

**EVALUATION OF ANTHURIUM VARIETIES UNDER  
GREENHOUSE FOR YIELD AND QUALITY OF CUT  
FLOWERS**

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*By*

**AKKAMAHADEVI D. AGASIMANI**

**DEPARTMENT OF HORTICULTURE  
COLLEGE OF AGRICULTURE, DHARWAD  
UNIVERSITY OF AGRICULTURAL SCIENCES,  
DHARWAD - 580 005**

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5. \_\_\_\_\_  
(M. S. BIRADAR)

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# 1. INTRODUCTION

Floriculture is fast emerging industry in the world. Today, floriculture is a lucrative profession with higher potential for returns than most of the field and other horticultural crops. The demand for flowers both in India and International markets is increasing at a faster rate owing to the liberalization of economy and globalization of trade. The leading flowers which are in great demand are rose, chrysanthemum, carnation, gladiolus and anthurium. Anthuriums are gaining popularity due to higher returns per unit area and their beautiful and attractive long lasting flowers.

Anthurium (*Anthurium andraeanum* Linden Ex André) is a slow-growing perennial that requires shady, humid conditions as found in tropical forests. It includes more than 100 genera and about 1500 species. The genus, *Anthurium*, is neotropical in origin, evergreen and occurs in Central, South America and the West Indies at varying altitudes and habitats.

Anthurium belongs to the family Araceae and is native of tropical zones of Central and South America. The name anthurium is derived from Greek word 'anthos' meaning flower and 'oura' tail referring to the spadix. Thus, anthurium is also known as 'tail flower' (Tajuddin and Prakash, 1996).

Cultivated anthurium belongs to two sections viz., Calomystrium and Porphyrochitonium. The section, Calomystrium includes the popular *Anthurium andraeanum* (Linden) ex André, the best known among the cultivated anthurium species.

*Anthurium andraeanum* (Linden) ex André (the original exported anthurium) characteristically produces numerous inflorescences (spadices) subtended by brightly coloured spathes or bracts, which are carried on long, slender peduncles. The spathes are characteristically heart-shaped, flat, puckered and shiny. Although *A. andraeanum* (Linden) ex André has a limited range of spathe colours from orange to red, the colour range has been augmented through interspecific hybridization with other anthurium species belonging to the sections Calomystrium and Porphyrochitonium mainly in the Netherlands and Hawaii, USA. The commercially cultivated anthuriums hence are complex interspecific hybrids, collectively referred to as *Anthurium andraeanum*.

Anthurium development proceeds in two phases, the monopodial growth phase and the sympodial growth phase. Two growth patterns differ in shoot organization and branching patterns. The monopodial phase occurs during the juvenile period prior to the flowering, while the sympodial phase begins at flowering, where one cut-flower is produced from each leaf axil, independently, beneath each new leaf a new root forms.

The cultivated anthurium species are erect plants that have petiolated, lobed and cordate green leaves of variable size. The leaves have a reticulate venation with a prominent midrib, lateral veins and a well-defined leaf margin. The anthurium plant possesses an underground rhizome with adventitious roots, characteristic of the Araceae family. The arrangement of the foliage leaves is spiral, either clockwise or anticlockwise.

The anthurium cut-flower comprises an inflorescence (spadix) subtended by a modified leaf (spathe) borne on a long stalk (peduncle). *Anthurium andraeanum* flowers have a wide range of spathe colours viz., white, pink, salmon-pink, red, light-red, dark-red, brown, green, lavender, cream or multi-colored. There are also variations in the shape and firmness of the spathe varying from flat to cup-shaped and firm to floppy.

The 'true' flowers are found on the spadix and have large numbers of pistils, each surrounded by four stamens. The 'true' flowers are bisexual and protogynous, with the spadix first producing a female phase followed by, after about a month, a male phase. This prevents self-pollination of the flowers and as such, anthuriums are cross-pollinated. Bees, beetles, flies and ants effect pollination under natural conditions. Six months after pollination, colored berries develop on the spadix bottom upwards.

Each berry contains one or two seeds that can be planted to generate heterozygous and heterogeneous seedlings. Anthurium also reproduces vegetatively through suckers, which arise around the base of the stem. The suckers are identical to the mother plant and to each other. Many anthurium cultivars do not produce suckers or produce very few. Vegetative propagation can also be achieved through the use of 'topplings' or micro-propagation techniques.

Anthurium ranks ninth in the global flower trade and commands a respectable price both for its cut flower and whole plant. Presently the Netherlands is the world's leading producer and exporter followed by Mauritius. It is the national flower of Mauritius.

In India, the anthurium cut flower industry is still in its infancy. At present anthuriums are mostly grown in some small gardens and nurseries. However, some progressive farmers started growing anthurium under protected condition around Bangalore, Belgaum, Goa, Sirsi etc. The important states cultivating anthuriums are Assam, Kerala, Tamilnadu (Salem) and Karnataka (Coorg), where the favourable climate exists.

Of the several varieties grown in the world, 'Tropical', 'Lady Jane', 'Johnson Pink', 'Agnihotri', 'Kalimpong Red', 'Honey Moon Red', 'Samba', 'Winstons Delight', 'Midori' etc., are mainly cultivated in India. There have been no systematic studies on the performance of commercial cut flower production in India. Considering the importance of this crop, there is a prime need to evaluate some of the leading anthurium cultivars for cut flower production so that suitable variety could be recommended for the Dharwad region which is transitional tract of Karnataka.

Even though anthurium is grown by many planters in Karnataka; there is no scientific information on the use of high yielding varieties, standardization of suitable variety for yield, quality and vase life and also no proper studies on economics. Hence identification of suitable varieties for yield, quality, vase life and working out economics of production under this agro-climatic condition is beneficial to the anthurium growers to obtain high yield of good quality flowers and returns. Keeping the above points in view, the present investigations were taken up with the following objectives:

1. To study the yield performance of different varieties of anthurium under green house condition
2. To assess the quality and vase life of cut flowers of anthurium varieties
3. To work out the economics of cultivation of anthurium under greenhouse conditions

## 2. REVIEW OF LITERATURE

This chapter deals with the brief review of the research work done in the past and presented under the following headings based on the objectives of study.

- 2.1 Performance of anthurium varieties
- 2.2 Varietal performance in other crops
- 2.3 Quality and vase life of anthurium cut flowers
- 2.4 Vase life studies in other crops
- 2.5 Economics of anthurium cultivation
- 2.6 Costs and returns in other cut flower production

### 2.1 Performance of anthurium varieties

Of 113 clones evaluated by Kamemoto and Nakasone (1963), 13 were recommended for commercial cut flower production including Haga white, Nitta, Kaumana, Ozaki, Kansako No.1 and Hirose.

Aragaki *et al.* (1968) reported that cultivars Marian Seefurth, Abe Pink and Kansako No.2 were resistant to anthracnose where as Kaumana was found to be most susceptible one.

Kamemoto and his co-workers (1969) described three new cultivars of anthurium and two seedling selections. 'Avenue' and 'Chameleon' were found suitable for cut flower production.

Leeuwen (1981) evaluated the performance of 20 *Anthurium andreanum* clones. Out of that, 15 were considered as promising cultivars. Cultivars Bock Rot, Bock Orange, Rusinski, FBA and Lachs produced less number of inflorescence compared to other cultivars.

In an evaluation trial conducted by Leeuwen (1984) cultivars Avo-natte, Avo-Tineke, Favoriet, Germa, Avo-Claudia, Avo-Ingrid, Nova-Aurora, Avo-Jose, Jaimaca, Hoennette, Sarina and Avo-Anneke were considered the best.

The plant and inflorescence characteristics were evaluated for 34 *Anthurium andreanum* cultivars in five color groups. Promising cultivars including Favoriet, Mirjam, Rico, Sarina and Poolster were selected by Gelder *et al.* (1984).

Klapwijk *et al.* (1984) studied the leaf and inflorescence formation pattern for four years in six anthurium cultivars. The cultivar 'Hawaii' showed very slow bloom development but yielded heavily, while other cultivar Avo-Tineke produced few inflorescence but blooms matured rapidly.

Evaluation of anthurium was carried out in Trinidad and the results showed that *Anthurium scandem* was one of the best species (Lashley, 1986). Betonio (1996) observed that yield of flowers and suckers were greatly affected by cultivars itself. 'Gloria Angara' gave the highest flowers and suckers per plant and Pink Obake' exhibited the largest flower.

The first anthuriums that were introduced into the country were types which produced only pastel-colored flowers. Today hundreds of varieties are known in different colours. A desirable anthurium should grow erect and produce more suckers and flowers; short internodes are preferred in order to limit the height of the plant with an ideal spathe (heart shaped and symmetrical) and spadix (reclining and shorter than spathe) (Singh, 1987).

In anthuriums, flower colour and shape of the spathe are given more importance in commerce. The most common cultivars based on colour are 'Ozaka', 'Kaumana', 'Kozohara', 'Kausaka', 'Pahoa', 'Toyama' and 'Tanaka' (red colour), 'Nitta' and 'Sun Burst' (orange colour), 'Marian seefurth' and 'Abe' (pink color), 'Manoa mist', 'Uniwali' and 'Haga white' (white colour). There are other cultivars like 'Obake', with bicoloured spathe. They are extensively variable in size and shape and contain some development of chlorophyll in spathe. The important ones are 'Avanue', 'Chameleon' and 'Mauna Kae', 'Novelties' and Tulip-types. They are miniatures with spathe cupped and tulip type. Brown types have brown spathe with green spadices, grown on limited extent. Double are the double flowering anthuriums, produce one small and large spathes on same stem with a single spadix. Red, pink, orange doubles are reported (Singh, 1987).

Many forms of anthurium represent terrestrial herbs, climbers and epiphyte with the latter class predominating. *A. andreaum* is anthurium epiphyte with anthurium somewhat vining habit of growth, anchoring itself by means of aerial roots to its support (Criley, 1988).

Arndt (1991) developed anthurium variety named 'Arabella', which produces uniform and compact leaves than Flamenco red. It is an early flowering, medium sized plant with dark green, short leaves. The spathe is broad with free lobes, a shallow sinus and recurving spadix are red in color.

Henley and Robinson (1995) evaluated 21 potted anthurium cultivars. After 38 weeks growth, data were collected on plant foliage, canopy height and width, leaf and inflorescence count and colour of leaves and inflorescence (spathe and spadix)

Variety 'Agnihotri' is moderately tall, erect stout plant with sparse leaves, length of internodes being 2 cm, deep green oblong leaves with over lapping leaf lobes at the base; length X breadth of the leaf measuring 26 cm X 24 cm; petiole 37 cm long, bulged near the leaf base; cordite dark red spathe of 8 cm X 9.5 cm, thick erect spadix of 9 cm long and deep mauve in color with stalk length of 20 cm. number of suckers produced were 2-3 per plant per year (Nirmala, 1996).

A distinct variety of *Anthurium andreaum* named 'Lady Jane' is characterized by short bushy plant with many suckers, compact internodes, lanceolate leaves of moderate green colour measuring 26 X 15.5 cm, petiole of 36 cm length, bulged towards the leaf base. Elliptical to lanceolate spathe of pink colour, length X breadth being 8 X 4 cm and thin erect spadix of 7.6 cm long, pink in colour, with stalk length of 23 cm. flower yield is 16-18 per year. Eight to ten suckers were produced per plant per year (Nirmala, 1996).

Evaluation of genotypes showed the presence of wide variation in shape of the leaf, length of the petiole, shape and color of spathe, thickness, length and color of spadix, nature of spadix, yield of the flower per plant per year and number of suckers produced per plant per year. Fifteen of the 28 genotypes showed nearly all the characters of the spathe that is desired for good variety (Nirmala, 1996).

