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Evaluation and influence of GA_3 on anthurium (*Anthurium andreanum* lind.) under shadenet

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ABSTRACT: *An experiment on "Evaluation and influence of GA_3 on Anthurium (Anthurium andreanum Lind.) under shadenet" was carried out at floriculture section, RHREC, Bangalore during 2012-2013 under Factorial concept with Completely Randomized Design replicated thrice, which included five varieties (Acropolis, Cheers, Tropical, Fire and Xavia) and five GA_3 concentrations (control, 150, 300, 450 and 600 ppm).Among the treatments highest plant height (64.87 cm), number of leaves (6.56) , leaf length (38.72 cm) and width (21.83 cm), stalk length (48.59 cm), stalk diameter (0.56 cm), spathe length (12.61 cm) and spathe width (9.15 cm) were recorded in treatment GA_3 @ 600 ppm, whereas control treatment showed lowest results. Maximum Plant height (68.92 cm), superior flower characters were noticed by var. Xavia and maximum yield (2.49 flowers / plant) was recorded by var. Tropical. Var. Fire failed to give better performance with respect to vegetative and flower characters.*

Keywords: *Anthurium, Gibberellic acid, Varieties, Spathe*

INTRODUCTION

Anthurium is one of the important, high value cut flower crop, which belongs to the family Araceae and is a native of tropical zones of Central and South America. It is gaining importance in the global cut flower trade due to its attractive and long lasting flowers. Anthurium ranks next to orchids in the global flower trade and commands respectable price both for its cut flowers, foliage and also as a potted plant. It is a slow-growing perennial flower crop that requires shade and humid conditions (Handaragall *et al.*, 2010). In recent years several varieties of anthuriums with wide range of colours have entered in to the market, but all cultivars cannot be grown everywhere especially under Indian condition. Hence, in order to identify suitable cultivars for commercial cultivation to a particular agroclimatic zone there is a need to evaluate for their growth, quality and productivity.

Gibberellins are phytohormones, synthesized naturally in plants, and they are also available in synthetic forms for commercial use. GA_3 plays a major role in flower crops, it enhances cell elongation, cell division, reproductive growth, dormancy breaking, increase in plant height, production of higher number of flowers per plant and also it inhibits senescence.

MATERIAL AND METHODS

The investigations were carried out at Floriculture section, RHREC, GKVK, Bangalore from September 2012 to May 2013. Experiment was conducted to find out the best performing variety for cut flower production for Eastern dry zone and to study the effects of foliar application of gibberellic acid to promote growth, to reduce the juvenile phase and to improve the yield and quality of flowers. The research plot is situated between 13.05° latitude and 77° East longitude at an altitude of 924 m above mean sea level. The climate of the area is mild with mean annual rainfall of about 923.7 mm with about 55 rainy days. The mean maximum temperature vary from 27.2° to 34.6° and the mean minimum temperature vary from 14.8° to 21.8°. The mean maximum relative humidity (90%) during the month of October and the mean

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minimum relative humidity (85%) during the months of December and May were recorded during the experimental period (2012-2013). Five varieties of anthurium viz., V_1- Acropolis, V_2 - Cheers, V_3 - Tropical, V_4 - Fire and V_5 - Xavia were used for this study. The experiment was laid out in a Randomized Complete Block Design with factorial concept having five varieties and five levels of GA_3 (G_0 - control, G_1 - 150 ppm, G_2 - 300 ppm, G_3 - 450 ppm and G_4 - 600 ppm) and replicated thrice.GA_3 was applied five times at bimonthly interval. Observations were recorded nine months after planting on various growth, quality and yield parameters.

