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Evaluation and Studies on Effect of Gibberellic Acid on Growth and Yield of Anthurium

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ABSTRACT: *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 a slow-growing perennial flower crop that requires shade and humid conditions (Srinivasa and Reddy, 2005). Performance of anthurium cultivars varies with region, season and other growing conditions. There is always demand for new types and high yielding genotypes. Similarly role of gibberellic acid (GA_3) is a milestone in flower crops in obtaining quality flowers. Growth and yield of anthurium could be modified and controlled by the application of GA_3. Hence there is a need to evaluate suitable cultivar/s for different agro climatic zones to find out their suitability and there is also a need to find out optimum concentration of GA_3 for anthurium. This will go in a long way in helping the local flower growers to select suitable commercial cultivars and optimum concentration of GA_3 which gives high yield and quality flowers under protected cultivation to achieve desirable results.*

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

INTRODUCTION

Anthurium is a spectacular South American epiphytic plant, valued for its colourful long lasting glossy spathe and spadix. It belongs to the family Araceae and is native of tropical zones of Central and South America. The name Anthurium is derived from the Greek word 'anthos' means flower and 'oura' tail referring to the spadix. Thus, Anthurium is also called as 'tail flower' (Tajuddin and Prakash, 1996).

Native: Tropical zones of Central and South America

National flower of **Mauritius**

Rank: next to Orchids (Global trade).

Famous for its attractive colour, heart shape spathe, glossy appearance and colourful spadix.

Common name: Tail flower, Oil cloth flower and Painters palette.

Propagation: seeds, suckers, tissue culture plants.

Climate:

Temperature: 18^0C-27^0C

Shade: 75%

Humidity: 70-85%

Media: Soil less: 1:1:1- cocopeat: sand: brick pieces).

The global anthurium trade is valued about 50 million US dollars and is next only to orchids among the tropical cut flowers. The Netherland, Mauritius and Hawaii are the major producers of anthurium where as Germany, Italy, Japan, France and the USA are the major consumers.

In India they are successfully cultivating in southern parts, especially in Kerala, Tamilnadu, Maharashtra and parts of Karnataka (Coorg, Chickmagalure and Shimoga etc).

Plant growth regulators have contributed a great deal in floriculture and have been effectively utilized in regulating/ modulating various plant processes and thus boosting the flower productivity directly/ indirectly and especially the role of gibberellic acid is a milestone in horticulture.Gibberellins are a group of growth promoting hormones influencing a range of developmental processes in higher plants including stem elongation, germination, flowering, plant and

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flower size, sex expression and enzyme induction. Anthurium is a potential crop where these effects are manifested in a convincing manner. So there is a need to standardize the correct dosage of gibberellic acid for various desirable effects.

AREA AND PRODUCTION: India

Area: 102 ha and production is 97 ton

TYPES: Foliage and Flowering type

Flowering type- *Anthurium andreanum*

Potted plant- *A. scherzerianum*

Foliage type – *A. veitchii, A. crystallinum, A. clarinervium.*

IMPORTANCE

Cut flower, potted plant, Foliage as a filler material, Exhibition purpose, Indoor decoration and Flower vases.

Important Varieties grown in India

Standard Type

- Can Can – red
- Samba – saffron
- Tropical – red
- Acropolis – white
- Midori – green
- Mauritius red and orange (highly puckered)
- Choco – chocolate
- Pistache – green
- Carnival- white with pink margine
- Fantasia- light pink

Obake Type: Cultivars with bicoloured spathe

- Lambada
- Paradiso

Novelties: Tulip types / Miniatures

- LadyJane
- LadyAnn
- Southern Blush

Double types: Double layer spathe is present in single stalk

Among the entire colours red colour is leading and followed by white and green.

Major exporter: The Netherlands.

In Karnataka 70 % share occupied by Coorg, because of good climate and interested Farmers.

Each plant produces 7- 8 flowers/ year.

EVALUATION

- Performance of anthurium cultivars varies with region, season and other growing conditions.
- In anthurium in different parts of the world, there are many varieties released by different research stations and private companies for commercial cultivation. Before recommending these varieties to a particular Agroclimatic zone for commercial cultivation there is a need to evaluate for their growth, quality and productivity.

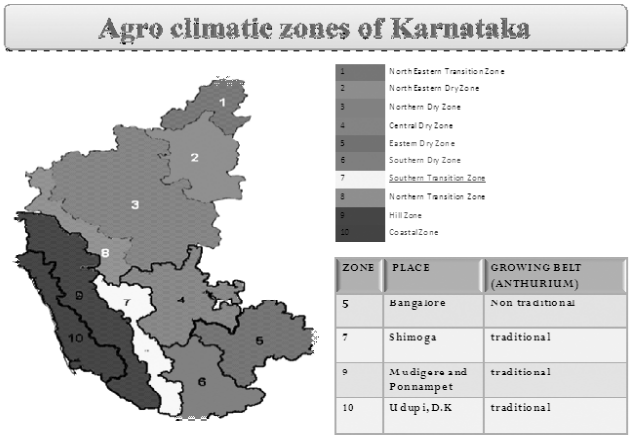
Agro ecological zone is defined as a **land unit in terms of major climates, suitable for certain ranges of crops and cultivars.**

During 1985-90, the planning Commission accepted 15 broad agro climatic zones such as:

1. Western Himalayan Region
2. Eastern Himalayan Region
3. Lower Gangetic plain Region
4. Middle Gangetic plain Region
5. Upper Gangetic plain Region
6. Trans- Gangetic plain Region
7. Eastern Plateau and Hill Region
8. Central Plateau and Hill Region
9. Western Plateau and Hill Region
10. Southern Plateau and Hill Region
11. East coast plains And Hill Region
12. West coast Plains and Ghats
13. Gujarat plains and Hill Region
14. Western Dry Region
15. The Island Region

Table I
Agroclimatic Regions and Respective States of India

Agro-climatic regions	*States*
Humid Western Himalayan Region	Jammu and Kashmir, H.P. and Uttarakhand
Humid Bengal- Assam Region	West Bengal and Assam
Humid Eastern Himalayan Region	**Bay Islands, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Sikkim, Meghalaya and Andaman Nicobar Islands**
Sub- humid Sutlej- Ganga Alluvial Plains	Punjab, Delhi, Uttar Pradesh plains and Bihar
Sub –humid to Humid Eastern and Southern Island	Eastern Madhya Pradesh, Orissa and Andhra Pradesh
Arid Western Plains	Haryana, Rajasthan, Gujarat, Dadra and Nagar Haveli and Daman and Diu
Semi Arid Lava Plateaus and Central Island	Maharashtra, Western Central Madhya Pradesh and Goa
Humid to semi-humid Western Ghats	**Karnataka, Tamil Nadu, Kerala, Pondicherry and Lalakshdweep Island**



ZONE	PLACE	GROWING BELT (ANTHURIUM)
5	Bangalore	Non traditional
7	Shimoga	traditional
9	Mudigere and Ponnampet	traditional
10	Udupi, D.K	traditional

Figure I: Agroclimatic zones of Karnataka

Humid Eastern Himalayan Region and Humid to semi-humid Western Ghats are very much suitable for anthurium cultivation because of favorable environment. Here we can find high humidity and optimum temperature.