Variety 'Ruth Morat' derived from the cross *Anthurium antioquinse* x Rotolante1. Spathes are larger than those of Lady Jane, with anthurium mean width and length of 50.1 and 76.8 mm, respectively (Oglesby plant laboratory Inc., Florida, 1996). 'Champion' variety derived from *Anthurium andreaum* hybrids which possesses small leaves and flowers with cupped white spathe held above the canopy and red spadix (Anthura, 1997).

Jawaharlal *et al.* (1998) evaluated six *Anthurium andreaum* and two *Anthurium scherzerianum* cultivars. Among the six *A. andreaum* cultivars, 'Lady Jane' was the most prolific but produced small sized spathes. Among the two cultivars of *A.scherzerianum*, 'Amazonica' produced more blooms per plant, maximum peduncle length, spathe length, width and spadix length which are ideally suited for pot plant.

Twenty lines of *Anthurium andreaum* were evaluated under 50 percent shade for eight important characters like stalk length, spathe length, spathe and spadix diameter, basal lobe length, number of flowers, lobes overlap and number of blisters. Among 20 lines, PN 18, PN 16, PN 1 and KP5 were selected by Aswath *et al.* (1998).

Cultivar 'Red Hot' is a new interspecific hybrid pot plant developed by Henny (1999). The typical characteristics of this cultivar are: leaves dark green, 18-20 cm long and 11-12 cm wide; spathes 6-7 cm long, 4-5 cm wide; spadix orange-red, 3-4 cm long and 5-6 cm wide. Plants reached marketable size in 11 months with quality rated between excellent and good.

Wang-YinTung and Wang (1999) reported that vegetatively propagated lines of 6 hybrid *Anthurium* cultivars (Pink Aristocrat, Patty Anne, Purple Viking, Royal Pink, Royal Orange and Royal Red) were planted in pots and grown under warm (highest temperature of 30° C) or hot (highest temperature of 35° C) conditions in greenhouses. Growing these cultivars at highest air temperatures of 30° C is recommended for good quality and high flower count.

Praneetha *et al.* (2002) evaluated Eight *Anthurium andraeanum* cultivars, AA-2, AA-15, AA-29, AA-40, AA-43, AA-55, AA-69 and Lady Jane, and two *A. scherzerianum* cultivars, AS-1 and AS-2 for their flower yield and floral characters under a 50 percent shade net condition in Yercaud, Tamil Nadu, India. Among the *A. andraeanum* cultivars, AA-43 and Lady Jane recorded the highest number of flowers/plant per year. The maximum values for spathe length (16.3 cm) and spathe width (13.4 cm) were observed in AA-2 and AA-29, respectively.

Henny *et al.* (2003) evolved *Anthurium andraeanum* cv. 'Orange Hot', a sport found among a large greenhouse population of tissue-cultured plants of 'Red Hot', is a new cultivar developed and released by the University of Florida's, Mid-Florida Research and Education Center, Apopka, Florida, USA. 'Orange Hot' displays numerous showy light orange spathes and spadices and, like its parent, possesses a compact, freely branching growth habit.

Talia *et al.* (2003) conducted an experiment to evaluate the productivity and quality of six new cultivars *viz.*, Carnaval, Neon, Queen, Sante, Terra, and Vanilla, in soilless culture and under heated glasshouse conditions. Terra was the most productive cultivar and with regards to quality, Queen showed a bigger spathe.

Ashish *et al.* (2003) conducted an experiment on 50 anthurium genotypes showing variation were selected and raised in a pot culture experiment. SA, NSPPY and CL showed maximum difference between GCV and PCV. High heritability was recorded for AC (99.73percent) followed by ICTS (99.45%), LOS (99.43%) and PF (99.05%). NSPPY recorded a low heritability of 39.34%. Maximum genetic advance was obtained for AC (118.98%) followed by PF (86.55%).

Investigations were conducted to study performance of 50 *Anthurium (A. andraeanum)* genotypes by Paiva (2004). Cultivars Astral, Netuno, Iguape, Cananea and Isla were considered to be suitable in Ceara, Brazil.

A new species, *Anthurium leonii* sp. nov., from Minas Gerais State in southeastern Brazil, is described, illustrated, and compared with *A. solitarium*, the most similar species by Goncalves (2005). *A. leonii* belongs to section Pachyneurium, seems to occur only above 1100 m elevation in the Caparao National Park.

An experiment was conducted by Srinivasa and Reddy (2005) in Madikeri, Coorg, Karnataka, during 2001-02 to evaluate the performance of anthurium cultivars Hondura, Tinora, Senator, Tropical and Pasricha for cut flower production. The cultivars significantly influenced all the vegetative and flower parameters. Hondura was the most superior cultivar followed by Senator, Pasricha, Tinora and Tropical.

Femina *et al.* (2006) conducted studies on four anthurium cultivars namely, Tropical, Pistache, Mauritius orange and passion, to ascertain the influence of four different types of growing structures on growth and quality of flowers. Cultivar 'Pistache' was the best in terms of plant spread (22.45 cm), leaf number (5.68) and leaf area (80.22 cm<sup>2</sup>).

A study was conducted in Karnataka, India, to evaluate the vegetative, physiological and flower characters of anthurium cultivars (Hondura, Pasricha, Senator, Tinora and Tropical) for cut flower production. Among the cultivars, Hondura was considered as a better one by Srinivasa (2006).

Tombolato *et al.*, 2006a reported new cultivars 'IAC Astral' with red spathe and white spadix cultivated under 80% shade net on organic soil producing an average of 7.5 flowers during eleven months.

'IAC Eidibel' cultivar exhibiting red spathe and white spadix which was selected among seedlings introduced from local growers to IAC Experimental Station in Sao Paulo, Brazil is cultivated under 70-80percent shade net on organic soil having keeping quality of about 25 days and other cultivars 'IAC Iguape' and 'IAC Isla' cultivated under 80percent shade net on organic soil is having better post harvest keeping quality (Tombolato *et al.*, 2006b).

A comparative trial run on six Anthurium (*Anthurium andreaeanum* Lind.) cultivars by Cristiano *et al.* (2007) for cut flower production (Cheers, Choco, Cognac, Pistacea, Premier and Simba) cultured by the soilless technique and tested for their quantitative and qualitative response. All tested cultivars showed a good productivity except Premier.

A study was conducted in Thrissur, Kerala, India to evaluate the performance of anthurium (*Anthurium andreaeanum*) cultivars Tropical, Pistache, Mauritius Orange and Passion adopting 3 different dates of planting at 4-month intervals, May, October and February. The effect of planting date differed significantly, irrespective of cultivars. May planting was significantly superior with respect to plant height (16.89 cm) and spread compared to October and February (Femina *et al.*, 2007).

Rajeevan *et al.* (2007) studied 10 cut flower varieties of anthurium to ascertain the influence of two agroclimatic situations, one in the plains (Vellanikkara) and other at an altitude of 1050 m above MSL (Nelliampathy) on growth and flowering. Vegetative and number of flowers were significantly higher at Nelliampathy compared to Vellanikkara in cultivars Esmeralda, Benicito and Jewel.

Shriram *et al.* (2007) conducted studies on anthurium cultivars under poly house at Modibaug, College of Agriculture, Pune, to evaluate the performance and quality characters. They revealed that Cv. Esmeralda performed the best among the other cultivars.

Croat and Lingan (2008) evaluated ten new species of Anthurium (Araceae) from Amazonian Peru. Nine of the species are from a single area of high endemism in the southern Huallaga River Valley of Huanuco and the other was between Tingo Maria and La Divisora and they were namely *A. carpishense* Croat, *A. cerrateae* Croat & Lingan, *A. debilipeltatum* Croat, *A. josei* Croat, *A. linganii* Croat, *A. longissimilobum* Croat, *A. pradoense* Croat, *A. puberulum* Croat & Lingan, and *A. timplowmanii* Croat.

A study was conducted by Shiva and Nair (2008a) to evaluate the performance of 14 anthurium cultivars under shade-net house in Andaman. Based on the observations, the cultivars Mirage, Agnihothi and Deep Pink were found suitable for sucker production, whereas Honey, Mauritius and Wrinkled Orange for flower production in Andaman.

Field studies were conducted by Shiva and Nair (2008b) in the Andaman and Nicobar Islands, India, to estimate genetic variation, heritability and genetic advance of 15 quantitative characters in 14 anthurium (*Anthurium andraeanum*) cultivars. Significant differences were observed for all the characters under study. In general, both the sucker production and flower production are negatively correlated with each other.

## 2.2 Varietal performance in other crops

Soorianatha Sundaram *et al.* (1996) evaluated the performance of orchid plants belonging to 28 different genera and 50 species at Horticultural Research Station, Yercaud. They concluded that Dendrobiums, Cattleyas and Paphiopedilums performed very well under greenhouse.

Soocheon *et al.* (1998) observed the performance of *D. nobile* cultivars Yukidaruma king, Malones fantasy, Golden Blossom Kongane and Snowflake Red Star. Yukidarma king, Malones fantasy and Golden Blossom Kongane performed better with slight difference in the spike yield than the cultivar Snowflake Red Star.

Upadhyay and Nagaraju (2001) evaluated a collection of 390 species of orchids in 93 genera, several hybrids of *Cymbidium* (60), *Dendrobium* (5), *Aranda* (2) and *Vanda* (1) at the National Research Centre for Orchids, Pakyong and reported that the genera *Cymbidium* and *Dendrobium* performed better. Bhattacharjee *et al.* (2002) gave the passport of orchids collected and evaluated at various coordinating centers under floriculture in India.

Botanical exploration conducted in the forest floor of Andaman and Nicobar group of islands led to a collection of 20 species of ornamental indigenous orchids. Further evaluation revealed suitability of *Cymbidium aloifolium*, *Dendrobium crumenatum*, *Eria andamanica*, *Papilionanthea teres* and *Rhynchosstylis retusa* for commercial cultivation (Shiva *et al.*, 2003).

Looking to the overall performance of the gladiolus hybrids, 'AB' x 'MC', 'M' x 'HVG', 'SP' x 'TS', 'MC' x 'HGV' and 'MC' x 'AB' were found to be good for cut flower production under transitional tract of Northern Karnataka (Patil *et al.*, 2004).

Among seventeen *Chrysanthemum* genotypes evaluated, Harvest home, Mutant No. 9, Selection-5, Karnool, Saraval and Chandrika were superior for their vegetative growth in terms of plant spread, number of branches, leaf area etc (Kulkarni and Reddy, 2004).

An evaluation programme on 21 *Dendrobium* spp. at Orchid Research Station, Kalimpong revealed that *D. moschatum* followed by *D. fimbriatum* and *D. nobile* var. *alba* had the maximum plant height. Shoot production was more in *D. jenkinsii* followed by *D. gibsoni* and *D. ochreatum*. The number of leaves per plant was highest in *D. chrysotoxum* followed by *D. farmeri* and *D. nobiliscens* (Roychowdhury *et al.*, 2004).

Among seventeen *chrysanthemum* genotypes evaluated, Harvest home, Mutant No.9, selection-5, Karnool, Saraval and Chandrika were superior for their flower yield as compared to other genotypes (Kulkarni and Reddy, 2004).

Swaroop *et al.* (2005) found that the cultivars Dhanvantari, Anjali, Chandani, Glod dust, Synayana, Hunting song and African star were superior among the 20 cultivars of gladiolus for various flowering parameters. Dhanvantari was found to be special grade where as Gold dust and Synayana were to be considered as utility grade according to length of spike.

Kulkarni and Reddy (2006) found that the china aster cultivar Phule Ganesh white performed better in terms of flower yield followed by Phule Ganesh violet and PG purple Rao and Janakiram (2006) compared the performance of exotic orchidiolas (Cultivars Adi and Tal tal) from Israel and IIHR gladiolus cultivars Dharsan, Dhiraj and Kumkum. They reported that IIHR gladiolus cultivars performed better for one or the other quantitative and qualitative traits than the cultivars of orchidiolas.