RESULTS AND DISCUSSION

On Growth Attributes

Among the varieties studied, var. Xavia showed (Table I) maximum plant height (68.92 cm) and it was minimum (57.55 cm) in var. Acropolis. The differences in plant height among the varieties may be attributed to the inherent genetic character associated with the varieties. These results are in conformity with the reports of Henny and Robinson (1994), Srinivasa and Reddy (2005), Rajeevan *et al*. (2007), Chandrappa (2002) and Agasimani *et al*. (2010). In case of GA_3 levels, 600 @ ppm gibberellic acid was recorded highest plant height (64.87 cm) which was on par with GA_3 @ 450 ppm (63.58 cm) and it was lowest (59.47 cm) in control treatment. Increased plant height could be attributed to the physiological action of GA_3, where in GA_3 increases the size of meristematic region as well as the proportion of the cells undergoing cell division. These results are in conformity with the findings of Srinivasa (2005), Chandrappa *et al*. (2006) and Handaragall (2010).The interaction effect between different GA_3 treatments and varieties were found non significant with respect to plant height.

Number of leaves per plant (Table I) was more (6.79) in var. Acropolis. Whereas, less number of leaves per plant (5.82 cm) was recorded by var. Xavia. This might be due to variability among varieties. Variations in leaf production could also be expected among the cultivars as the attribute is generally a genetic character. These results are in accordance with the reports of Chandrappa (2002), Srinivasa and Reddy (2005) and Shiva and Sujatha (2008). Maximum (6.56) number of leaves per plant was observed in treatment GA_3 @ 600 ppm and it was minimum (5.96) in control. More number of leaves with the application of gibberellic acid was a result of enhanced induction of leaf primordial in the apical growing region. These findings are in conformity with the findings of Srinivasa (2005), Handaragall (2010) and Pancholi *et al*. (2010). The interaction effect between different varieties and GA_3 levels was found non significant.

Different varieties found to be significant with respect to leaf length (Table II). The maximum leaf length (40.07 cm) was recorded by var. Tropical. Whereas, it was minimum (30.74 cm) in var. Fire. The difference in leaf length could be attributed to the genetic makeup of the cultivars. These findings confirm the reports of Henny (1999), Femina *et al.* (2007) and Rajeevan *et al*. (2007). Leaf length (38.72 cm) was highest in GA_3 @ 600 ppm and it was lowest (33.79 cm) in control. It might be due to the fact that GA_3 is a growth promoting substance which is known to increases cell division and cell elongation. These results are in line with the results of Srinivasa (2005) and Handaragall (2010). The interaction effects between different varieties of anthurium and levels of GA_3 and their interactions found non significant.

Different varieties had significant effect with respect to leaf width (Table II). The maximum leaf width (23.16 cm) was observed in variety Xavia. Whereas, minimum leaf width (18.63 cm) was noticed in var. Fire. The difference in leaf width is a varietal trait as it is governed by the genetic makeup. These results are in conformity with the earlier findings of Rajeevan *et al*. (2007), Agasimani *et al.* (2010) and Srinivasa and Reddy (2005) in anthurium.GA_3 showed significant role with respect to leaf width. The treatment GA_3 @ 600 ppm gave maximum leaf width (21.83 cm). However, minimum leaf width recorded by control (18.88 cm). Enhancement of leaf width might have resulted from increased cell division and cell elongation under the influence of GA_3. Similar results were obtained by Salvi (1997), Chandrappa (2002) and Srinivasa (2005). The interaction effect between different GA_3 treatments and varieties were found non significant with respect to leaf width.

Flower Quality Attributes

Stalk length of anthurium varieties had significant effect with respect to varieties and application of different levels of GA_3 at different stages of plant growth (Table III). The highest stalk length (52.24 cm) was recorded in var. Xavia, whereas, least stalk length (42.42 cm) was recorded in var. Acropolis. The differences in flower stalk length among the varieties may be attributed to the inherent genetic character associated with the varieties. Similar results were reported in different varieties of anthurium by Ashwath *et al*. (1998), Cocozza *et al*. (2003) and Femina

Table I
Plant Height and Number of Leaves Per Plant as Influenced by Varieties and Levels of GA_3 in Anthurium under Shadenet

