-17) in hybrid gerbera cv. Goliath

Treatments No.	Characters/Treatments	Leaf length(cm)			Leaf width(cm)		
		Winter	Summer	Rainy	Winter	Summer	Rainy
T ₁	Control	32.26	25.64	27.15	10.40	8.88	9.29
T ₂	GA @ 100 ppm	33.49	28.31	29.26	10.85	10.00	10.27
T ₃	GA @ 150 ppm	34.15	29.82	30.68	11.23	10.53	10.87
T ₄	Cycocel @ 700 ppm	30.69	23.80	25.73	10.06	8.38	8.70
T ₅	Cycocel @ 800 ppm	29.42	22.44	24.48	9.78	7.96	8.18
T ₆	GA @ 100 ppm + AA	34.89	29.57	30.71	11.27	10.69	10.97
T ₇	GA @ 150 ppm + AA	35.65	31.21	31.96	11.69	11.36	11.61
T ₈	Cycocel @ 700 ppm + AA	32.01	26.15	27.68	10.46	9.14	9.56
T ₉	Cycocel @ 800 ppm + AA	30.97	24.84	26.80	10.15	8.75	9.03
	SE (m) ±	0.422	0.809	0.907	0.136	0.401	0.284
	CD (0.05)	1.20	2.64	2.96	0.39	1.31	0.93

Table 3: Impact of plant bio regulators on vegetative characters i.e. Length of petiole and Number of Suckers (Pooled over years 2015-16 and 2016-17) in hybrid gerbera cv. Goliath

Treatments No.	Characters/Treatments	Length of petiole(cm)			Number of suckers/plant/month		
		Winter	Summer	Rainy	Winter	Summer	Rainy
T ₁	Control	8.21	6.50	7.06	1.42	1.00	1.34
T ₂	GA @ 100 ppm	9.09	7.37	7.66	2.48	1.77	2.09
T ₃	GA @ 150 ppm	9.43	7.90	7.97	2.21	1.46	1.86
T ₄	Cycocel @ 700 ppm	7.90	5.97	6.58	2.94	2.13	2.84
T ₅	Cycocel @ 800 ppm	7.49	5.55	6.19	2.66	1.84	2.61
T ₆	GA @ 100 ppm + AA	9.56	8.02	8.32	2.69	1.94	2.38
T ₇	GA @ 150 ppm + AA	9.95	8.56	8.68	2.36	1.71	2.09
T ₈	Cycocel @ 700 ppm + AA	8.54	6.45	7.43	3.33	2.44	3.27
T ₉	Cycocel @ 800 ppm + AA	8.23	6.08	6.83	2.94	2.09	2.86
	SE (m) ±	0.219	0.384	0.119	0.206	0.069	0.076
	CD (0.05)	0.71	1.25	0.39	0.67	0.20	0.22

Table 4: Impact of plant bio regulators on vegetative characters i.e. Leaf area and Chlorophyll content (mg/g leaf) (Pooled over years 2015-16 and 2016-17) in hybrid gerbera cv. Goliath

Treatments No.	Characters/Treatments	Leaf area(m ²)			Chlorophyll content(mg/g leaf)			Number of flowers/plant/m ²		
		Winter	Summer	Rainy	Winter	Summer	Rainy	Winter	Summer	Rainy
T ₁	Control	178.57	101.05	164.20	3.06	1.87	1.90	75.84	50.34	62.34
T ₂	GA @ 100 ppm	204.84	118.43	177.15	3.68	2.61	3.12	118.56	78.78	92.28
T ₃	GA @ 150 ppm	228.33	130.06	187.91	3.41	2.30	3.04	105.12	68.34	79.62
T ₄	Cycocel @ 700 ppm	167.55	93.64	160.08	3.82	2.74	3.26	133.56	95.34	109.56
T ₅	Cycocel @ 800 ppm	161.46	86.03	152.62	3.70	2.64	3.17	114.18	85.56	96.84
T ₆	GA @ 100 ppm + AA	213.54	129.41	188.44	3.89	2.72	3.21	130.56	90.12	100.62
T ₇	GA @ 150 ppm + AA	265.10	139.68	201.28	3.44	2.54	3.15	119.34	81.84	89.28
T ₈	Cycocel @ 700 ppm + AA	196.22	102.31	173.63	3.94	2.91	3.39	141.90	108.84	118.56
T ₉	Cycocel @ 800 ppm + AA	171.99	95.53	170.43	3.89	2.79	3.31	128.28	93.90	109.62
	SE (m) ±	11.551	5.763	3.295	0.143	0.084	0.038	3.680	2.508	2.155
	CD (0.05)	37.66	18.79	9.39	0.47	0.24	0.21	12.00	7.15	6.14

Conclusion

From the above investigation it can be concluded that application of GA₃ @ 150 ppm with amino acid recorded maximum plant spread, length of leaf, leaf width, length of petiole and leaf area while maximum number of suckers/plant, maximum chlorophyll content and maximum number of flowers/plant was found in cycocel @ 700 ppm + Amino acid. The result will be torch bearer for the researcher as well as gerbera grower for enhancing quality and flower production under open field condition.

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