In Karnataka, Shimoga, Coorg, DK and Chickmagalure regions are considered as a traditional belt. Whereas Bangalore region is considered as a non traditional belt, but in Bangalore opportunities for Farmers and marketing facilities are good, so there is a need to expansion of area under anthurium to improve the economy and status of farmer and country.

PLANT GROWTH REGULATORS

Natural type

Synthetic type

Mainly 6 types

- Auxins, Gibberellins, Cytokinins, Ethylene and Abscisic acid.

Gibberellins

- GA was first identified in Japan in 1935, as a metabolic byproduct of the plant pathogen *Gibberella fujikuroi.*
- *Gibberella fujikuroi* Bakanae disease (young rice plants grow ridiculously tall).
- Gibberellins are used in ornamental crops extensively for modifying the developmental processes.
- Gibberellins are diterpenoid acids that are synthesized by the terpenoid pathway in plastids and then modified in the endoplasmic reticulum and cytosol until they reach their biologically-active form.
- As of 2003, there were 126 GAs identified from plants, fungi, and bacteria

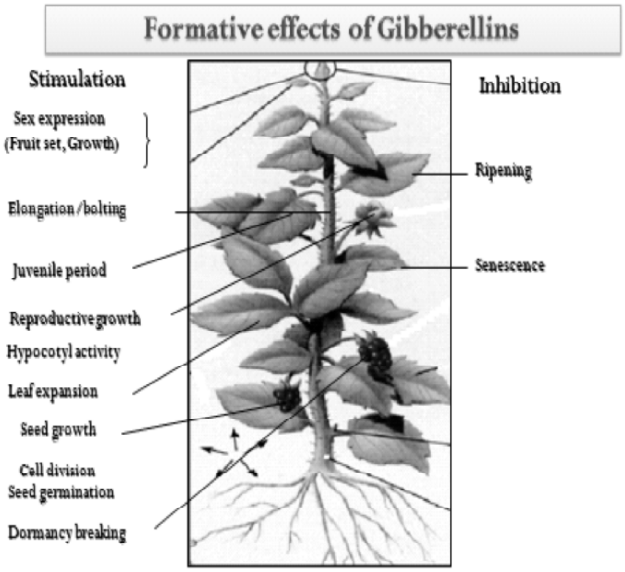


Plate I: Formative Effects of Gibberellins

Effects of Gibberellic Acid

Gibberellic acid is considered as mile stone in horticulture. It is extensively used for growth and yield of Horticulture crops. In case of grapes, it shows marked effect by inducing fruit berry size. Many of the floriculture crops show positive result by the application of gibberellic acid. In case of gladiolus and other bulbous plants it is extensively used for dormancy breaking, whereas many flowering plants are showing maximum floral character and yield by this gibberellic acid application.

Promotion Effects

Fruit set, cell enlargement, cell elongation, Cell division, seed germination, Dormancy breaking, leaf expansion, hypocotyls activity, seed growth, reduction of juvenile period, reproductive growth, number of flowers and bolting.

Retardation Effect

- Ripening
- Senescence

1. Performance of anthurium varieties under green house

UAS, Dharwad (North transition Zone)

Method: RCBD

(Agasimani *et al.*, 2010)

Table II
Vegetative Characters of Different Anthurium Varieties

Sl. No.	*Varieties*	*Av No. of leaves /plant*	*Leaf length(cm)*	*Leaf breadth(cm)*	*No. of suckers/plant*
1	Flame	3.95	12.74	10.26	1.83
2	Caesar	3.65	16.18	12.61	1.65
3	Aymara	4.20	15.88	13.36	2.30
4	Grace	3.05	12.86	9.51	1.60
5	Ivory	3.80	15.43	11.87	4.14
6	Acapana	3.75	14.24	9.62	3.47
7	Jewel	4.25	14.46	10.86	0.49
8	Titicaca	4.90	17.42	12.33	2.30
9	Esmeralda	5.20	18.49	14.84	1.90
10	Chicas	4.60	13.32	8.84	2.67
	CD at 5%	0.64	1.49	1.06	0.15

Table III
Floral Characters of Different Anthurium Varieties

Varieties	*Stalk length (cm)*	*Stalk dm (mm)*	*Spathe length (cm)*	*Spathe breadth(cm)*	*Spadix length (cm)*	*No. of flowers/ plant/ year*	*Vase life (days)*
Flame	24.20	2.73	10.20	8.11	5.54	5.83	15.00
Caesar	25.44	3.40	9.39	9.11	6.41	5.43	11.67
Aymara	22.81	3.67	9.41	7.04	6.41	6.17	15.00
Grace	28.64	3.37	9.06	8.23	3.35	7.43	16.00
Ivory	18.29	3.33	7.54	5.15	4.26	3.33	10.00
Acapana	19.90	5.37	11.84	7.08	3.71	4.83	19.00
Jewel	18.43	3.93	10.61	10.68	7.48	6.67	12.33
Titicaca	30.20	5.37	13.40	16.18	4.24	7.83	15.00
Esmeralda	39.46	6.83	15.71	13.95	8.24	9.33	21.00
Chicas	28.55	4.17	9.53	9.25	5.33	9.00	11.67
CD at 5%	0.68	0.88	0.14	0.21	0.12	0.63	1.21

Conclusion

The maximum vase life was observed in cv. Esmeralda (21 days) where as minimum was recorded in Ivory. Results revealed that with respect to foliage, Varieties Esmeralda, Titicaca, Caesar, Ivory and Aymara are preferred because of their attractive lustrous and good size foliage having more leaf area with good keeping quality and with respect to floral characters variety Esmeralda, Chicas and Titicaca are highly preferred because of their attractive flower colour in market, excellent flower size, high yield production and long shelf life.