GA_3	*Plant height (cm)*						*Number of leaves*					
	Varieties											
	V_1	*V_2*	*V_3*	*V_4*	*V_5*	*Mean*	*V_1*	*V_2*	*V_3*	*V_4*	*V_5*	*Mean*
G_0	55.44	57.11	63.00	56.77	65.03	59.47	6.44	6.00	6.10	5.78	5.50	5.96
G_1	56.73	60.67	64.33	58.11	67.22	61.41	6.77	6.22	6.33	5.88	5.77	6.20
G_2	57.13	61.03	65.53	58.30	68.44	62.09	6.77	6.22	6.44	5.99	5.77	6.24
G_3	58.53	61.50	66.72	60.16	71.00	63.58	6.89	6.43	6.55	6.16	5.99	6.40
G_4	59.89	62.61	67.72	61.28	72.88	64.87	7.05	6.44	6.78	6.44	6.09	6.56
Mean	57.55	60.58	65.46	58.92	68.92		6.79	6.26	6.44	6.05	5.82	
	V	G		V X G			V	G		V X G		
SEm ±	0.95	0.95		2.13			0.09	0.09		0.21		
CD @ 5%	2.70	2.70		NS			0.27	0.27		NS		

Table II
Leaf Length and Leaf Width as Influenced by Varieties and Levels of GA_3 in Anthurium under Shadenet

GA_3	*Leaf length (cm)*						*Leaf width (cm)*					
	Varieties											
	V_1	*V_2*	*V_3*	*V_4*	*V_5*	*Mean*	*V_1*	*V_2*	*V_3*	*V_4*	*V_5*	*Mean*
G_0	35.44	32.11	37.11	28.27	36.00	**33.79**	18.54	17.33	20.10	17.10	21.33	**18.88**
G_1	37.00	33.11	39.33	30.39	38.39	**35.64**	19.22	18.39	21.22	18.17	22.50	**19.90**
G_2	37.39	33.27	39.50	30.44	38.42	**35.80**	19.43	18.48	21.66	18.55	23.29	**20.28**
G_3	38.61	34.39	41.00	31.22	39.47	**36.92**	19.77	19.27	21.89	19.10	23.72	**20.75**
G_4	39.44	36.27	43.39	33.39	41.44	**38.78**	21.11	19.89	22.99	20.22	24.94	**21.83**
Mean	37.57	33.83	40.07	30.74	38.72		19.62	18.67	21.57	18.63	23.16	
	V	T		V XT			V	T		V X T		
SEm ±	0.15	0.15		0.34			0.09	0.09		0.19		
CD @ 5%	**0.44**	**0.44**		**NS**			**0.25**	**0.25**		**NS**		

Table III
Stalk Length and Stalk Diameter as Influenced by Varieties and Levels of GA_3 in Anthurium under Shadenet

GA_3	*Stalk length (cm)*						*Stalk diameter (cm)*					
	Varieties											
	V_1	*V_2*	*V_3*	*V_4*	*V_5*	*Mean*	*V_1*	*V_2*	*V_3*	*V_4*	*V_5*	*Mean*
G_0	38.89	43.00	43.00	40.20	49.10	**42.84**	0.49	0.44	0.49	0.47	0.58	**0.49**
G_1	41.68	44.50	45.56	42.44	51.56	**45.15**	0.53	0.46	0.52	0.49	0.60	**0.52**
G_2	42.55	44.70	45.75	43.64	52.43	**45.81**	0.53	0.47	0.52	0.49	0.61	**0.52**
G_3	43.44	45.73	46.22	45.67	53.03	**46.82**	0.55	0.48	0.55	0.51	0.63	**0.54**
G_4	45.55	47.22	48.10	47.00	55.10	**48.59**	0.57	0.52	0.55	0.53	0.65	**0.56**
Mean	42.42	45.03	45.73	43.79	52.24		0.53	0.47	0.53	0.50	0.61	
	V	G		V X G			V	G		V X G		
SEm ±	0.29	0.29		0.64			0.01	0.01		0.02		
CD @ 5%	**0.82**	**0.82**		**NS**			**0.03**	**0.03**		**NS**		

et al. (2007). Foliar application of GA_3 had a significant effect on promotion of stalk length in different varieties. The treatment GA_3 @ 600 ppm was recorded maximum stalk length of 48.59cm, whereas it was minimum in (42.84 cm) control. This might be due to the cell enlargement occurred as a result of plasticity of cell wall. This reduces the cell wall pressure around the cell wall and turgour pressure caused by osmotic force in the vascular sap which leads to entry of water resulting in improved stalk length. Similar findings were reported by Srinivasa (2005), Dhaduk *et al.* (2007) and Handaragall (2010).