Paraneetha (2006) reported that the accessions Gj. 23 and Gj. 5 and Rosalin among the named varieties of *Gerbera* performed well for their plant and floral traits under 30% shade

Kulkarni and Reddy (2006) noticed that the china aster cultivar Phule Ganesh white performed better in terms of vegetative growth followed by Phule Ganesh violet and Phule Ganesh purple. All the Phule Ganesh cultivars proved better than the cultivars Kamini and Violet cushion.

Sindhu (2006) opined that the *Lilium* cultivar Yellow Giant among the cultivars planted was the most suitable one as cut flower which produced maximum spike length, flower size, good bud count and took least number of days for bud initiation and flowering.

Swaroop *et al.* (2006) reported the performance of standard *chrysanthemum* cultivars grown under low cost polyhouse for various flowering characters. Among the cultivars, Snow Don performed better followed by Tata Centenary and Thai Chen Queen.

Jauhari and Singh (2006) evaluated the performance of inbreds and their F<sub>1</sub> hybrids for flower quality attributes in Snapdragon. They opined that F<sub>1</sub> performed better than the inbreds for various flower quality parameters except spike length. On the basis of evaluation of 10 inbreds and 45 F<sub>1</sub> hybrids, the hybrids of the crosses SA-1 x AG-4, Vilmorin x Sant-11 and AG-3 x AG-5 were recommended for cut flower production.

Barman *et al.* (2007) made an attempt to evaluate the performance of 31 cymbidium hybrids for floral characters under partially modified greenhouse. Maximum number of florets was recorded in the hybrid Yankalilla and the biggest size of flowers in Stanley fouraker white Magic and Fantasia Deserio Dulmar.

Barman *et al.* (2007) evaluated the performance of 31 Cymbidium hybrids for morphological characters under partially modified greenhouse. They reported that the hybrid "Miss Sanders" recorded the highest value for plant height and leaf length where as the hybrid penneshaw 'Inter flush' recorded the highest value for pseudobulb length and width.

Fadelah (2007) studied the performance of four tissue cultured orchid hybrids, namely Den. Tuanku Najihah, Den. Doctor Sharif, Den. Tuanku Fauziah (miniature) and Den. Abdullah Badawi. Results indicated that the flower production varied among the hybrids significantly and it was maximum in the cultivar Den. Tuanku Najihah.

Thomas and Lekha Rani (2008) studied the performance of 15 monopodial orchid genotypes belonging to the genera *Aranda*, *Aranthera*, *Kagawara*, *Mokara*, *Renanthera* and *Vanda* which are commercially popular for quantitative (number of inflorescence produced per year, length of inflorescence and length and width of flowers) and qualitative (flowering nature, mode of display of flowers, vase life and fullness value) floral characters. They observed a wide range of variation for most of the traits studied and concluded that these genotypes can be utilized further for the production of novel monopodial orchids.

Nazir and Raj Pravin (2009) observed that the gladiolus cultivars Candy man and summer sunshine gave more yield under the coastal areas of Tamil Nadu.

## 2.3 Quality and vase life of anthurium cut flowers

The post harvest life of various ornamental species and cultivars in vases of water was evaluated twice a week from harvest of *Anthurium andraeanum* cultivars, Leucadendron and Leucospermum species and hybrids by Hansen *et al.* (1991) and reported that the cut plant material was held in an enclosed area under ambient conditions (around 25°C and 50 percent RH); the vase water was changed weekly and no additives or preservatives were used. Exponent models were best for these cultivars.

An investigation was carried out by Yapa *et al.* (2000) to extend the vase life of cut flower *Anthurium andraeanum* using inexpensive treatments compared with conventional methods. The flowers were treated with different concentrations of anti-ethylene compounds, such as AgNO<sub>3</sub>, silver thiosulfate (STS), benzylaminopurine (BAP), KMnO<sub>4</sub>, glycerine and hot water. Distilled water treatment was used as the control. Among the conventional treatments, AgNO<sub>3</sub>, BAP and STS at tested concentrations were not found to be cost-effective.

Paull and Chantrachit (2001) concluded that the vase life of *Anthurium andraeanum*, *Heliconia psittacorum* cv. Andromeda, *H. chartacea* cv. Sexy Pink, red and pink ginger inflorescence (*Alpinia purpurata*) was increased by benzyl adenine (BA 100 mg litre<sup>-1</sup>) applied as a dip or as a spray. The vase life of anthurium leaves was extended by BA.

Mujaffar and Sankat, 2003 examined the improvement of the shelf life of cut anthurium (cv. Trinidad Pink) through the application of fruit wax was evaluated. Waxing of the spadix maintained the fresh weight and extended the shelf life of the flowers. Waxing of the spathe tissue resulted in the discoloration of the spathe.

Guo-ZhaoWu *et al.* (2003) Cut-flower vase life of 12 Anthurium cultivars was studied. Cultivars can be divided into easily declining and non-easily declining types according to their vase life. Cultivars Tropical, Fantasia, Rapido, Rosa, and Casino wilted easily, while cultivars Pistache, Carre, Cognac, Sonate, Senator, President, and Pierrot remained fresh for longer.

The effect of post harvest treatments on the water balance and keeping quality of cut "Trinidad Pink" anthuriums were investigated by Sankat and Mujaffar (2004). Flowers held in more dilute solutions of Floralife (1 and 5 g/litre) showed better keeping quality.

Flower stalks were subjected to different holding solutions by Devi and Jawaharlal (2005) and results indicate that the BA 25 ppm + sucrose 2% and 8-HQC 100 ppm + sucrose 2% were the best holding solutions for prolonging the vase life of anthurium.

Effects of benzyl adenine (BA) on vase life of imported anthurium flowers was examined by Fukui *et al.*, 2005, results indicate that the post importation BA treatment is mostly effective in extending the vase life of cut anthurium during summer, but may not be reliable during winter in temperate regions.

Studies were conducted to compare different pulsing treatments with the cut flowers of anthurium (*Anthurium andraeanum*) cv. Nitta by Soumen and Roychowdhury (2006) and concluded that maximum post harvest longevity was found in the flowers treated with 8-HQS at 400 ppm +sucrose 5% (28.17 day).

Out of seven holding solutions tested, Benzyl adenine 25 ppm+2 per cent sucrose extended the vase life of anthurium (*Anthurium andraeanum* cv Temptation) up to 34.3 days was concluded by Akiladevi (2007a).

Akiladevi (2007b) concluded that ethylene evolved in the flowers due to pulsing treatments is insignificant and also concluded that longevity of anthurium is not affected by ethylene.

Thawiang *et al.* (2007a) conducted experiment for improving the quality and vase life of cut flowers of Anthurium through the application of thidiazuron (TDZ) was investigated. TDZ was the most effective in prolonging the vase life of flowers at concentration of 10 and 15 micro M (21.5 and 21 days, respectively) while treatment of 100 ppm BA had the shortest vase life (16.4 days) as compared to control (18.4 days). Besides, TDZ maintained green color on spathe in cut Anthurium. However, there were no significant differences in water uptake and changes in flower colour among all treatments.

The effects of ethanol on cut flowers of anthurium (*Anthurium andraeanum* L. cv. Marshall) were studied by treating stems with up to 2 percent ethanol solution and measuring spathe color changes, change of fresh weight, water uptake and vase life. Treatment with 0.05 percent ethanol did not affect the vase life of cut anthurium in comparison with control (29 days), while use of 2 percent ethanol solution shortened the vase life of flower (16 days). However, there were no significant differences in fresh weight, water uptake and changes in flower color among all treatments (Thawiang *et al.*, 2007b).

An effect of coconut water on vase life of Anthurium cut flowers was investigated by Agampodi and Jayawardena<sup>1</sup> (2007) and they concluded that flowers treated with 50 percent coconut water with 0.23 percent NaOCl recorded the longest vase life (21 days) compared with other treatments. Therefore, 50percent coconut water with 0.23percent NaOCl has the potential to be used as a preservative medium for Anthurium cut flowers.

The vase life of 26 anthurium (*Anthurium andraeanum*) cultivars was evaluated in three separate trials by Elibox Winston and Umaharan Pathmanathan (2008) and concluded that time to spadix necrosis was the only senescence indicator that occurred in all cultivars and was highly correlated to vase life determined by a complex criterion in all trials.

## 2.4 Vase life studies in other flower crops

Eyk and Eykelboom (1976) assessed the keeping quality by measuring the longevity of the flowers in the field. Differences between varieties in keeping quality are one of the most decisive factors in varietal evaluation of cutflowers and it is an important selection criterion. The method to measure vase life depends on the crop. Not only each crop but also variety reacts differently for handling and transport. Also the senescence symptom varied among crops and even within a crop differences exist (Gelder, 1989). Conduct of vase life trials is still the best method to measure keeping quality (Jong, 1978).

Loser (1985) found that the gerbera cultivars Aluxins, Fredking, Salmera, Billitis and Ankhe had a 15 days vase life when no additives were added to vase solutions.

Singh and Sangama (2003) revealed that the cultivars Lilac tores, Aicardi, Forca, Navajo grown under greenhouse recorded better post harvest qualities than other cultivars of carnation studied.

Krishan and Sangama (2003) reported that maximum vase life of 12.60 days was recorded in carnation cv. Sunrise, followed by cv. Force (12.40 day), White (10.53) and Aicardi (10.26). Cultivar Lilac Torres has shortest vase life of 8.40 days.

Archana *et al.* (2004) reported that carnation cultivar Gaudina exhibited significantly superior results in respect of growth and flower quality. Cultivar Salsa required less period for bud initiation and flower opening. As regards vase life Supergreen has recorded maximum vase life (9.50 days) followed by Niva (9.00 days), Salsa (8.00 days), Montezuma (7.00 days), Cobra (6.00 days) and Gaudina (5.80 days).

Mukund *et al.* (2004) reported that vase life was maximum in carnation cultivars Amla (16.33 day) followed by Desio (16.17 day), SugarBaby (15 day), West Pretty (15 day), Aicardi (14.83 day) and Madame Collette (14.50 day) while Sorisso recorded minimum vase life of 6.67 days.

While evaluating nine exotic gerbera cultivars, Singh and Sangama (2005) observed that the varieties Lyonella, Tiramisu and Twiggy had better vase life and stalk strength whereas Diablo and Tara had poor vase life and less stalk strength.

Jauhari and Singh (2006) evaluated the performance of inbreds and their F<sub>1</sub> hybrids for postharvest attributes in snapdragon. They opined that F<sub>1</sub> performed better than the inbreds for post harvest attributes

Bala *et al.* (2008) studied the thirty rose cultivars for postharvest attributes. The results revealed that the cultivars Imperatrice and Impatient were the desired ones which can be used for breeding purpose to evolve rose genotypes with better vase life.

## 2.5 Economics of anthurium cultivation

Salvi (1997) carried out an experiment in anthurium cultivation in an area of 400 m<sup>2</sup> with 1975 plants and estimated the total cost of cultivation as Rs. 3, 37,972 of which Rs. 1, 93,950 constituted the fixed expenses. The net inflow in this case was worked out to Rs.4, 38,200. It also observed that about 6 suckers per plant were produced during this period. Thereafter as the age of the plant advances, expenditure incurred on plant will increase to a considerable extent due to the higher number of flowers and suckers.

Gajanana and Subrahmanyam (1999) examined the costs and returns in growing anthurium in Coorg district, Karnataka, India; to study the marketing practices; and to understand the constraints in production and marketing of anthurium. Primary data pertaining to the year 1997-98 were collected from 33 anthurium growers by interview method. The cultivation of anthurium proved to be a profitable enterprise despite its huge capital outlay. Adequate steps need to be taken to strengthen credit support.