Among all the cultivars cv. Esmeralda is good. This result might be due to varietal genetic makeup.

2. Performance of anthurium cultivars in Andaman

Division of Horticulture and Forestry, CARI, Port Blair.

(Humid Eastern Himalayan Zone)

Method: CRD

(Shiva and Nair, 2008)

Table IV
Evaluation of Anthurium Cultivars for Sucker Production in Andaman.

Cultivar	*Plant height (cm)*	*Leaf size*	*Number of leaves/ plant*	*Plant spread (cm)*	*Number of suckers / plant*
Red Dragon	7.09	4.81	1.13	9.53	0.35
Agnihothri	6.87	4.18	3.75	10.35	1.24
Tarus	4.27	2.95	1.38	6.15	0.02
Tropical	7.13	4.91	1.50	9.90	0.04
Salasaga	7.33	5.25	1.25	9.97	0.01
Mirage	9.22	4.37	5.88	11.84	2.00
Leem	5.87	4.44	1.25	8.27	0.06
Colorado	7.68	5.25	1.13	11.57	0.42
Campara	5.00	4.11	1.13	8.15	0.06
Mauritius	7.73	5.18	2.50	12.25	0.10
Wrinkled Orange	8.38	5.24	2.25	13.19	0.08
Butter fly	6.64	4.34	1.13	8.66	0.04
Honey	8.59	5.36	2.00	13.26	0.11
Deep pink	5.13	4.19	0.63	8.73	1.00
CD @5%	0.14	0.21	0.06	0.21	0.03

Table V
Evaluation of Anthurium Cultivars for Flower Production in Andamans.

Cultivar	*Days taken for flowering from flower initiation*	*Spathe size (cm)*	*Spadix length (cm)*	*Peduncle length (cm)*	*Shelf-life of flower on plant (days)*	*No. of flowers/ plant/ Year*	*Number of suckers/ plant*
Honey	22.67	8.48	2.22	19.55	120.30	24.00	0.11
Mauritius	16.67	8.52	2.43	17.17	119.50	22.00	0.10
Wrinkled Orange	16.67	7.77	2.07	20.10	127.30	20.00	0.08
Agnihothri	25.00	6.88	2.00	13.50	112.87	4.00	1.24
Colorado	25.32	5.80	2.75	16.85	107.00	4.12	0.42
CD @5%	0.69	0.09	0.09	0.12	7.04	2.60	0.03

Conclusion: Among 14 cultivars maximum number of suckers, leaves and plant height was recorded in cv. Mirage. However, leaf size, leaf area and plant spread were found maximum in cv. Honey. Maximum number of flowers was obtained with cv. Honey followed by cv. Mauritius and cv. Wrinkled Orange. The cultivars, Mauritius and cv. Wrinkled Orange, took minimum time for flowering from flower initiation. The maximum spathe size was recorded in Mauritius followed by cv. Honey. The cv. Colorado produced maximum spadix length and number of coils per spadix, while cv. Wrinkled Orange produced maximum peduncle length. The shelf life of flower on plant was found longest in followed by cv. Wrinkled Orange followed by cv. Honey. Based on these observations, the cultivars Mirage, Agnihothri and cv. Deep pink were found suitable for sucker production, where as cv. Honey, Mauritius and Wrinkled Orange for flower production in Andamans.

This could be due to varietal genetic makeup. Leaf size and leaf area play an important role in photosynthetic activity as it intercepts more of solar energy. Leaf size, area and number of leaves per plant decide the efficiency of photosynthetic activity, which contribute to the better growth and yield.

3. Performance of anthurium (*Anthurium andreanum Lind* :) cultivars with respect to planting time in humid tropical plain.

KAU, Trissur.(West Coast plain and Ghats Zone)

Method: FRCBD

(Femina *et al.*, 2007)

Table VI
Effects of Planting Times, Cultivars and their Interactions on Growth and Flowering of Anthurium.
(6 months after planting)

Treatment	*Plant height (cm)*	*Plant spread (cm)*	*No of leaves/ plant*	*Leaf length (cm)*	*Leaf breadth (cm)*	*Leaf area (cm^2)*	*Days taken to first flowering*
Planting time							
May (P_1)	16.89	21.60	4.99	12.31	6.68	61.32	74.56
October(P_2)	15.64	20.49	4.55	13.55	7.03	67.74	52.56
February(P_3)	15.77	20.83	6.28	12.90	6.64	62.70	No flowering
C.D. (P=0.05)	0.48	0.87	0.26	0.76	0.26	3.90	2.30
Cultivar							
Tropical(C_1)	14.48	19.41	5.11	12.08	6.43	51.90	82.75
Pistache(C_2)	16.16	22.41	5.68	13.36	6.94	80.22	65.67
Mauritius(C_3)	16.70	21.36	4.81	12.78	6.87	67.20	70.75
Passion (C_4)	17.05	20.70	5.49	13.46	6.88	56.35	35.08
C.D.(P=0.05)	0.55	1.01	0.31	0.88	0.30	4.50	3.25

P X C	*Plant height (cm)*	*Plant spread (cm)*	*No of leaves/ plant*	*Leaf length (cm)*	*Leaf breadth (cm)*	*Leaf Area (cm^2)*	*Days taken to first flowering*
P_1C_1	15.47	21.12	4.14	10.97	6.02	50.35	97.17
P_1C_2	18.09	25.71	5.19	12.55	6.46	85.05	62.75
P_1C_3	16.64	20.76	4.35	12.05	7.13	56.16	68.17
P_1C_4	17.35	18.79	6.29	13.69	7.11	52.71	70.17
P_2C_1	13.19	19.52	4.58	14.05	7.22	51.12	68.33
P_2C_2	16.62	21.90	5.04	13.67	7.57	79.58	68.58
P_2C_3	16.15	20.15	4.19	13.38	6.67	78.07	73.33
P_2C_4	16.59	20.37	4.41	13.10	6.35	61.21	0.00
P_3C_1	14.78	17.60	6.62	11.21	6.06	53.26	–
P_3C_2	13.78	19.61	6.83	13.85	6.79	76.04	–
P_3C_3	17.33	23.15	5.89	12.92	6.51	66.36	–
P_3C_4	17.2	22.95	5.77	13.61	7.19	55.13	–
C.D.(P=0.05)	0.96	1.75	0.54	1.54	0.52	7.80	4.60

Conclusion

Among the four cultivars tried, plant spread, leaf number and leaf area were the highest in cv. Pistache compared to other cultivars. The time taken for first flowering was shortest in cv. Pistache. The most popular cv. Tropical flowered in 82.75 days after planting. Results revealed that influence of planting time differed significantly irrespective of cultivars. May planting was significantly superior in respect to plant height (16.89cm) and spread (21.60cm), while October planting was significantly superior in respect of leaf characters viz., leaf length (13.55cm), leaf breadth (7.03 cm). In October planting, plants came to flowering in 52.56 day while in May planting the first was occurred in 74.56 day after planting.