Significant differences were recorded in stalk diameter of different anthurium varieties (Table III). Maximum stalk diameter (0.61 cm) was recorded by var. Xavia, whereas, it was minimum in (0.47 cm) var. Cheers. The difference in stalk diameter is a varietal trait as it is governed by the genetic makeup. These results are in accordance with the reports of Chandrappa (2002) and Srinivasa and Reddy (2005).

Different GA_3 levels showed significant differences on stalk diameter. The maximum stalk diameter (0.56 cm) was recorded by treatment GA_3 @ 600 ppm at the end of the experiment, when it was on par with treatment GA_3 @ 450 ppm (0.54 cm). Whereas, minimum stalk diameter (0.49 cm) was noticed in treatment G_0 (control). This might be due to the cell enlargement occurred as a result of plasticity of cell wall. This reduces the cell wall pressure around the cell wall and turgour pressure, caused by osmotic force in the vascular sap which leads to entry of water resulting in improved stalk girth. Similar results were reported by Handaragall (2010), Chandrappa (2002) and Srinivasa (2005).

The varieties had significant effect on spathe length (Table IV) during crop growth of anthurium. The maximum spathe length (12.74 cm) was recorded in var. Xavia. Whereas, (12.10 cm) it was minimum in var. Fire. The differences in flower spathe length could be attributed to the genetic makeup of the cultivars. These findings are in conformity with the findings of Ashwath *et al*. (1998), Jawaharlal *et al*. (1998) and Jawaharlal *et al*. (2001).

The spathe length was significantly influenced by different GA_3 levels during crop growth period. The maximum spathe length (12.60 cm) was recorded in treatment GA_3 @ 600 ppm and it was minimum (10.70 cm) in treatment control. The increased spathe length was observed due to the application of GA_3, which can be attributed to activate cell division and cell elongation in the flowers to increase the sink strength of the actively growing parts. Action of gibberellic acid has been reported to stimulate the developmental activities in plants by activation of master regulatory genes in the later stages of corolla development as observed by Handaragall (2010) and Pancholi *et al*. (2010).

Different varieties showed significant results with respect to spathe width (Table IV). Spathe width had significant effect on flower quality. The var. Acropolis gave maximum spathe width (10.27 cm), however minimum spathe width (7.79 cm) was recorded in var. Xavia. The differences in spathe width among the varieties may be attributed to the inherent genetic character associated with the varieties. These results are in conformity with the reports of Agasimani *et al*. (2010), Srinivasa and Reddy (2005), Rajeevan *et al*. (2007) and Chandrappa (2002).

Significant differences were found in different GA_3 levels with respect to spathe width. The highest spathe width (9.15 cm) was recorded in treatment GA_3 @ 600 ppm which was on par with treatment GA_3 @ 450 ppm (9.01 cm). However the lowest spathe width (8.74 cm) was observed in treatment control. The increased spathe width with GA_3 application can be attributed to active cell division and cell elongation in the flowers to increase the sink strength of the actively growing parts. Action of gibberellic acid has been reported to induce an entire developmental program by activation of master regulatory genes in the later stages of corolla development as observed in anthurium by Chandrappa (2002), Handaragall (2010) and Pancholi *et al.* (2010).

Yield Attributes

Yield of an anthurium is the ultimate of what all is done to the crop to achieve the same. Yield (number of flowers) depends on the growth of the crop and the conditions that prevailed before and during the cropping period.

