Effect of Gibberellin and Cytokinin on lateral shoot formation of *Anthurium*

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ABSTRACT

Anthurium is a major cut flower species in tropical and subtropical countries and an economically important genus in the family Araceae. However, non availability of quality planting materials is a major problem in *Anthurium* cultivation. Therefore, present study was carried out to induce lateral shoot formation of topped *Anthurium andreanum* with Gibberellin (GA_3) in combination with Cytokinin (BAP). Two varieties of *Anthurium andreanum,* i.e. 'Tropical red' and 'Safari' were selected for the study. Six months old plants were potted in 4 cm diameter plastic pots containing leaf mould, cattle manure and sand (4:2:1) with ¼ inch brick pieces. Before decapitation, plants were kept for two months in a plant house of the National Botanic Gardens Peradeniya. Application of different concentrations of GA_3 (125, 250, 375 and 500 ppm) were applied in combination with constant level of BAP (250 ppm) at 10 days interval. Number of lateral shoots, length of lateral shoots, number of leaves per sucker, leaf length, number of roots and time taken for sucker formation were recorded after the hormone treatment at 10 days interval. Among different treatments tested, *Tropical red* recorded the highest number of new suckers, shoot length and number of roots per sucker than *Safari*. However *Safari* recorded the highest average value of leaf length than *Tropical red*. Number of leaves per plant did not increase remarkably due to application of hormones in both varieties. However, *Tropical red* performed better in all treatments tested. Overall results showed that the application of 375 ppm Gibberellin in combination with 250 ppm of Cytokinin was the most effective treatment to induce lateral shoots as well as to improve growth performance in both varieties. Furthermore, this study can be extended to induce sucker formation of foliage *Anthuriums* as well.

Key words: *Anthurium,* Tropical red, Safari, Gibberellin (GA_3), Cytokinin (BAP), lateral shoots

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Introduction

Anthurium is a major cut flower species in the tropical and subtropical countries and an economically important genus in the family Araceae (Anon, 2000). Even though *Anthuriums* have a high demand in the local market as well as in the export market, and large numbers of small scale growers are also involved in *Anthurium* cultivation, lack of availability of quality planting materials badly affect the industry. Therefore, it is essential to produce quality planting material consistently in order to maintain continuous production of Anthuriums (Yakandawela *et al*., 2000). *Anthurium* can easily be multiplied by division of offshoots with portion of aerial roots from the main stem (Ekanayake and Hagen, 1977). Cultivars belonging to *Anthurium andreanum* generally produce 14-15 offshoots per plants in a year (Singh, 2006). Propagation by tissue culture technique appears as an alternative to increase the production and propagation of *Anthurium,* and it is commercially used by growers. However, tissue culture is not a cost effective method (Martin *et al*., 2003). Furthermore, *Anthurium* can be reproduced through a lateral shoots (suckers) which arise around the base of the stem. However, many *Anthurium* cultivars do not easily produce suckers with large numbers (Godigamuwa, 2010). *Tropical red* and *Safari* varieties are cut flowers that have very high demand in the export market due to their attractive flowers. *Tropical red* and *safari* plants naturally produce very few numbers of suckers in their life cycle. Plant growth regulators such as Gibberrellin and Cytokinin are used to increase the plant growth and to obtain more suckers production (Godigamuwa, 2010). Cytokinin is used for multiplication of *Anthuriums* (Upamalika, 2003). It has been reported that after adding hormones i.e. Gibberellin and Cytokinin, the sucker formation in vegetatively propagated *Anthuriums* was enhanced (Godigamuwa, 2010). Thus, it is also envisaged that sucker formation can be increased in *in-vivo* propagated plants of *Tropical red* and *safari* with application of Gibberelline and Cytokinin. Hence this study was carried out to investigate the lateral shoots induction of topped *Anthurium andreanum* with Gibberellin and Cytokinin.

Materials and Methods

The experiment was carried out at the Floriculture Research Unit of the National Botanic Gardens Peradeniya from January 2013 to October 2013. Plants were grown under net house condition as a pot experiment.