Genetic makeup is main reason for superior characters of specific cultivars, and season of planting is also contributes for better yield. In case of more humid condition anthurium gives good result.

4. Performance evaluation of cut flower varieties of anthurium under two agroclimatic Condition

KAU, Vellanikara, Trissur (West Coast plain and Ghats Zone) (Humid to sub humid climate)

(N: Nelliampathy and V: Vellanikkara)

Method: RCBD

(Rajeevan *et al.*, 2007)

Table VII
Vegetative Characters of Cut Flower Varieties of Anthurium

Varieties	*Plant height (cm)*		*No leaves/ plant/ month*		*Leaf length (cm)*		*Leaf breadth (cm)*		*Petiole length (cm)*	
	N	*V*	*N*	*V*	*N*	*V*	*N*	*V*	*N*	*V*
Esmeralda	44	30.8	0.9	0.5	21.3	13.8	12.3	8.03	27.6	16.0
Chicas	33.1	29.8	0.8	0.6	15.5	13.5	11.1	7.17	18.3	16.7
Benicitio	40.5	28.7	1.8	0.5	20.6	13.1	12.1	7.80	22.5	14.8
Titicaca	37.0	31.5	1.2	0.4	23.3	18.1	13.5	9.17	19.1	16.8
Salasaga	50.6	31.6	1.4	0.6	20.1	14.8	10.6	7.37	29.3	18.0
Aymara	48.3	32.6	1.3	0.5	22.8	15.6	13.1	10.0	28.0	17.0
Caesar	52.5	32.5	2.3	0.4	24.5	16.8	13.4	9.00	27.3	16.2
Akapana	24.8	39.1	1.1	0.5	18.4	16.9	10.3	9.27	18.6	21.5
Jewel	21.3	39.3	1.2	0.5	17.9	19.6	8.80	9.30	16.6	20.5
Lucia	38.5	37.6	1.2	0.5	22.8	17.4	12.3	8.90	23.0	21.2

Table VIII
Floral Characters of Cut Flower Varieties of Anthurium

Varieties	*No flower/ plant/month*		*Spathe length (cm)*		*Spathe breadth (cm)*		*Spadix length (cm)*		*Stalk length (cm)*	
	N	*V*	*N*	*V*	*N*	*V*	*N*	*V*	*N*	*V*
Esmeralda	2.50	1.00	12.6	7.0	9.87	5.6	7.5	3.6	33.0	21.3
Chicas	1.33	1.25	10.8	7.7	9.03	6.3	5.5	3.2	30.5	28.6
Benicitio	1.75	1.67	10.1	5.0	8.40	4.8	4.8	2.8	34.5	20.0
Titicaca	1.50	1.42	12.5	9.1	10.5	8.0	6.7	3.9	37.0	24.5
Salasaga	1.08	1.17	10.3	7.3	8.20	6.4	4.1	3.0	35.6	29.6
Aymara	1.67	0.92	8.00	8.8	6.57	7.0	6.0	6.0	31.9	27.2
Caesar	1.00	1.00	11.7	8.0	9.90	6.4	7.6	3.4	39.1	29.1
Akapana	1.00	1.17	7.67	8.9	7.90	7.9	5.3	2.9	27.3	31.0
Jewel	1.75	1.09	8.43	8.8	7.23	6.9	3.7	3.2	23.3	36.3
Lucia	1.00	1.00	10.3	9.3	8.80	7.4	5.0	2.9	28.6	29.9

Conclusion

Among the cultivars vegetative characters and number of flowers were significantly higher at Nelliampathy compared to Vellanikkara. Nelliampathy could be identified as a suitable location for growing cut flower varieties of anthurium compared to Vellanikkara in terms of plant growth, number of flowers, spathe size and quality flowers. Maximum number of flowers was for cv. Esmeralda, Benicito and cv. Jewel and minimum for cv. Caesar, cv Akapana and cv. Lucia. At Vellanikkara, highest number of flowers was recorded for cv. Benicito and lowest for cv. Aymara, cv. Esmeralda, cv. Caesar and cv. Lucia. I n all varieties, flowering was earlier at Vellanikkara.

Varietal genetic makeup contributes for better result and topography; environment also plays a major role in better growth and yield. Among two places Vellanikkara belongs to Plain and Nelliampathy belongs to hill. Anthurium cultivation under hill zone shows superior characters, because the climate is very good (high humidity).

5. Evaluation of different varieties of anthurium under Hill Zone of Coorg (D), Karnataka

College of Forestry, Ponnampet, Coorg.(Hill zone)

Method: RCBD

(Srinivasa and Reddy, 2005)

Table IX
Data on Growth Traits of Anthurium as Influenced by Different Varieties

Varieties	*Plant height(cm)*	*Number of leaves*	*Leaf length(cm)*	*Leaf width (cm)*	*Number of suckers/plant*
Hondura	40.94	9.63	21.50	11.56	2.94
Pasricha	29.47	6.56	19.69	10.64	2.56
Senator	36.44	8.50	22.88	13.06	3.50
Tinora	29.60	6.31	20.90	11.33	2.19
Tropical	23.85	5.69	13.36	8.80	2.19
CD@5%	6.16	0.96	3.80	1.76	0.63

Table X
Data on Reproductive Traits of Anthurium as Influenced by Different Varieties (Srinivasa and Reddy, 2005)

Varieties	*Days taken to flower initiation*	*Stalk length (cm)*	*Spathe length (cm)*	*Spathe width (cm)*	*Spadix length (cm)*	*Spadix girth (cm)*	*Number of flowers /plant*
Hondura	270.88	52.00	11.52	9.35	6.57	7.93	8.13
Pasricha	231.81	33.00	9.67	8.42	5.73	6.67	5.31
Senator	209.00	40.78	12.66	10.94	5.74	7.71	7.88
Tinora	242.19	38.76	8.62	7.08	5.53	6.61	5.44
Tropical	176.56	26.80	6.89	5.53	4.66	5.66	4.13
CD@5%	12.54	3.97	0.47	0.60	0.18	0.22	0.53

Conclusion

Among all the cultivars cv. Hondura recorded the maximum plant height (40.94 cm), number of leaves (9.63 cm), leaf width (11.56 cm), flower stalk length (56.76 cm), spadix length (6.57 cm), spadix girth (7.93 mm), number of flowers/ plant (8.13), number of flowers/sq mt (97.56) and number of flowers/ ha. Variety Hondura was the most superior variety followed by Senator, cv. Pasricha, cv. Tinora and cv. Tropical.