Shivaprasad (2002) conducted an experiment on anthurium cultivation in Madikeri taluk of Coorg district. He analysed a total recurring expenses of Rs.3, 88,060. The total income analysed per year was Rs.23, 32, 800 per 5148 m<sup>2</sup>.

Beena (2003) conducted study on *A. andreaenum* cultivars Liver Red, Ceylon Red and Kalimpong Orange were treated with 100, 300 and 500 ppm gibberellic acid, kinetin or TIBA in pot experiments conducted in Thiruvananthapuram, Kerala, India to determine the effects of the plant growth regulators on the plant. Treatment with 500 ppm gibberellic acid resulted in the highest profit from Liver Red (Rs. 133.70), Ceylon Red (Rs. 70.10) and Kalimpong Orange (Rs. 86.30).

Kiyuna *et al.* (2004) calculated the cost and evaluate the investment in the production of anthurium (*Anthurium andraeanum*) in a greenhouse of the Experimental Farm of Brazil. The feasibility of the investment was evaluated using as indicators the internal rate of return, net present value and payback period. It is concluded that the investment is feasible at an internal rate of return of 24.54percent. The results of the research indicate that anthurium cultivation near the metropolis can be an attractive option for small and average producers.

Studies were conducted by Cui-YueLing (2006) to develop a quick and low cost breeding technique for *Anthurium andraeanum*. Results showed that natural lighting during sunny days and fluorescent lighting during cloudy days could save as much as 20 percent electric energy.

## 2.6 Costs and returns in other cut flower production

Papaiah and Balakrishna (1989) recorded a net income of Rs.42, 885 from the cultivation of red rose in Bangalore with a gross output value at Rs.60, 000 over the total input cost of Rs.17, 115. The input-output ratio was calculated as 1:2.5.

In rose cultivation the major item of input cost was planting and plant material. The investment in roses was found to be economically viable as it gave a benefit-cost ratio of 1.7 to 1.8 with hardly 2-3 years payback period depending upon the channel of sale (Subramanyan, 1989).

Zawanberg (1990) compared the cost and returns of the five major greenhouse cut flower crops, *viz.* carnation, chrysanthemum, freesia, gerbera and roses in Netherlands over a ten year period. According to him chrysanthemum production had showed lowest increase in labour cost. Rapid growing cycle and closer planting resulted in higher productivity.

In an economic analysis made at Taiwan revealed that the production of gypsophilla, carnation, gerbera and lilies under protected structure indicated that although the production costs were higher for lilies, the returns were also higher. Both, the production cost and revenues obtained from gypsophilla was lower, thereby the profit margin was higher in gypsophilla as compared to carnation and lilies. However, production cost and revenues were similar in gerbera (Lin and Chin, 1990).

Reddy *et al.* (1992) in their study suggested the scope for developing orchid cut flower and production of orchids as a cottage industry. They estimated the profitability for a period of six years based on the assumption of cultivating 1,750 plants in pots under shade house condition in an area of 100 m<sup>2</sup>. They also assessed a net profit of Rs.6000 per month after deducting the initial cost of investment excluding the value of land.

Nagarajan (1992) conducted study on cost of cultivation of Soundarya Kanakambaram at Olakkur village in Tindivanam taluk (Madras). The results revealed that, it provides a net income of Rs.1, 59, 485 per acre with a gross output value of Rs.2, 40, 000 on total input cost Rs.80, 575.

Subramanyam and Sudha (1992) studied the input expenditure towards aster crop in Karnataka which was Rs.9, 678 per hectare in kharif, Rs.9, 861 per hectare in rabi and Rs.9, 833 per hectare in summer showing that there was much difference in different seasons.

The returns on cut roses can be increased during winter by increasing the plant density and by providing supplementary heating than traditional system of management (Ferratto and Benedetto, 1994).

Chadha and Bhattacharjee (1995) stated that the cultivation and production of orchids is emerging as an absorbing and a rewarding vocation. The genera *Arachnis*, *Cattleya*, *Cymbidium*, *Dendrobium*, *Paephipedilum* and *Phalaenopsis* command a high price for their cutflowers and have contributed immensely to the international trade in floriculture.

Ravindrakumar (1996) studied the cost of production of gladiolus in Karnataka. He estimated the total cost of cultivation of Gladiolus per hectare to be Rs.2, 84, 365. The net return realized per hectare of Gladiolus was Rs.1, 40, 554.

Samuel *et al.* (1996) showed that once orchid plants start flowering it gives an annual rate of return of over 100 percent with an initial investment of Rs.35000 in an area extending to 14 m<sup>2</sup>.

Chengappa *et al.* (1998) compared the net returns across flowers such as rose, chrysanthemum, aster, tuberose gladiolus, in and around Bangalore. The study indicated that the net returns was maximum in rose (Rs.79, 671) followed by tuberose (Rs.57, 666) and gladiolus (Rs.61, 097). in terms of returns per rupee of investment it was observed that tuberose yielded the maximum input output ratio at 1:3.28 followed by gladiolus (1:2.98), chrysanthemum (1:2.92) and aster (1:2.04).

Pawan and Goyal (1998) studied the cost of establishing the rose gardens in Sonapat district of Haryana state. The total cost of establishing the garden worked out to be Rs.27, 356 per hectare and the average annual net returns was Rs.44, 457.

The economic viability and feasibility analysis indicated that the production of carnation is highly profitable and economically viable with a Net Present Value of Rs. 3, 56,302 in Bangalore and Rs.1,12,839 in Pune. Results indicated that growers could expand the area under this cut flower, but should undertake self marketing in distant markets to reap higher profits (Mysore *et al.*, 2005).

Floriculture is fast emerging as a major venture in the world. Today, floriculture is a lucrative profession with higher potential for returns than most of the field and other horticultural crops. The demand for flowers both in India and International markets is increasing at a faster rate owing to the liberalization and opening of economy. The costs incurred on planting material and labour formed the major items of expenditure from the above reviews. In spite of high cost of cultivation, flower production proved to be a profitable venture because of higher returns realized.

### 3. MATERIAL AND METHODS

The present investigation on "Evaluation of Anthurium varieties under greenhouse" was carried out at the Hi-Tech Horticulture Unit, Main Agricultural Research Station, Saidapur Farm, Department of Horticulture, University of Agricultural Sciences, Dharwad during 2007-08. Experiment was conducted to find out the best performing variety for cut flower production, vase life and to work out the economics of cultivation of anthurium under greenhouse conditions. The details of the experiments conducted and the methods followed for analysis of the data are presented in this chapter along with an account of the general cultural practices adopted during the period of the experiment.

#### 3.1 Experimental location

The experiment was carried out in partially environment controlled fan and pad greenhouse at the Hi-Tech Horticulture unit, MARS, Saidapur farm, Dept. of Horticulture, UAS Dharwad, which is situated in the transitional tract of Karnataka at 15°26' Northern latitude, 76°07' Eastern longitude and at an altitude of 678m above mean sea level.

#### 3.2 Climate

Dharwad is situated in transitional tract, wherein the climate is fairly equilateral without much extremes. The annual rainfall received during the year was 1116.80 mm with fairly even distribution from June, 2008 to May, 2009. The average maximum temperature reaches 35°C during the months of April- May and the minimum of 13°C in the month of January. The relative humidity fluctuates between 45.0 - 85.0 per cent. The meteorological data for the year 2008-09 and the average data for the preceding 57 years as recorded at the meteorological observatory at the Main Agricultural Research Station, Dharwad are presented in Appendix -I.

#### 3.3 Varietal Evaluation

Experiment: Evaluation of Anthurium varieties under greenhouse.

##### 3.3.1 Experimental Material

The varieties viz., Flame, Caesar, Aymara, Grace, Ivory, Jewel, Acapana, Titicaca, Esmeralda and Chias produced and supplied by KF-Bio plants, Pune were selected to study their performance for different vegetative and flower traits. Seedlings were planted in the field September 6, 2007.

##### 3.3.2 Details of experimental design

Number of varieties	: 10
Number of replications	: Three
Design	: RCBD

An experiment was conducted in Randomized Complete Block Design with three replications. The plan of layout is furnished in Fig. 1.

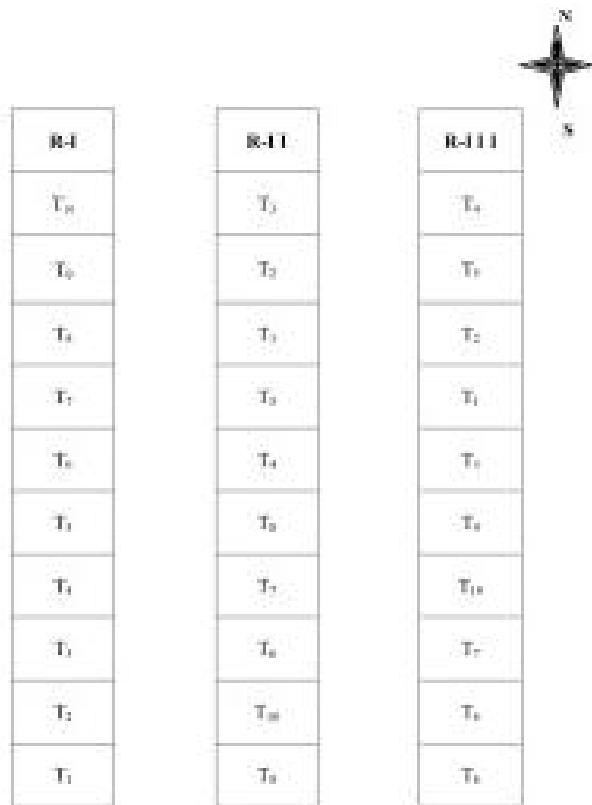


**Plate 1: Esmeralda best performed variety of Anthurium growth under green house**

### 3.3.3 Treatments

The treatments comprised of ten cultivars as listed below:

Treatments	Spathe color	Spadix color
T <sub>1</sub> - Flame	Red	Cream-yellow
T <sub>2</sub> - Caesar	Purple	Dark purple
T <sub>3</sub> - Aymara	Pink	Greenish yellow
T <sub>4</sub> - Grace	Creamish green	Cream-white
T <sub>5</sub> - Ivory	Ivory	Ivory-green
T <sub>6</sub> - Acapana	Creamish green	Pink
T <sub>7</sub> - Jewel	Red- Obake	Creamish yellow
T <sub>8</sub> - Titicaca	Cream-Obake	Pink-red
T <sub>9</sub> - Esmeralda	Green	Green-yellow
T <sub>10</sub> - Chias	Chocolate	Cream-yellow



Experiment No. 1: Evaluation of Anthurium varieties under greenhouse

**Fig 1: Plan of layout**



**Outside view**



**Inside view**

**Plate 2: General view of the Fan and Pad greenhouse**

### 3.3.4 Greenhouse structure

The greenhouse is partially environmental controlled with fan and pad system of size 560 m<sup>2</sup> (28 x 20 m) which is oriented at East-West direction. This involves placing a mattress (pad) on one side of the greenhouse and on opposite side ventilators (fans) to regulate the temperature. Foggers are fixed inside the greenhouse to control the humidity. Shade nets of 50 percent used to regulate the shade. The temperature and humidity under the greenhouse were maintained throughout at about 20-28<sup>0</sup> C and 70-85 percent RH respectively. Cost of the structure is Rs. 600 per meter square area with life span of 20 years.

### 3.3.5 Bed size

Plot size	: 2600 x 120 cm <sup>2</sup>
Bed size	: 860 x 120 cm <sup>2</sup>
Spacing	: 30 cm x 25 cm
No. of plants per bed	: 400

### 3.3.6 Growing media

The well decomposed coir pith washed thoroughly with good quality water to remove the soluble salts. Equal proportions of coir pith and coconut husk were used as growing media after washing in fungicide (Bavistin 0.2%) and insecticide (Chloropyriphos 0.3%).