There were significant results recorded by different varieties of anthurium with respect to flower yield per plant and yield per square meter (Table V). The var. Tropical gave maximum flower yield per plant (2.49) and flower yield per square meter (17.25) which was on par with var. Xavia (2.32 and 16.24 respectively) at 4 months interval. Whereas, minimum (1.97 and 13.81 respectively) in var. Fire. It could be due to influence of genetic makeup of the cultivars. Increased number of flowers had positive and significant correlation with leaves, leaf length and leaf width. Thus the increased number of leaves, leaf area and plant spread helped in better synthesis of carbohydrates and their utilization for buildup of new

Table IV
Spathe Length and Spathe Width as Influenced by Varieties and Levels of GA_3 in Anthurium under Shadenet

GA_3	Spathe length (cm)						Spathe width (cm)					
	Varieties											
	V_1	V_2	V_3	V_4	V_5	Mean	V_1	V_2	V_3	V_4	V_5	Mean
G_0	10.89	9.93	10.87	9.83	11.99	**10.70**	10.03	8.00	9.50	8.50	7.67	**8.74**
G_1	12.07	10.63	11.33	10.67	12.53	**11.45**	10.23	8.10	9.73	8.60	7.73	**8.88**
G_2	12.17	11.33	11.87	10.97	12.67	**11.80**	10.30	8.23	9.73	8.63	7.77	**8.93**
G_3	12.33	11.39	12.05	11.33	12.73	**11.97**	10.33	8.33	9.80	8.73	7.83	**9.01**
G_4	12.61	11.73	12.83	12.10	13.77	**12.61**	10.47	8.47	9.97	8.87	7.97	**9.15**
Mean	12.01	11.00	11.79	10.98	12.74		10.27	8.23	9.75	8.67	7.79	
	V	G		V X G			V	G		V X G		
SEm ±	0.15	0.15		0.34			0.08	0.08		0.18		
CD @ 5%	**0.43**	**0.43**		**NS**			**0.23**	**0.23**		**NS**		

Table V
Yield Per Plant and Yield Per Square Meter as Influenced by Varieties and Levels of GA_3 in Anthurium under Shadenet

GA_3	Yield per plant (number of flowers)						Yield per m^2 (number of flowers)					
	Varieties											
	V_1	V_2	V_3	V_4	V_5	Mean	V_1	V_2	V_3	V_4	V_5	Mean
G_0	1.53	1.20	1.73	1.07	1.60	**1.43**	10.73	8.40	12.13	7.47	11.20	**9.99**
G_1	2.07	1.53	2.13	1.53	1.87	**1.83**	14.47	10.73	14.93	10.73	13.07	**12.79**
G_2	2.20	2.13	2.60	2.33	2.53	**2.36**	15.40	14.93	15.87	13.53	14.93	**14.93**
G_3	2.20	2.13	2.60	2.33	2.53	**2.36**	15.40	16.33	18.20	16.33	17.73	**16.80**
G_4	2.73	3.33	3.73	3.00	3.47	**3.25**	19.13	23.33	26.13	21.00	24.27	**22.77**
Mean	2.15	2.11	2.49	1.97	2.32		15.03	14.75	17.45	13.81	16.24	
	V	G		V X G			V	G		V X G		
SEm ±	0.07	0.07		0.16			0.50	0.50		1.12		
CD @ 5%	**0.20**	**0.20**		**NS**			**1.43**	**1.43**		**NS**		

NS: Non significant

cells, thereby increasing the production of flowers. These findings confirm the reports of Bentonio (1996) in anthurium, Fiobenza and Paradiso (2000) in gerbera, Jawaharlal *et al*. (2001) and Srinivasa and Reddy (2005).

Different levels of GA_3 spray recorded significantly higher yield. Number of flowers per plant (3.25) and flower yield per square meter (22.77) were maximum in treatment GA_3 @ 600 ppm and minimum in (1.43 and 9.99 respectively) control. The increased production of flowers may be due to enhanced induction of floral bud break i.e., differentiation of floral primordial in the apical growing region by GA_3. Similar results were obtained by Henny (1983) in aglonema, Beena (2003), Dhaduk *et al.* (2007), Handaragall (2010) and Pancholi *et al.* (2010).

Finally we can conclude that, foliar application of GA_3 @ 600 ppm is optimum for promoting vegetative growth, flower quality and flower yield of anthurium. Among the varieties var. Xavia followed by var. Tropical, var. Acropolis are promising varieties.

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