- **Leaf size and leaf area play an important role in photosynthetic activity as it intercepts more of solar energy. Leaf size, area and number of leaves per plant decide the efficiency of photosynthetic activity, which contribute to the better growth and yield.**
- **Sucker production is mainly cultivar dependent. Being a genetically controlled factor, the sucker production varied among the cultivars.**
- **Increased number of flowers had positive and significant correlation with the leaves, leaf length and leaf width.**

6. Evaluation of anthurium cultivars under Shade net house.

UAS, Bangalore (Eastern Dry Zone)

Experimental location: K.S.G Nursery (Bangalore)

Method: CRD

(Chandrappa, 2002)

Table XI
Varietal Influence on Growth Characters of Anthurium

Treatment	*Plant height(cm)*	*No. of leaves*	*Leaf area(cm^2)*	*No. of suckers*
Puruvadia Lavender	24.75	14.55	73.16	2.32
Lilian	36.16	14.96	107.28	1.81
Julia	28.42	15.20	48.92	1.47
Carmen	43.37	14.00	102.55	2.29
Lady Jane	67.05	12.29	221.17	1.77
Lady Ruth	55.40	11.16	211.97	1.58
Lady Beth	47.27	12.90	194.09	2.09
Lady Ane	72.2	9.88	262.28	1.22
Pink Aristocrat	59.92	12.18	169.36	1.64
Viking	55.14	10.57	227.90	1.35
Can Can	60.58	5.11	293.27	0.71
Rosa	59.51	7.70	260.85	0.71
Pink	46.44	9.55	157.75	1.22
Red	42.00	10.16	128.77	1.02
Marry Jane	38.88	10.14	132.75	1.39

Table XII
Varietal Influence on Floral Characters of Anthuriums

Treatment	*Stalk length (cm)*	*Stalk girth (mm)*	*Spadix length (cm)*	*Spadix girth (mm)*	*Spathe size*	*No. of flowers/ plant*
Puruvadia Lavender	21.26	3.54	3.63	5.79	12.40	8.09
Lilian	28.99	3.30	4.71	5.80	12.88	6.21
Julia	21.14	2.83	3.14	4.49	7.39	7.42
Carmen	25.42	3.06	4.21	5.13	9.34	6.33
Lady Jane	37.16	3.74	5.90	5.52	16.84	5.61
Lady Ruth	41.14	4.08	5.30	5.89	30.26	5.53
Lady Beth	41.84	4.41	5.40	5.72	23.56	5.60
Lady Ane	38.08	4.16	5.24	5.74	21.13	4.12
Pink Aristocrat	40.07	4.38	4.39	5.98	29.34	5.29
Viking	33.37	4.75	5.60	5.60	43.74	4.78
Can Can	48.05	5.39	7.91	8.23	101.21	3.89
Rosa	45.64	5.25	6.43	7.44	79.56	3.67
Pink	21.79	3.15	4.00	4.89	12.82	4.78
Red	22.65	3.15	3.58	5.35	17.99	5.02
Marry Jane	24.76	3.39	5.33	5.45	13.48	5.15

Conclusion: Among all the cultivars, cv. Can Can shows superior floral and vegetative characters. Whereas cv. Puruvadia Lavender recorded maximum number of flowers and suckers. Hence for flowering purpose cv. Can Can is best and for suckers and foliage purpose cv. Puruvadia Lavender is good.

- **Leaf size and leaf area play an important role in photosynthetic activity as it intercepts more of solar energy. Leaf size, area and number of leaves per plant decide the efficiency of photosynthetic activity, which contribute to the better growth and yield. Sucker production is mainly cultivar dependent. Being a genetically controlled factor, the sucker production varied among the cultivars. Increased number of flowers had positive and significant correlation with the leaves, leaf length and leaf width. Here cv. Puruvadia Lavender belongs to *Anthurium antiquines* group (suckering type) and cv. Can Can belongs to *Anthurium andreanum* (flowering type).**

EFFECT OF GIBBERELLIC ACID

7. Studies on the effect of GA_3 and foliar nutrients along with biofertilizers on growth and flowering of anthurium cv. Tropical Red.

UAS, GKVK, Bangalore.(Eastern dry Zone)

Method: CRD

(Handaragall, 2010)

Treatment details:

T_1 NPK 30:10:10 @ 0.2% spray+ Azospirillum +PSB +VAM+ GA_3 @ 0 ppm

T_2 NPK 30:10:10 @ 0.2% spray+ Azospirillum +PSB +VAM+ GA_3 @ 50 ppm

T_3 NPK 30:10:10 @ 0.2% spray+ Azospirillum +PSB +VAM+ GA_3 @ 100 ppm

T_4 NPK 30:10:10 @ 0.2% spray+ Azospirillum +PSB +VAM+ GA_3 @ 200 ppm

T_5 NPK 30:10:10 @ 0.2% spray+ Azospirillum +PSB +VAM+ GA_3 @ 300 ppm

T_6 NPK 15:10:10 @ 0.2% spray+ Azospirillum +PSB +VAM+ GA_3 @ 0 ppm

T_7 NPK 15:10:10 @ 0.2% spray+ Azospirillum +PSB +VAM+ GA_3 @ 50 ppm

T_8 NPK 15:10:10 @ 0.2% spray+ Azospirillum +PSB +VAM+ GA_3 @100ppm

T_9 NPK 15:10:10 @ 0.2% spray+ Azospirillum +PSB +VAM+ GA_3 @200ppm

T_{10} NPK 15:10:10 @ 0.2% spray+ Azospirillum +PSB +VAM+ GA_3 @300ppm

T_{11} Control

Table XIII
Effect of GA_3 and Foliar Nutrients along with Biofertilizers on Vegetative growth of Anthurium cv. Tropical Red