### 3.3.7 Irrigation

The method of irrigation practiced was sprinkler irrigation through which fertilizers were also given. In each bed two lines of sprinkler were maintained so that water reach each and every plant very easily. The plants are watered twice daily during summer and once in rainy depending on environmental conditions. Even water was sprinkled twice a day over the paths in-between the beds to maintain the humidity.

### 3.3.8 Fertigation

The major nutrients nitrogen, phosphorus and potassium were supplied in the form of complex fertilizer i.e. 19:19:19. Entire dosage (3:1:1) @ 2g/lit, twice a week during vegetative period and 1:2:2 NPK mixture @ 2-3g /lit, twice a week were applied during flowering period. Calcium nitrate and magnesium nitrate were also supplied through fertigation.

### 3.3.9 Greenhouse management

Before entry of the greenhouse there is a small cementing structure for foot dip in which KMnO<sub>4</sub> was added with water so that hygienic condition of plants and greenhouse are maintained. Once in every three years the cladding material and shade net were replaced. Care was taken that no sharp and pointed objects should come in contact with polyethylene cover so that no damage to the structure. The door of the greenhouse was always closed so that temperature and relative humidity are maintained throughout and there was no incidence of pest inside greenhouse.

### 3.3.10 Temperature and Relative Humidity management

The temperature and relative humidity maintained under greenhouse are 20-28<sup>0</sup> C and 60-80% respectively. Fan and pad are situated opposite to each other. Air from the fan is sucked in through the pad. By circulating water through the mattress (pad), the air will absorb the (evaporating) water. This process requires energy and the energy is extracted from the air, so that the temperature drops and simultaneously the relative humidity of the greenhouse air rises. Even water was sprinkled twice a day over the paths in-between the beds to maintain the humidity.

### 3.3.11 Preparation of beds

The bed consists of plastic foil (0.1cm thick), with a drainage tube for removing excess water at the lowest point. The side of the bed consisted of a strong polystyrene sheet. A wire on posts covered with plastic sheet used to create the bed shape. The bed has the width of 1.20 meter and length 26 meters. Path width of 0.8 meter was maintained. Plastic is used to separate the substrate from underground. The bottom of the bed was sloped from the side to the middle of the bed (2-3 cm), so that the drain water flows to the drainage hose.

A growing medium of coconut husk and coco peat were maintained at the thickness of 20-30 cm which were disinfected by fungicides and pesticides. It is refilled after every two to three years of interval.

### 3.3.12 Planting

The beds were irrigated two days prior to planting. Planting was done at the spacing of 30cm x 25 cm by making small holes of about 5-6 cm depth and width at each spot of planting. Plants were inserted in the holes carefully so that the roots of plant should not touch the ground then, a handful of coir pith was put to avoid contact with ground plastic cover. Dead and diseased plants were discarded. Plants were sprinkled with water immediately after planting and planting was done during evening time.

## 3.4 Cultural practices

### 3.4.1 Weeding:

Hand weeding was done as and when weeds were noticed to avoid the competition with crop.

### 3.4.2 Pruning of leaves:

Pruning of leaves was one of the important operation as too many leaves often leads to crooked stems and damaged flower buds. The old and diseased leaves were pruned regularly. Only 3-5 leaves were maintained on the plant to get good quality flowers.

### 3.4.3 Plant protection measures:

To prevent and control pest and diseases the plant protection measures were taken as and when noticed with appropriate chemicals.

### 3.4.4 Harvesting and Grading

The flowers were harvested after unfolding of the spathe was complete. They were harvested in the morning and were cut with anthurium long stalks. The best time for harvest was when 1/3 to 2/3 of the true flowers on the spadix were open. The flowers were cut with a sharp knife, leaving 3 cm of stem on the plants to prevent rotting of stem.

The flowers having any sort of blemishes, black spots, discoloured spathe, short stalk as well as deformed flowers were removed before grading. The flowers of spotlessly clean and shining were used.

Flowers were graded into five classes depending on their flower size in Caribbean and Hawaii markets. The anthurium cut flower grades were as follows:

<u>Grade</u>	<u>Flower size (inch)</u>	
Peewee	<2.5	
Mini	2.5-3	
Small	3-4	
Medium	4-5	Spathe length + spathe breadth
Large	5-5.5	Flower size = $\frac{\text{-----}}{2}$
Extra large	5.5-6	
Premium	>6	

### 3.4.5 Post harvest handling

After harvest, the basal portion of the stalk of the flower were kept in water to prevent drying out. Flowers were cleaned with shampoo in clean water to remove the adhering particles of dust, pesticides or fungicides and for shining effect. The care was taken while transporting flowers by placing a piece of cotton soaked in water at the end of the stem to prevent desiccation.

### 3.4.6 Shelf life study

Senescence of flowers is associated with the plugging of stem vascular tissues accompanied by the loss in weight, visible changes including spathe glow loss, necrosis of spadix, bluing of spathe, stem collapse and abscission of the spathe and spadix from the stem.

## 3.5 Observations

There were ten beds each with different variety. Each bed was divided into three replications in which five plants were selected randomly for recording observations. The parameters on which the observations recorded were as follows:

### 3.5.1 Vegetative parameters

#### 3.5.1.1 Number of leaves per plant

Number of leaves produced per plant was recorded at monthly interval from May to December and average number was taken for statistical analysis and expressed as number of leaves per plant in rainy season and winter season. Young developing, diseased and old drying leaves were not counted.

#### 3.5.1.2 Leaf length

The length of the leaf was recorded from the base to the tip of the leaf. Three fully opened leaves in each plant were measured and average of these three was worked out and expressed in centimeters. The data was recorded from May to December and average length was taken for statistical analysis.

#### 3.5.1.3 Leaf breadth

The breadth of the leaf was measured at the centre of the leaf. Three fully opened leaves in each plant were measured and average of these three was worked out and expressed in centimeters. The data was recorded from May to December and average breadth was taken for statistical analysis.

#### 3.5.1.4 Leaf area

Leaf area was estimated through linear parameters like length and width of leaf using the equation leaf area =  $L \times B \times 0.85$  where 'L' is the length and 'B' is the breadth of the leaf. The factor 0.85 was derived by dividing the actual leaf area measured accurately from the graph paper by the leaf area computed from length and breadth of leaf (Lila *et al.*, 1996). The data was recorded from May to December and average area was taken for statistical analysis which is expressed in centimeter square.

#### 3.5.1.5 Number of suckers per plant

The number of new suckers with independent root system arising from the base of the plant was recorded and expressed as number of suckers per plant. The data was recorded from May to December and average number of suckers was taken for statistical analysis.

### 3.5.2 Flower characters

#### 3.5.2.1 Flower stalk diameter

Flower stalk diameter was measured using vernier-caliper and data was recorded in millimeters. The data was recorded in the month of November average flower stalk diameter was taken for statistical analysis.

#### 3.5.2.2 Flower stalk girth

Flower stalk circumference is measured by using thread and then length of thread was actually measured on scale. The data was recorded in millimeters. The data was recorded in the month of November average flower stalk circumference was taken for statistical analysis.

#### 3.5.2.3 Flower stalk length

Flower stalk or peduncle length from its point of emergence to the point of attachment to the spathe was measured and recorded in centimeters. The data was recorded from June to February and average flower stalk length was taken for statistical analysis.

#### 3.5.2.4 Spathe length

The length of the spathe was recorded from the base to the tip of the spathe and expressed in centimeters. The data was recorded from June to February and average flower spathe length was taken for statistical analysis.

#### 3.5.2.5 Spathe width

The width of spathe was measured at the centre of the spathe and expressed in centimeters. The data was recorded from June to February and average flower spathe width was taken for statistical analysis.

#### 3.5.2.6 Spadix length

Spadix length was measured from the point of its attachment to the stalk and spathe to the tip of spadix with the help of scale and expressed in centimeters. The data was recorded from June to February and average flower spadix length was taken for statistical analysis.

#### 3.5.2.7 Candle position

Candle position is the orientation between spathe and spadix which was measured as an angle between the tip of spathe to the tip of spadix. It was recorded in degrees ( $^{\circ}$ ). The data was recorded and average candle position was in the month of November taken for statistical analysis.

#### 3.5.2.8 Spathe angle

Spathe angle is the orientation between spathe and flower stalk which was measured as an angle between spathe and the flower stalk. It was recorded in degrees ( $^{\circ}$ ). The data was recorded in the month of November was taken for statistical analysis.

#### 3.5.2.9 Spathe and spadix colour

Color of the spathe and spadix were recorded by using color chart at 75% of their development.

#### 3.5.3 Vase life

Vase life studies of all the ten varieties were conducted during the month of November and October under normal water. The data was recorded in terms of number of days and average was taken for statistical analysis.

#### 3.5.4 Yield parameters

##### 3.5.4.1 Number of flowers per plant

Number of flowers produced per plant was recorded at monthly interval and average number of flowers were taken into consideration at monthly interval for statistical analysis and expressed as number of flowers produced per plant. The data was recorded from June to February

##### 3.5.4.2 Number of flowers per meter square area

Number of flowers produced for a meter square area was recorded at monthly interval and cumulative number of flowers were taken into consideration at monthly interval for statistical analysis and expressed as number of flowers produced per meter square area per year.

##### 3.5.4.3 Number of flowers per hectare

Number of flowers produced per hectare was recorded by converting meter square area into hectare.

#### 3.5.5 Cost of cultivation

The technique of tabular analysis was employed for computing the cost, returns and problems in production (Appendix III).

### 3.6 Statistical analysis

The data of the experiment were subjected to statistical analysis of RCBD as described by Sundar Raj *et al.* (1972). The level of significance used in 'F' test was  $P = 0.05$ . Critical difference were calculated whenever the 'F' test was found significant.



Plate 3: Crop and stand of individual anthurium varieties under greenhouse

## 4. EXPERIMENTAL RESULTS

The present experiment was carried out to study the performance of different anthurium varieties under greenhouse, their vase life and economics. The results are presented in this chapter.

### 4.1 Vegetative parameters

The different morphological characters *viz.*, number of leaves, leaf length, leaf breadth, leaf area and number of suckers as influenced by the different varieties during the experimental period are presented separately.

#### 4.1.1 Number of leaves

The data on influence of varieties in production of number of leaves per plant at different growth stages are presented in Table 1 and Fig. 2. Different varieties significantly influenced the number of leaves production in rainy and winter season. Variety Esmeralda produced the maximum number of leaves per plant (4.43) followed by Variety Titicaca (4.1) which were significantly superior to other varieties. The minimum number of leaves per plant (2.80) was recorded in Variety Grace in rainy season. In winter, maximum numbers of leaves were recorded in Varieties Esmeralda and Titicaca (6 and 5.7 respectively) which were on par with each other and minimum was recorded in Variety Grace (3.3) followed by Variety Ivory (3.7).

#### 4.1.2 Leaf length

The data on influence of different varieties on leaf length during rainy and winter seasons are given in Table 2 and Fig.3.

Different varieties showed significant influence on leaf length. In both rainy and winter seasons of growth Variety Esmeralda gave maximum leaf length (16.28cm and 20.69cm respectively) followed by Variety Titicaca (18.87cm and 15.97cm respectively). Minimum leaf length was recorded in Variety Flame (12.10cm) in rainy and (13.37cm) in winter which was on par with Variety Grace (12.15cm and 13.57cm respectively).

#### 4.1.3 Leaf breadth

Data presented in Table 3 and Fig. 4 showed that the effect of different varieties on leaf breadth. Varieties had significant influence on leaf breadth during rainy and winter season.

Variety Esmeralda gave maximum leaf breadth (12.41cm) in rainy and (17.27cm) in winter season followed by Variety Aymara (11.85cm and 14.87cm respectively) which was on par with Variety Caesar (11.59cm and 13.62cm respectively). Minimum leaf breadth was recorded in Variety Chias (8.37cm) in rainy and (9.31cm) in winter respectively.