Design of the Experiment: The experiment was laid out in a Completely Randomized Design (CRD) with three replicates for each treatment and each replicate consisted of 04 individual plants.

Selection of varieties: Two *Anthurium andreanum* varieties, *Tropical Red* (dark green heart shaped leaves and large red colour spathe) and Safari (long reddish green leaves and red colour spathe), maintained under similar conditions, were selected for the experiment.

Plant management: Six-month old potted *Anthurium* plants were kept for two months in a plant house in preparation for decapitation. All cultural practices were done according to the DOA recommendations; i.e. weed control, shading, fertilization and watering etc. A weekly Cu Fungicide – Copper Oxychloride, treatment was applied in order to control spread of bacterial blight disease.

Topping of plants: Plants were topped two months after keeping in a plants house. Plant stems were cut with the basal section having at least 2-3 leaves and upper section having a minimum of 1-2

adventitious roots. Topping is the manual removal of the terminal portion. Slanted cuts using sharp secateurs were made and instruments were disinfected by dipping in a fungicide when using from plant to plant. Cutting surfaces were also disinfected using Mancozeb in a paste form.

Application of Gibberellin (GA_3) and Cytokinin (BAP): Plants were treated twice with 250 ppm BAP in combination with different concentrations (125, 250, 375 and 500 ppm) of Gibberellin. Topped *Anthurium* plants were sprayed with BAP after topping on the first day. GA_3 was sprayed on the following day. Hormonal treatments were done in the morning. Second hormone application was done after 10 days of the first application.

Data collection: Data were recorded just after initiation of lateral shoots 10 days after the second hormone application. Number of shoots per plant, length of shoots, leaves per shoots, leaf length, and roots per shoots as well as time duration for higher sucker formation were recorded.

Statistical Analysis: Date were tabulated and analyzed by using Analysis of Variance (ANOVA) procedure of Statistical Analysis System (SAS). Duncan's New Multiple Range Test (DNMRT) was used to compare the differences among the treatment means at p=0.05. Linear Correlation Analysis was performed to determine the strength of the relationships between measured parameters.

Results and Discussion

Effect of Gibberellin (GA_3) in combination with Cytokinin (BAP) on sucker formation of *Anthurium andreanum*

Newly developing lateral shoots (suckers) were clearly visible in 10 days after the second hormone application. Number of lateral shoots per plant increased with increasing concentration of GA_3 (125, 250, 375 and 500 ppm) in combination with 250 ppm of BAP compared to the control in both varieties. *Tropical red* produced the highest number of lateral shoots per plant 20 days after planting while *Safari* produced the highest number of lateral shoots 30 days after hormone application. The highest number of lateral shoots was recorded in plants treated with 250 ppm BAP with 375 ppm GA_3 in both varieties. Furthermore, production of lateral shoots per plant was significantly different in all treatments compared to the control (p=0.05). According to the study findings, there was a significantly difference (p=0.05) between treatments in both varieties, i.e. *Tropical red* and *Safari* (Table 1).

Table 1: Effect of Gibberellin and Cytokinin on new sucker formation of *Tropical red and Safari*

Treatment	Number of new suckers	
	Tropical red	*Safari*
T_1	1.42^c	1.25^c
T_2	1.61^c	1.5^c
T_3	2.42^b	2^b
T_4	3.75^a	2.58^a
T_5	2.17^b	1.51^c
LSD	0.3	0.45

Note : Means of each category with the same letters are not significantly different at p=0.05.

The tendency for shoot formation depends on the variety (Upamalika, 2003). *Tropical red* recorded the highest mean value of suckers than *Safari*. The success rate of shoot induction of *Anthurium* in this study was similar to that of Godigamuwa (2010).

Effect of Gibberellin (GA_3) and Cytokinin (BAP) on time taken for sucker formation of Anthurium andreanum:

Newly developed lateral buds were observed 10 days after the second hormone application. Maximum number of lateral shoots for *Tropical red* (4) were observed after 20 days and for *Safari* (3), it was observed after 30 days. Plants treated with 250 ppm BAP in combination with 375 ppm GA_3 recorded the maximum number of suckers (lateral shoots) within a short period of time when compared to the control in both varieties tested (Figure 1).