Treatment	*Plant height (cm)*	*Number of leaves*	*Leaf area (cm^2)*	*Plant spread (cm)*	*No. of Suckers*
T_1	15.12	7.13	97.90	21.67	1.56
T_2	18.98	7.49	127.17	22.68	2.06
T_3	**21.42**	**8.33**	136.86	**26.49**	**3.50**
T_4	20.18	7.98	143.14	25.13	2.93
T_5	19.48	7.81	132.88	23.76	2.30
T_6	17.41	7.02	107.05	21.13	1.36
T_7	18.77	7.49	123.17	22.12	1.66
T_8	20.85	8.15	**152.82**	25.79	2.93
T_9	19.11	7.74	134.05	24.48	2.60
T_{10}	18.15	7.53	129.46	23.25	1.93
T_{11}	16.62	6.69	86.95	19.59	1.16

Table XIV
Effect of GA_3 and Foliar Nutrients along with Biofertilizers on Flowering Attributes of Anthurium cv. Tropical Red

Treatment	*Spathe length (cm)*	*Spathe width (cm)*	*Spadix length (cm)*	*Spadix girth (cm)*	*Stalk length (cm)*	*Stalk girth (cm)*	*No. of days taken for flowering*	*Flower yield/ plant*
T_1	5.10	5.70	4.80	0.61	18.33	0.25	97.41	3.30
T_2	5.43	6.33	5.20	0.72	19.66	0.29	79.45	3.56
T_3	7.10	7.96	6.73	1.22	26.83	0.48	61.20	4.46
T_4	6.46	7.13	6.36	1.00	23.93	0.41	73.95	3.90
T_5	5.86	6.63	5.86	0.85	21.63	0.35	84.41	3.50
T_6	4.90	5.50	4.60	0.57	18.00	0.22	97.35	3.13
T_7	5.26	5.96	5.10	0.67	19.16	0.27	82.98	3.63
T_8	6.73	7.50	6.46	1.10	25.00	0.44	66.98	4.06
T_9	6.23	6.96	5.80	0.93	23.00	0.38	76.05	3.70
T_{10}	5.66	6.56	5.43	0.78	20.50	0.32	73.68	3.33
T_{11}	4.13	5.00	3.50	0.49	16.16	0.17	116.08	2.10

Conclusion

Application of NPK @ 30:10:10 @ the rate of 0.2 % spray, gibberellic acid @ 100 ppm along with application of biofertilizers (Azospirillum, PSB and VAM each @2g/ plant) recorded significantly maximum plant height, max number of leaves and highest number of suckers/ plant. Early flower bud appearance and least number of days to flower opening (61.20) and maximum number of flowers per plant and flower yield per sq mt respectively and flower quality characters like spathe length and width (7.1 cm and 7.96 cm) was significantly max with longest spadix (6.73 cm), highest spadix girth (1.22 cm) max stalk length (24 cm) and longest vase life (19.33) days was observed in the same treatment combination.

GA_3 increases the size of meristematic parts and cell proportion. Biofertilizers enhances better nutrient uptake this leads max stalk length.

- **Enhanced induction of leaf primordial differentiation in the apical growing region leads max number of leaves.**
- **GA_3 reduces juvenile phase and advancing bud formation leads early flowering.**
- **Due to anti senescence property of GA_3, it enhance the longevity of flower in plant.**
- **Max flower character and size: Induce an entire developmental programme by activation of master regulatory genes in the later stages of corolla development.**
- **Max flower stalk length and girth: Due to cell enlargement as a result of plasticity of cell wall. This reduces the cell wall pressure around the cell wall and turgour pressure, caused osmotic force in vascular sap which leads to entry of water resulting in improved stalk length.**
- **Specific cultivars show better result for specific concentration because growth regulators are mainly concentration specific.**
- **Biofertilizers enhances nutrient uptake, better root structure and bio activities.**
- **NPK plays major role in vegetative, floral and resistance character.**

8. Response of anthurium to foliar application of urea and growth regulators in Shade net house

ASPEE College OF Hort and Forestry, UAS, Navarasi, Gujarat (Arid western climate) Zone: Gujarat plains and Hill Region

Method: FRCBD

(Pancholi *et al.*, 2010)

Table XV
Influence of Foliar Spray of Urea and Plant Growth Regulators on Growth Attributes of Anthurium

Treatments	*Number of leaves per plant*			*Number of suckers per plant*		
	Coralis	*Patino*	*mean*	*Coralis*	*Patino*	*mean*
$T_{1:}$ BA@50ppm	3.9	3.8	3.9	1.4	1.1	1.3
$T_{2:}$BA@100ppm	4.3	3.8	4.1	1.6	1.7	1.4
$T_{3:}$BA150 ppm	3.8	3.9	3.9	1.7	1.2	1.4
$T_{4:}$ GA_3 @50ppm	4.8	4.1	4.4	1.4	1.7	1.4
$T_{5:}$ GA_3 @100ppm	4.9	4.3	4.6	1.6	1.4	1.5
$T_{6:}$ GA_3 @150ppm	5.2	4.6	4.9	1.8	1.5	1.7
$T_{7:}$ Urea @0.5%	3.4	3.4	3.4	1.4	1.2	1.3
$T_{8:}$ Urea @1%	4.1	3.9	4.0	1.5	1.3	1.4
$T_{9:}$ Urea @1.5%	4.2	4.9	4.1	1.7	1.4	1.6
$T_{10:}$ control	3.2	3.1	3.1	1.1	1.0	1.1
Mean	4.2	3.9	–	1.5	1.3	–
Source	S.E _+	C.D (P=0.05)	C.V. %	S.E _+	C.D (P=0.05)	C.V. %
Variety	0.03	0.08		0.02	0.05	
Treatment	0.06	0.18	3.88	0.04	0.11	6.55
V XT	0.09	0.26		0.05	NS	

Table XVI
Influence of Foliar Spray of Urea and Plant Growth Regulators on Flowering Attributes of Anthurium

Treatments	*Spathe length*			*Spathe width*		
	Coralis	*Patino*	*mean*	*Coralis*	*Patino*	*mean*
$T_{1:}$ BA@50ppm	5.3	5.4	5.4	2.7	2.5	2.6
$T_{2:}$BA@100ppm	5.6	6.8	6.2	2.8	3.0	2.9
$T_{3:}$BA 150 ppm	5.6	5.6	5.6	2.8	2.9	2.9
$T_{4:}$ GA_3 @50ppm	5.9	5.7	5.8	2.7	2.6	2.6
$T_{5:}$ GA_3 @100ppm	6.1	7.6	6.8	3.2	2.8	3.0
$T_{6:}$ GA_3 @150ppm	6.2	7.9	7.1	4.0	3.0	3.5
$T_{7:}$ Urea @0.5%	5.0	4.6	4.8	2.6	2.2	2.4
$T_{8:}$ Urea @1%	5.3	5.3	5.3	2.7	2.6	2.7
$T_{9:}$ Urea @1.5%	5.4	5.8	5.6	2.9	3.0	3.0
$T_{10:}$ control	4.0	4.1	4.1	2.2	2.1	2.1
Mean	5.4	5.9	–	2.9	2.7	–
Source	S.E _+	C.D(P=0.05)	C.V. %	S.E _+	C.D(P=0.05)	C.V. %
Variety	0.06	0.17		0.03	0.07	
Treatment	0.13	0.38	5.75	0.06	0.17	5.13
V XT	0.19	0.54		0.08	0.23	