#### 4.1.4 Leaf area

All the varieties statistically differ significantly with respect to the leaf area during different seasons i.e. rainy and winter which is given in Table 4 and Fig.5.

Varieties Esmeralda and Titicaca had the maximum leaf area (171.24cm<sup>2</sup> and 151.07cm<sup>2</sup> respectively) in rainy which were found to be on par and minimum was found in Varieties Chias, Grace, Flame and Acapana (90.14cm<sup>2</sup>, 91.23cm<sup>2</sup>, 101cm<sup>2</sup> and 108.07cm<sup>2</sup> respectively) which were on par. In winter Varieties Esmeralda and Titicaca gave maximum leaf area (303.24cm<sup>2</sup> and 221.20cm<sup>2</sup> respectively) which were on par with each other. Varieties Chias, Grace, Flame and Acapana (110.05cm<sup>2</sup>, 116.32cm<sup>2</sup>, 121.20cm<sup>2</sup> and 124cm<sup>2</sup> respectively) had the minimum leaf area in winter and were found to be on par.

**Table 1. Number of leaves in anthurium varieties**

Variety	No. of Leaves /plant	
	Rainy (Jun-Sept)	Winter (Oct-Jan)
Flame	3.6	4.3
Caesar	3.3	4.0
Aymara	3.4	5.0
Grace	2.8	3.3
Ivory	3.9	3.7
Acapana	3.2	4.3
Jewel	3.5	5.0
Titicaca	4.1	5.7
Esmeralda	4.4	6.0
Chias	3.9	5.3
Mean	3.5	4.7
S.Em $\pm$	0.08	0.35
CD at 5%	0.23	1.05

**Table 2. Leaf length (cm) in anthurium varieties**

Variety	Leaf length (cm)	
	Rainy (Jun-Sept)	Winter (Oct-Jan)
Flame	12.10	13.37
Caesar	14.39	17.96
Aymara	14.23	17.53
Grace	12.15	13.57
Ivory	14.23	16.63
Acapana	12.95	15.52
Jewel	13.24	15.67
Titicaca	15.97	18.87
Esmeralda	16.28	20.69
Chias	12.71	13.92
Mean	13.82	16.37
S.Em $\pm$	0.44	0.55
CD at 5%	1.32	1.65

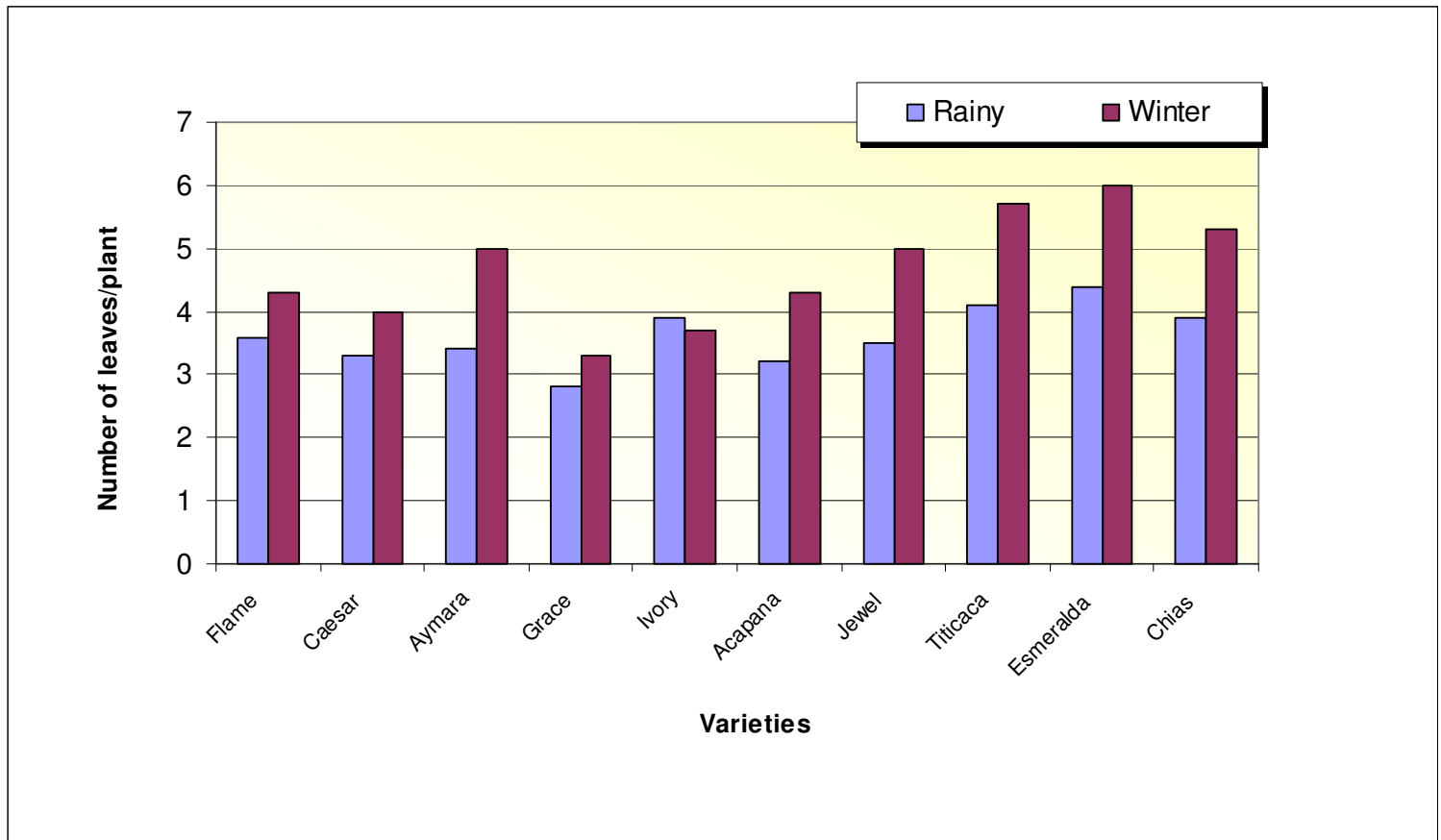
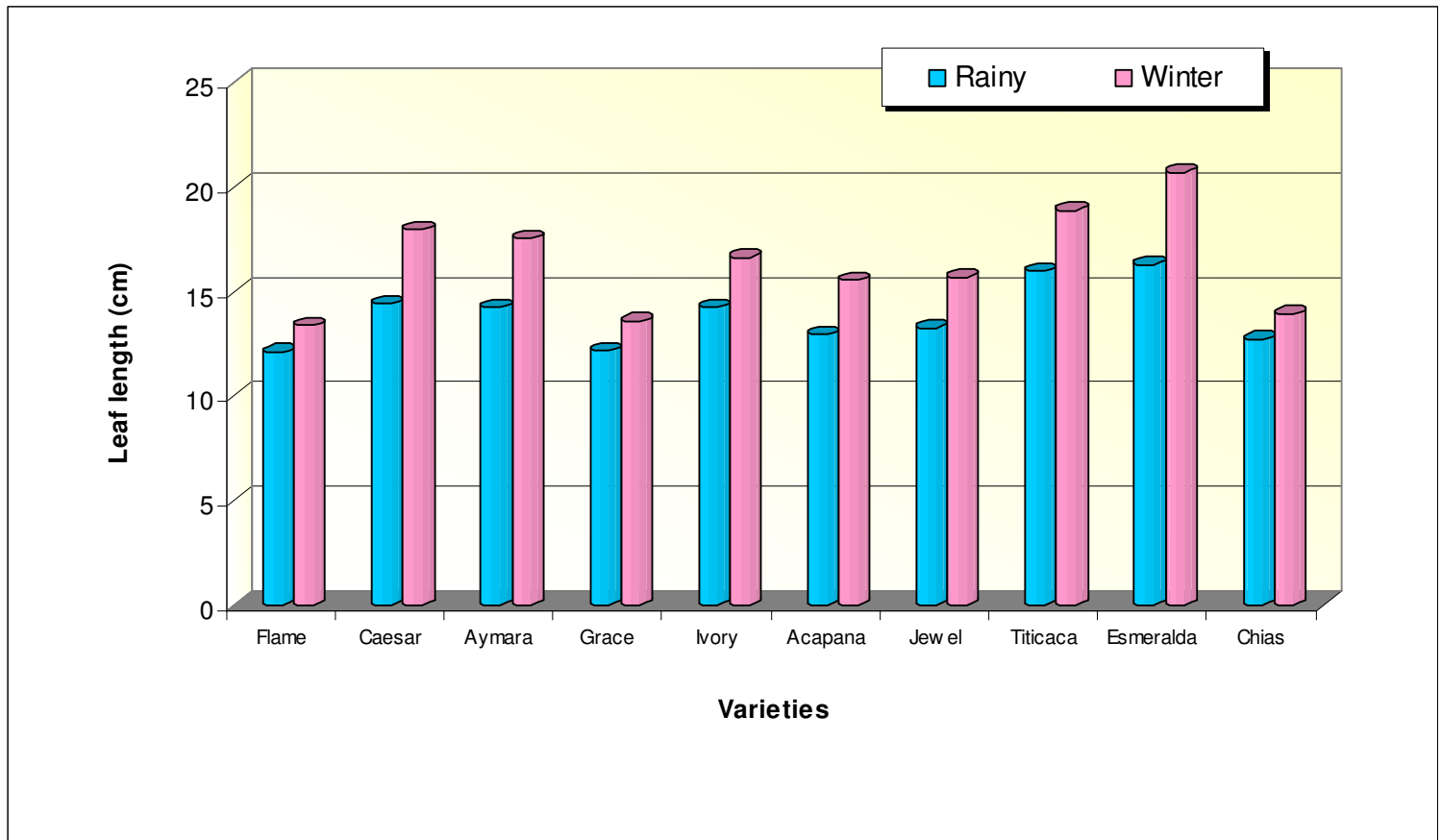


Fig.2 Number of leaves in anthurium varieties



**Fig. 3 Leaf length (cm) in anthurium varieties**

### 4.1.5 Number of suckers

Data pertaining to number of suckers per plant are presented in Table 5 and Fig. 6. The number of suckers produced per plant during the experimental period was significantly influenced by all 10 different varieties.

Varieties Acapana and Ivory had maximum number of suckers (2.60 and 2.60 respectively) which was superior over other varieties but were on par, while variety Jewel gave minimum number of suckers per plant (0.30) in rainy. In winter variety Ivory produced maximum number of suckers (5.67) which was followed by variety Acapana (4.33) was superior over other varieties with respect to vegetative character while variety Jewel produced minimum number of suckers per plant (0.67).

## 4.2 Flower parameters

The flower characters, viz., flower stalk length, spathe length and breadth, spadix length, candle position, spathe angle, number of flowers per plant, number of flowers per meter square area and vase life were recorded during the studies.

### 4.2.1 Flower stalk characters

#### 4.2.1.1 Flower stalk diameter

All the varieties statistically differed significantly with respect to the flower stalk diameter which is recorded in Table 6.

Variety Esmeralda had maximum flower stalk diameter (6.83mm) followed by Varieties Acapana and Titicaca (5.37mm and 5.37mm respectively) which found to be superior but on par with each other. Variety Flame (2.73mm) recorded minimum stalk diameter. All other varieties were statistically significant over each other.

#### 4.2.1.2 Flower stalk girth

All the varieties statistically differ significantly with respect to the flower stalk girth which is recorded in Table 6.

Variety Esmeralda had maximum flower stalk girth (18.33mm) followed by Variety Acapana (15.96mm) which found to be superior. Variety Flame (7.86mm) gave minimum stalk girth. All other varieties were statistically significant to each other.

#### 4.2.1.3 Flower stalk length

Data presented in Table 7 and Fig.7 showed the variation in different varieties in different months with respect to flower stalk length.