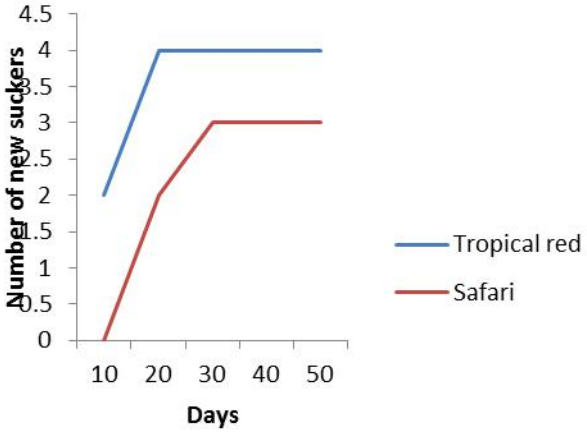

Figure 1. Effect of Gibberellin and Cytokinin on time taken for sucker formation

Effect of Gibberellin and Cytokinin on growth parameters of new suckers

(a) Shoot length of new suckers: Statistical analysis indicated that there was a treatment effect in the experiment (p=0.05). According to the results obtained, tallest shoots were observed in plants treated with 375 ppm GA_3 in combination with 250 ppm BAP (T4) in both varieties. They were significantly different compared to the control. Comparatively, *Tropical red* recorded the highest mean number of shoot length (6.5 cm) than *Safari* (4 cm) as shown in Table 2.

Table 2: Effect of Gibberellin and Cytokinin on Shoot length (cm) per sucker

Treatment	Shoot length(cm)	
	Tropical red	*Safari*
T_1	3.65^{d}	2.05^{c}
T_2	4.23^{c}	2.73^{d}
T_3	6.21^{b}	4.11^{b}
T_4	6.56^{a}	4.38^{a}
T_5	5.62^{c}	3.64^{c}
LSD	0.37	0.35

Note : Means of each category with the same letters are not significantly different at p=0.05.

(b) Number of leaves per sucker: There is no significant difference between treatments compared to the control in both varieties. *Tropical red* recorded the highest number of leaves per sucker (2) when compared to the *Safari*. Both varieties showed a significant difference (p=0.05) between treatments as shown in Table 3. Plants were affected with bacterial blight during the study and it may have led to a decrease in further growth and development of plants. This may have directly affected the decrease of leaves in both varieties.

(c) Leaf length of new suckers: There was a significant difference between treatments (P=0.05). The highest mean value of leaf length per plant was observed in plants treated with 375 ppm GA_3 in combination with 250 ppm BAP (T4) in both varieties. Comparatively *Safari* recorded the highest leaf length (5.32 cm) than *Tropical red* (4.1 cm) as shown in Table 4.

(d) Number of new roots per suckers: Among different treatments tested, the highest number of roots per plant was recorded in plants treated at 375 ppm GA_3 in combination with 250 ppm BAP (T4) in both varieties. They also were significantly different compare to the control. Comparatively *Tropical red* recorded the highest number of roots (8) than *Safari* (6) as shown in Table 5.

Table 3: Effect of Gibberellin and Cytokinin on number of new leaves per sucker

Treatment	Number of new leaves	
	Tropical red	*Safari*
T_1	1.96^{a}	1.46^{a}
T_2	1.87^{b}	1.29^{a}
T_3	1.49^{b}	1.25^{a}
T_4	1.68^{ab}	1.66^{a}
T_5	1.75^{ab}	1.33^{a}
LSD	0.34	0.27

Note: Means of each category with the same letters are not significantly different at p=0.05.

Table 4: Effect of Gibberellin and Cytokinin on leaf length (cm) per sucker

Treatment	Leaf length(cm)	
	Tropical red	*Safari*
T_1	2.25^{d}	2.44^{e}
T_2	2.73^{c}	3.91^{d}
T_3	3.56^{b}	4.73^{b}
T_4	4.51^{a}	5.32^{a}
T_5	3.05^{c}	4.2^{c}
LSD	0.34	0.27

Note: Means of each category with the same letters are not significantly different at p=0.05.