Conclusion: Among the treatments, GA_3 @ 150ppm was recorded for maximum result. In case of cv. Coralis, maximum number of leaves, suckers, and spathe length and spathe width were recorded in treatment GA_3@150ppm.Whereas cv. Patino recorded maximum spathe length and spathe width and max. number of leaves in same treatment.

- **Enhanced induction of leaf primordial differentiation in the apical growing region leads max number of leaves.**
- **Max flower character and size: Induce an entire developmental programme by activation of master regulatory genes in the later stages of corolla development.**
- **Max flower stalk length and girth: Due to cell enlargement as a result of plasticity of cell wall. This reduces the cell wall pressure around the cell wall and turgour pressure, caused osmotic force in vascular sap which leads to entry of water resulting in improved stalk length.**
- **Specific cultivars show better result for specific concentration because growth regulators are mainly concentration specific.**

9. Influence of GA_3 on growth and flowering in anthurium cv. Mauritius Red College of Forestry, Ponnampet, Coorg.

(Hill Zone), Method: RCBD

(Srinivasa, 2005)

Table XVII
Influence of Gibberellic Acid on Vegetative Parameters of Anthurium cv. Mauritius Red

Treatment	*Plant height (cm)*	*No. of leaves*	*Leaf length (cm)*	*Leaf width (cm)*	*No. of lateral branches*
T_1 -Control	26.32	6.44	14.19	5.84	2.25
$T_{2:}$ 75 ppm GA_3	37.18	10.85	19.00	10.36	3.00
T_3 -150 ppm GA_3	38.94	10.95	20.15	10.34	4.19
T_4 -225 ppm GA_3	43.47	13.33	20.75	11.19	4.25
T_5 300ppm GA_3	44.44	12.10	21.00	10.86	4.56
C.D. (P=0.05)	7.64	2.13	2.85	2.49	1.32

Table XVIII
Influence of Gibberellic Acid on Flower Parameters of Anthurium cv. Mauritius Red

Treatment	*Days taken for flowering*	*Stalk length (cm)*	*Spathe length (cm)*	*Spathe width (cm)*	*Spadix length (cm)*	*Spadix width (cm)*	*Flower Weight (g)*	*No. flowers*
T_1 -Control	292.00	35.11	7.06	6.44	5.88	5.05	29.29	4.38
T_2- 75 ppm GA_3	283.06	37.11	7.00	6.00	6.49	6.25	37.13	4.69
T_3-150 ppm GA_3	236.75	38.94	6.56	6.38	6.36	6.44	33.64	5.38
T_4-225 ppm GA_3	222.31	43.47	7.38	6.56	6.47	5.50	32.26	5.75
T_5 300ppm GA_3	206.16	44.44	7.81	6.69	6.49	7.13	37.56	6.56

Conclusion

Results revealed that plants treated with GA_3 300 ppm produced significantly maximum plant height (44.44 cm), leaf length (21.0 cm), number of lateral shoots(4.56) and induced early flowering (206 days) as compared to other treatments. Maximum leaf width (11.19 cm) and number of leaves (13.33) were produced in plants treated with GA_3 at 225 ppm, while untreated plants produced minimum leaf width (5.84 cm) and number of leaves (6.44 cm). Flower characters did not significantly differ by GA_3 concentrations. However, GA_3 300 ppm produced maximum number of flowers, stalk length, spathe length, spathe width and other floral characters. Eventhough treatment GA_3 @ 300 ppm has given maximum result, GA_3 225 ppm is best, because it is on par with GA_3 @300 ppm and economically also good.

- **GA_3 increases the size of meristematic parts and cell proportion.**
- **Enhanced induction of leaf primordial differentiation in the apical growing region leads max number of leaves.**
- **GA_3 reduces juvenile phase and advancing bud formation leads early flowering.**
- **Due to anti senescence property of GA_3, it enhance the longevity of flower in plant.**
- **Max flower character and size: Induce an entire developmental programme by activation of master regulatory genes in the later stages of corolla development.**
- **Max flower stalk length and girth: Due to cell enlargement as a result of plasticity of cell wall. This reduces the cell wall pressure around the cell wall and turgour pressure, caused osmotic force in vascular sap which leads to entry of water resulting in improved stalk length.**
- **Increased vase life due to continuity in the water conductance by the tissue without any blockage and GA3 might have also increased the osmotically driven water uptake by the flower stalk.**
- **Specific cultivars show better result for specific concentration because growth regulators are mainly concentration specific.**
- **Enhanced induction of leaf primordial differentiation in the apical growing region leads max number of leaves.**

10. Economics of growth regulator application in *Anthurium andreanum.*

College of Agriculture, KAU, Vellayani,

(West Coast plain Ghats Zone)

(Humid to Semi humid climate)

Thiruvananthapuram

(Beena, 2003)

Table XIX
Total Profit/loss Per Plant Per Year by the Application of GA_3, TIBA and Kn in *A.andreanum.*

Growth regulator conc.	*Varieties* *Liver Red*	*Kalimpong Orange*	*Cylone Red*
GA_3 100 ppm	14.40	-9.60	-14.40
GA_3 300ppm	56.90	-1.90	13.10
GA_3 500 ppm	133.70	86.30	70.10
Kn 100 ppm	8.10	-15.30	-72.40
Kn 300 ppm	-11.60	-16.40	-46.40
Kn 500 ppm	22.10	-34.90	-37.30
TIBA 100 ppm	75.60	-30.60	-22.80
TIBA 300 ppm	25.90	-40.10	-26.30
TIBA 500 ppm	5.00	-6.40	1.40

Conclusion

Among all the treatments, all the cultivars have been recorded maximum growth, yield and economics in treatment GA_3 500 ppm.