Variety Esmeralda had maximum flower stalk length (45.1cm and 45.1cm respectively) in the month of November and December followed by Varieties Titicaca (33.9cm and 33.7cm) and Chias (33.7cm and 33.4cm) respectively. Varieties Titicaca and Chias were on par with each other. Minimum stalk length was recorded in the month of July in Variety Jewel (13.7cm) which was inferior to other varieties.

### 4.2.2 Spathe length

The spathe length was significantly influenced by different varieties and different months which are presented in Table 8 and Fig.8.

The maximum spathe length was recorded during December followed by November in variety Esmeralda (17.3 cm and 16.9 cm respectively) whereas minimum was recorded in the month of July and August in the variety Ivory (4.5 cm and 4.7 cm respectively).

**Table 3. Leaf breadth (cm) in anthurium varieties**

Variety	Leaf breadth (cm)	
	Rainy (Jun-Sept)	Winter (Oct-Jan)
Flame	9.82	10.70
Caesar	11.59	13.62
Aymara	11.85	14.87
Grace	8.88	10.14
Ivory	10.59	13.14
Acapana	9.83	9.40
Jewel	10.35	11.36
Titicaca	11.14	13.52
Esmeralda	12.41	17.27
Chias	8.37	9.31
Mean	10.38	12.33
S.Em±	0.34	0.38
CD at 5%	1.00	1.12

**Table 4. Leaf area (cm<sup>2</sup>) in anthurium varieties**

Variety	Leaf area (cm <sup>2</sup> )	
	Rainy (Jun-Sept)	Winter (Oct-Jan)
Flame	101.00	121.20
Caesar	141.25	216.19
Aymara	121.11	185.25
Grace	91.23	116.32
Ivory	128.03	207.31
Acapana	108.07	124.00
Jewel	116.16	151.10
Titicaca	151.07	221.28
Esmeralda	171.24	303.24
Chias	90.14	110.05
Mean	121.93	175.60
S.Em±	16.73	28.86
CD at 5%	49.41	87.18