Table 5: Effect of Gibberellin and Cytokinin on number of roots per sucker

Treatment	Number of new roots	
	Tropical red	*Safari*
T_1	3.00^{b}	3.00^{c}
T_2	3.00^{b}	3.00^{c}
T_3	6.00^{a}	5.50^{ab}
T_4	8.00^{a}	6.50^{a}
T_5	6.00^{a}	5.00^{b}
LSD	2.29	1.15

Note: Means of each category with the same letters are not significantly different at p=0.05

Roy et al., (2004) stated that the highest number of roots and the longest roots per plant in rose explants were observed in 1 mg/L 0.5 mg/L NAA. Wernner and Motyka (2001) found that BAP was involved in controlling both root growth and the generation of new root meristem.

Correlation Analysis

Correlation analysis for growth parameters of new suckers of *Tropical red:*

When correlation analysis was performed for the overall data set, number of suckers showed a highly significant ($p< 0.0001$) positive correlation with shoot length and leaf length of sucker (Table 6). Numbers of suckers were not significantly correlated with number of leaves and number of roots. Shoot length showed a negative correlation with number of leaves.

Table 6: Linear Correlation Coefficients between Number of Suckers (NS), Shoot length (SL), Number of Leaves per sucker (NLVS), Leaf length (LVFL), and Number of roots (RT) per sucker in *Tropical red*

	NS	SL	NLVS	LVFL	RT
NS	–	0.86***	−0.43^{ns}	0.96***	0.38^{ns}
SL	–	–	−0.68*	0.88***	0.41^{ns}
NLVS	–	–	–	−0.55*	0.03^{ns}
LVFL	–	–	–	–	0.26^{ns}
RT	–	–	–	–	–

Note: ns- non Significant at p =0.05; * Significant at $p< 0.05$; ** Significant at $p< 0.01$; *** Significant at $p < 0.0001$

Correlation Analysis for growth parameters of new suckers of *Safari*

When correlation analysis was performed for the overall data set, number of suckers showed moderately significant ($p< 0.01$) positive correlation with shoot length and leaf length of suckers (Table 7). Number of suckers showed significant ($p< 0.05$) positive correlation with number of roots per sucker and did not show a significant correlation ($p>0.05$) with number of leaves. Shoot length showed a highly significant ($p < 0.0001$) positive correlation with leaf length and did not show significant correlation with number of leaves per sucker.

Table 7 Linear Correlation Coefficients between Number of Suckers (NS) , Shoot length (SL), Number of Leaves per sucker (NLVS), Leaf length (LVFL), and Number of roots (RT) per sucker in *Safari*

	NS	SL	NLVS	LVFL	RT
NS	–	0.76**	0.32^{ns}	0.74**	0.51*
SL	–	–	0.06^{ns}	0.92***	0.28^{ns}
NLVS	–	–	–	0.03^{ns}	0.46^{ns}
LVFL	–	–	–	–	0.30^{ns}
RT	–	–	–	–	–

Note: ns- non Significant at p =0.05; * Significant at $p< 0.05$; ** Significant at $p< 0.01$; *** Significant at $p < 0.0001$

Conclusion

Among different treatments tested, *Tropical red* recorded the highest number of new suckers, shoot length and number of roots per sucker than *Safari*. However *Safari* recorded the highest average value of leaf length than *Tropical red*. Number of leaves per plant did not increase remarkably due to application of hormones in both varieties. However, *Tropical red* performed better in all treatments tested. Overall results showed that the application of 375 ppm Gibberellin in combination with 250 ppm of Cytokinin was the most effective treatment to induce lateral shoots as well as to improve growth performance in both varieties. Furthermore, in the present study, six months old *in vitro*

plants were treated with different concentrations of Gibberellin and Cytokinin. However, this could be stressful for plants. Therefore, it can be suggested to use at least one year old *Anthurium* plants to induce lateral shoot formation, in order to reduce the stress associated with the hormone application. Furthermore, this study could be extended to induce sucker formation of foliage *Anthuriums* as well.

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