Here different growth regulators are there, each one has its own function. Among the above growth regulators TIBA is growth retardant, it retards the

vegetative growth. Kinetin act as a branching enhancer but it is not effective in case of floral parameters.GA_3 plays a major role in growth and flowering characters. This GA_3 plays a major role in promotion of growth and flowering characters.

- **GA_3 increases the size of meristematic parts and cell proportion.**
- **Enhanced induction of leaf primordial differentiation in the apical growing region leads max number of leaves.**
- **GA_3 reduces juvenile phase and advancing bud formation leads early flowering.**
- **Due to anti senescence property of GA_3, it enhance the longevity of flower in plant.**
- **Max flower character and size: Induce an entire developmental programme by activation of master regulatory genes in the later stages of corolla development.**
- **Max flower stalk length and girth: Due to cell enlargement as a result of plasticity of cell wall. This reduces the cell wall pressure around the cell wall and turgour pressure, caused osmotic force in vascular sap which leads to entry of water resulting in improved stalk length.**
- **Increased vase life due to continuity in the water conductance by the tissue without any blockage and GA3 might have also increased the osmotically driven water uptake by the flower stalk.**
- **Specific cultivars show better result for specific concentration because growth regulators are mainly concentration specific.**
- **Enhanced induction of leaf primordial differentiation in the apical growing region leads max number of leaves.**

11. Influence of growth regulators on growth and flowering in anthurium cv. Royal Red.

UAS, Bangalore (Eastern Dry Zone)

Experimental location: K.S.G Nursery (Bangalore).

Method: CRD

(Chandrappa, 2002)

Treatment details

Treatment	Treatment details
T_1	Control
T_2	GA_3 250ppm
T_3	GA_3 500 ppm
T_4	GA_3 750 ppm
T_5	BA 500ppm
T_6	BA 1000 ppm
T_7	BA 1500 ppm
T_8	TIBA 125 ppm
T_9	TIBA 250 ppm
T_{10}	TIBA 500 ppm
T_{11}	GA_3 250 ppm+ BA 500 ppm
T_{12}	GA_3 250 ppm + BA 1000 ppm
T_{13}	GA_3 500 ppm+ BA 500 ppm
T_{14}	GA_3 500 ppm+BA 1000 ppm
T_{15}	GA_3 250 ppm+ BA 500 ppm+ TIBA 125 ppm
T_{16}	GA_3 500 ppm+ BA 500 ppm+ TIBA 125 ppm
T_{17}	GA_3 250 ppm+ BA 1000 ppm+ TIBA 125 ppm
T_{18}	GA_3 250 ppm+ BA 500 ppm + TIBA 500 ppm

Table XX
Effect of Growth Regulators on Growth Characters of Anthurium cv. Royal Red.

Treatment	*Plant height(cm)*	*No. of leaves*	*Leaf area (cm^2)*	*Suckers/ plant*
T_1	41.62	3.13	239.17	0.71
T_2	42.20	3.14	243.23	1.16
T_3	42.45	3.31	246.48	1.13
T_4	42.55	3.40	248.66	0.97
T_5	41.97	3.11	242.86	1.34
T_6	42.09	3.11	241.69	1.65
T_7	42.09	3.01	243.12	1.78
T_8	41.22	3.00	238.52	1.22
T_9	40.66	3.00	235.59	1.22
T_{10}	39.00	2.93	232.52	1.26
T_{11}	42.36	3.18	243.95	1.35
T_{12}	42.25	3.18	244.26	1.39
T_{13}	42.31	3.22	244.71	1.26
T_{14}	42.36	3.29	245.73	1.65
T_{15}	41.31	3.02	240.75	1.47
T_{16}	41.87	3.11	242.64	1.47
T_{17}	41.49	3.07	242.08	1.47
T_{18}	41.45	3.11	241.11	1.50

Table XXI
Effect of Growth Regulators on Floral Characters of Anthurium cv. Royal Red

Treatment	*Spathe size (cm²)*	*Stalk girth (mm)*	*Spadix length (cm)*	*Spadix girth (mm)*	*No. of flowers/ plant*
T_1	59.96	4.75	6.70	6.88	3.02
T_2	60.11	4.85	6.88	6.98	3.07
T_3	61.73	4.89	7.01	7.03	3.24
T_4	61.89	4.91	7.02	7.06	3.29
T_5	60.85	4.82	6.81	7.02	3.09
T_6	60.92	4.86	6.82	7.03	3.08
T_7	61.00	4.88	6.85	6.91	3.08
T_8	59.65	5.02	6.65	7.26	2.96
T_9	59.41	5.07	6.57	7.29	2.96
T_{10}	59.21	5.10	6.46	7.32	2.90
T_{11}	61.08	4.91	6.89	7.09	3.13
T_{12}	61.41	4.93	6.91	7.07	3.13
T_{13}	61.44	4.93	6.94	7.10	3.15
T_{14}	61.53	4.93	6.96	7.11	3.20
T_{15}	60.26	4.95	6.71	7.12	3.02
T_{16}	60.76	4.97	6.77	7.16	3.05
T_{17}	60.75	4.98	6.76	7.16	3.08
T_{18}	60.63	4.99	6.75	7.22	3.02

Conclusion

Among all the treatments GA_3 750 ppm was recorded maximum leaf characters. Whereas BA 1500 ppm was recorded maximum number of suckers. In case of floral characters, maximum spathe size, maximum spadix length and yield was recorded in treatment GA_3 @ 750 ppm.

- **GA_3 increases the size of meristematic parts and cell proportion.**
- **Enhanced induction of leaf primordial differentiation in the apical growing region leads max number of leaves.**
- **GA_3 reduces juvenile phase and advancing bud formation leads early flowering.**
- **Due to anti senescence property of GA_3, it enhance the longevity of flower in plant.**
- **Max flower character and size: Induce an entire developmental programme by activation of master regulatory genes in the later stages of corolla development.**
- **Max flower stalk length and girth: Due to cell enlargement as a result of plasticity of cell wall. This reduces the cell wall pressure around the cell wall and turgour pressure, caused osmotic force in vascular sap which leads to entry of water resulting in improved stalk length.**
- **Specific cultivars show better result for specific concentration because growth regulators are mainly concentration specific.**
- **Enhanced induction of leaf primordial differentiation in the apical growing region leads max number of leaves.**
- **BA induces number of branches, due to cell division and cell enlargement and induction of shoot primordial.**

There is always a demand for new types with high yielding genotypes. Hence there is a need to evaluate suitable cultivar/s for different zones for their suitability. Also application of optimum concentration of GA_3 in anthurium cultivation is most essential to achieve desirable results.

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