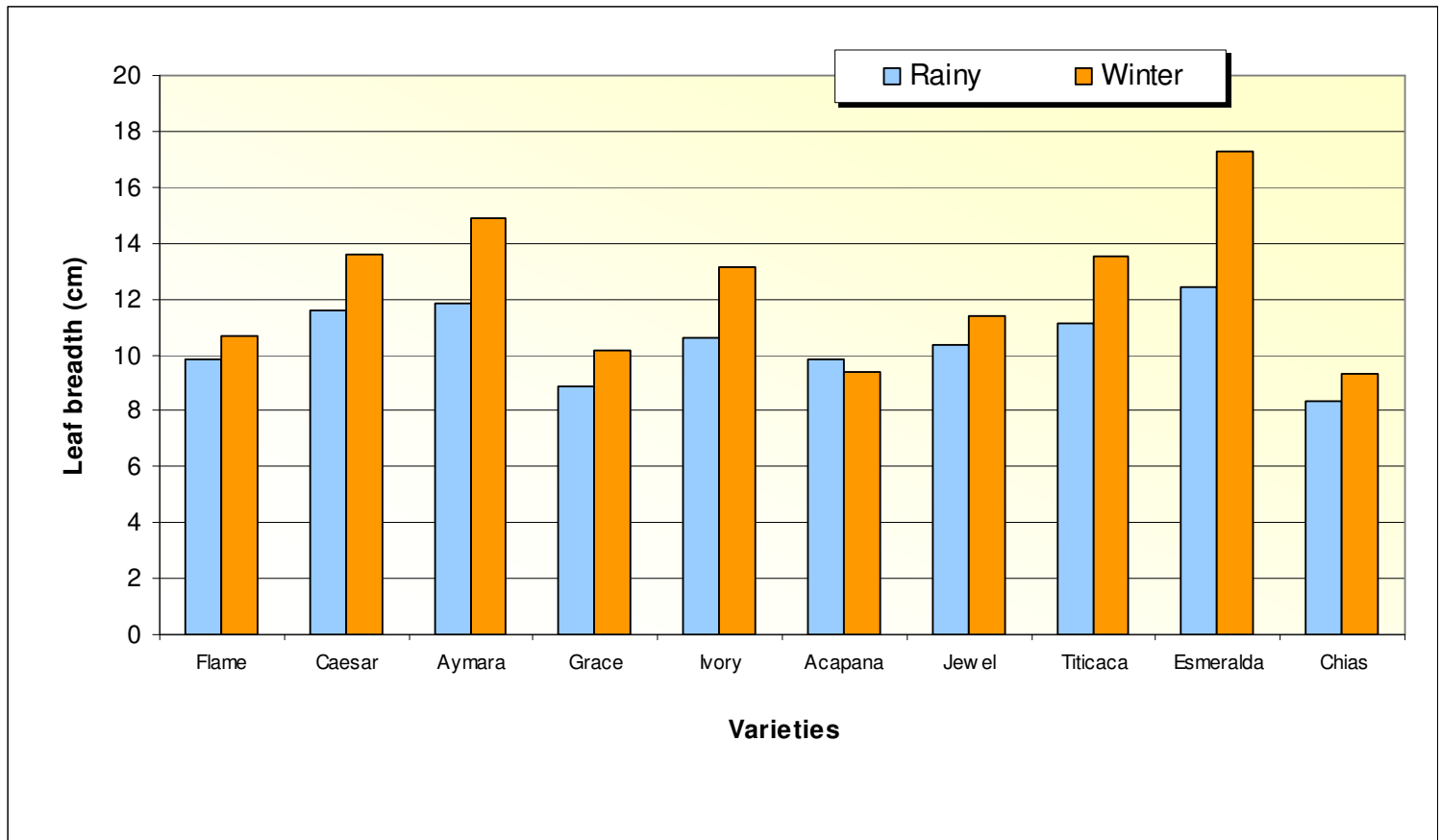


Fig. 4 Leaf breadth (cm) in anthurium varieties

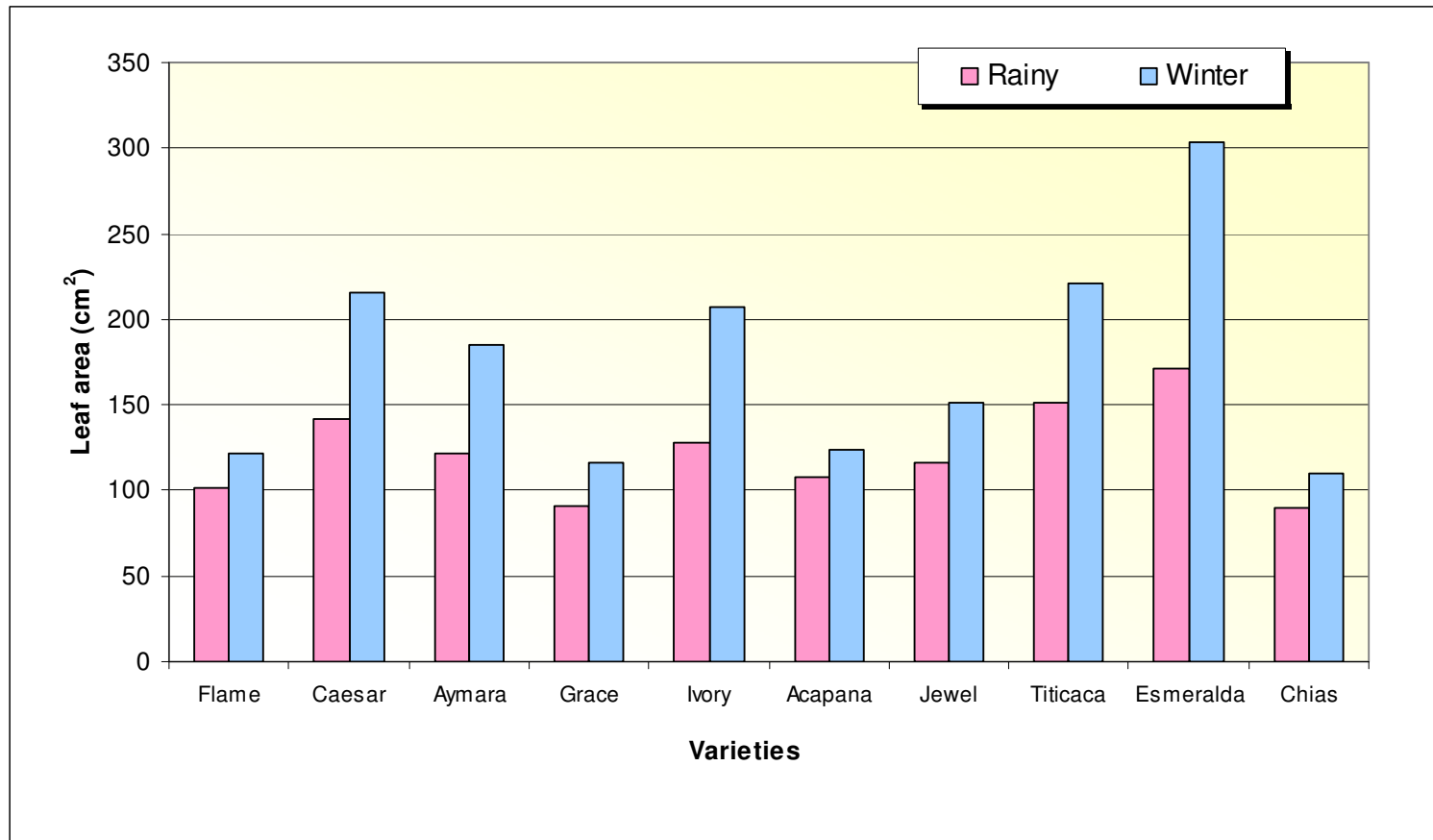


Fig.5 Leaf area (cm<sup>2</sup>) in anthurium varieties

**Table 5. Number of suckers produced in anthurium varieties**

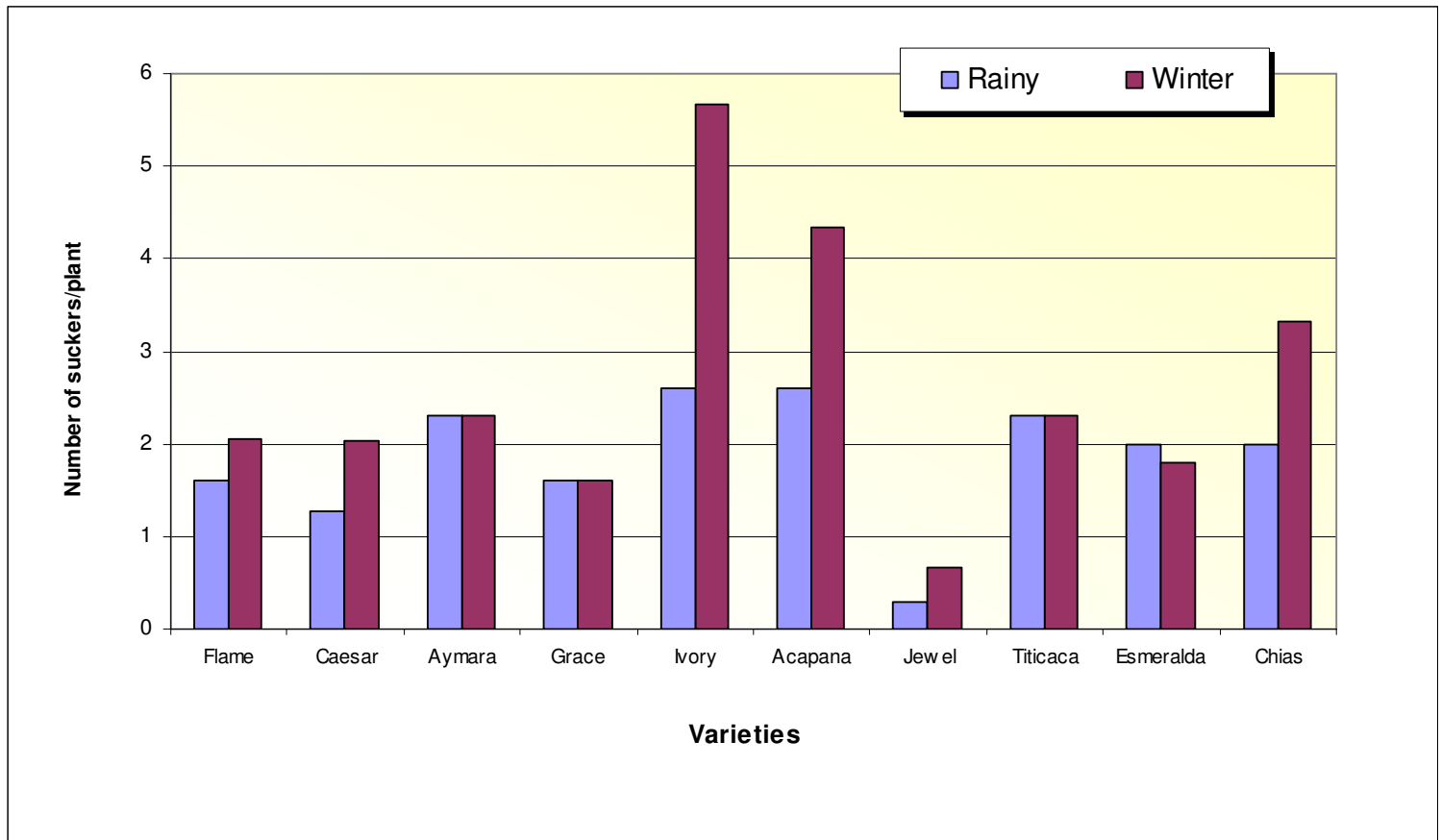
Variety	No. of Suckers/plant	
	Rainy (Jun-Sept)	Winter (Oct-Jan)
Flame	1.60	2.05
Caesar	1.27	2.03
Aymara	2.30	2.30
Grace	1.60	1.60
Ivory	2.60	5.67
Acapana	2.60	4.33
Jewel	0.30	0.67
Titicaca	2.30	2.30
Esmeralda	2.00	1.80
Chias	2.00	3.33
Mean	1.87	2.23
S.Em $\pm$	0.05	0.05
CD at 5%	0.14	0.16

**Table 6. Stalk diameter (mm) and girth (mm) of cut flowers of anthurium varieties**

Variety	Flower stalk characters	
	Stalk diameter (mm)	Stalk girth (mm)
Flame	2.73	7.86
Caesar	3.40	9.90
Aymara	3.67	10.84
Grace	3.37	9.86
Ivory	3.33	9.83
Acapana	5.37	15.96
Jewel	3.93	11.45
Titicaca	5.37	15.29
Esmeralda	6.83	18.33
Chias	4.17	13.37
Mean	4.22	12.27
S.Em $\pm$	0.30	0.61
CD at 5%	0.88	1.80

**Table 7. Stalk length (cm) during different months in cut flowers of anthurium varieties**

Variety	Stalk length (cm)							
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Flame	21.0	23.1	22.0	23.7	27.0	27.3	24.5	25.0
Caesar	23.9	25.0	23.0	24.9	27.4	27.3	25.6	26.4
Aymara	22.3	22.8	20.4	21.5	25.4	25.3	22.4	22.4
Grace	21.8	22.4	27.9	29.3	32.8	32.8	30.3	31.8
Ivory	16.5	18.0	16.2	17.5	20.7	20.3	18.4	18.7
Acapana	16.9	17.9	18.1	19.3	22.9	22.9	20.3	20.9
Jewel	13.9	15.6	17.2	18.3	22.6	22.5	18.7	18.6
Titicaca	25.5	28.5	29.2	30.3	33.9	33.7	30.6	29.9
Esmeralda	30.7	34.7	38.0	40.7	45.1	45.1	41.3	40.1
Chias	22.6	25.0	27.1	28.3	33.7	33.4	29.3	29.0
Mean	21.5	23.3	23.9	25.4	29.1	29.2	26.2	26.28
S.Em <sub>±</sub>	0.23	0.43	0.05	0.17	0.38	0.34	0.14	0.09
CD at 5%	0.67	1.27	0.15	0.50	1.12	1.00	0.41	0.28



**Fig.6 Number of suckers produced in anthurium varieties**

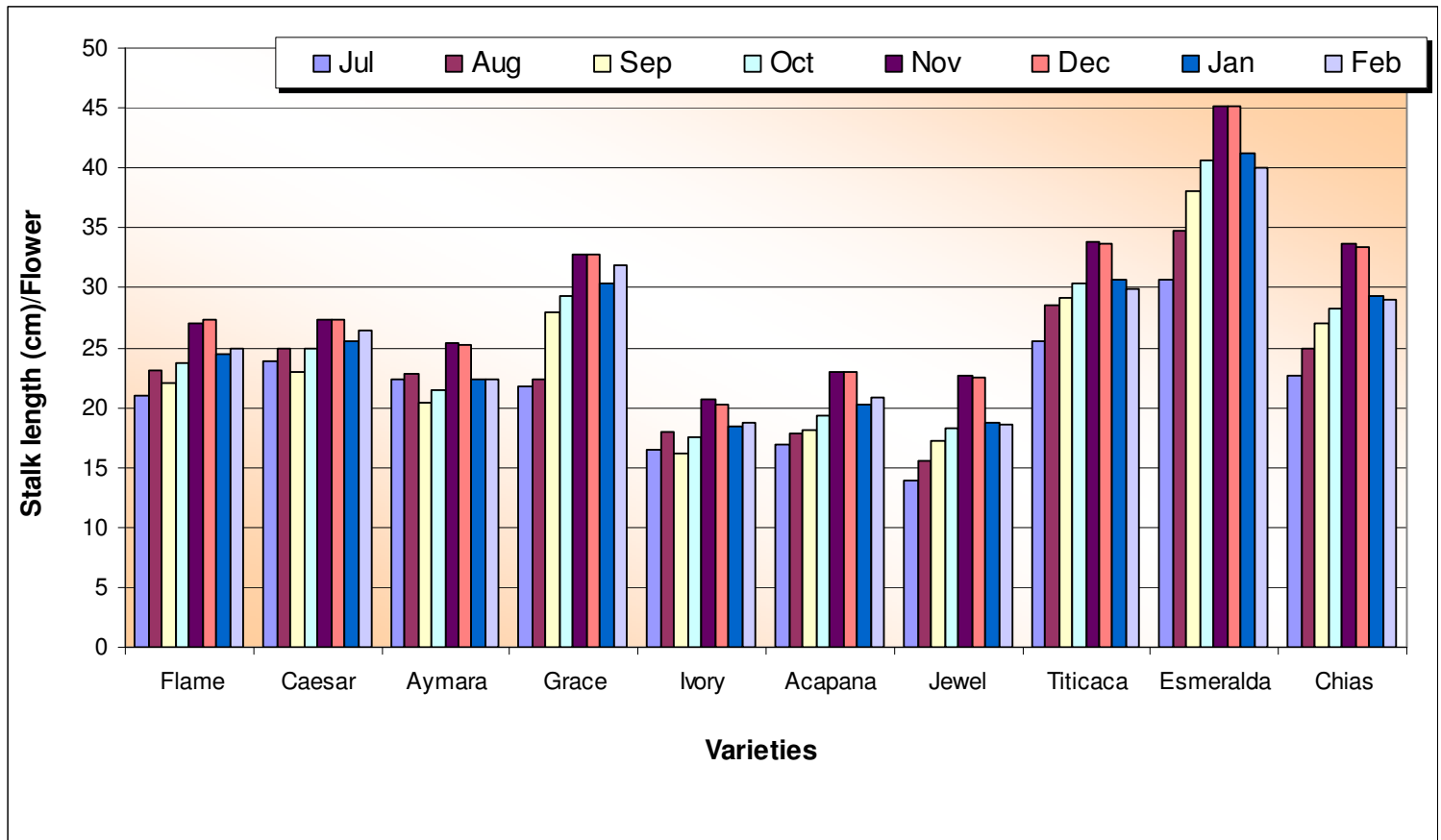


Fig.7 Stalk length during different months in cut flowers of anthurium varieties

### 4.2.3 Spathe breadth

Different varieties showed significant effect on spathe breadth during different months are presented in Table 9 and Fig. 9.

The maximum spathe breadth (17.3 cm and 17.1 cm) was recorded in the month of December and November in Variety Titicaca followed by Esmeralda (15.3 cm and 14.8 cm respectively) found to be superior over others. Minimum spathe breadth was recorded in the month of July and August in Variety Grace (7.0 cm and 7.2 cm respectively).

### 4.2.4 Spadix length

Data presented in Table 10 and Fig.10 showed the variation in different varieties in different months with respect to flower spadix length.

Variety Esmeralda had the maximum flower spadix length (8.7 cm and 8.6 cm respectively) in the month of December and November followed by variety Acapana (8.2 cm and 8.0 cm respectively). Minimum spadix length was recorded in the month of July and August in variety Grace (3 cm and 3 cm respectively) which was inferior to other varieties.

### 4.2.5 Candle position

The candle position was significantly varied in different varieties is presented in Table 11.

Varieties Aymara and Ivory showed minimum angle ( $31.67^{\circ}$  and  $36.67^{\circ}$  respectively) which is considered to be superior over other varieties and were on par with each other. Variety Jewel exhibited maximum angle ( $70^{\circ}$ ) which was inferior. All other varieties were found to be statistically significant over the variety Jewel.

### 4.2.5 Spathe angle

The spathe angle was significantly varied in different varieties is presented in Table 11.

Varieties Aymara, Ivory and Acapana had maximum spathe angle ( $152.03^{\circ}$ ,  $145.30^{\circ}$  and  $144.67^{\circ}$  respectively) which were considered to be superior over other varieties and were on par with each other. Variety Jewel showed minimum angle ( $105^{\circ}$ ) which was considered as inferior. All other varieties were found to be statistically significant over the Variety Jewel.

### 4.2.6 Vase life

The different varieties significantly influenced vase life which is presented in Table 12 and Fig.11.

Data showed that maximum vase life was observed in variety Esmeralda (21days) and followed by variety Acapana (19days) were found to be on par, and minimum was recorded in variety Ivory (10days). All other varieties were found to be statistically significant to each other.

## 4.3 Flower yield

### 4.3.1 Number of flowers per plant

Data presented in Table 13 showed that the influence of varieties on production of number of flowers per plant. From the data it is observed that maximum numbers of flowers per plant were recorded in varieties 'Esmeralda' and 'Chias' (9.33 and 9 respectively) were found to be on par and minimum was recorded in case of variety Ivory (3.33).



**Flame**



**Caesar**



**Aymara**



**Grace**



**Ivory**



**Acapana**



**Jewel**



**Titicaca**



**Esmeralda**



**Chias**

**Plate 4: Flower of individual anthurium varieties**

**Table 8. Spathe length (cm) during different months in cut flowers of anthurium varieties**

Variety	Spathe length (cm)							
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Flame	7.5	7.9	8.1	8.5	8.9	9.2	7.5	7.3
Caesar	8.5	8.9	9.0	9.5	9.8	10.2	8.5	8.5
Aymara	6.3	6.8	7.2	7.6	7.9	8.3	6.1	6.1
Grace	7.5	8.0	8.3	8.8	9.1	9.5	7.4	7.2
Ivory	4.5	4.7	5.0	5.6	5.9	6.5	4.5	4.5
Acapana	6.3	6.8	7.1	7.6	8.0	8.3	6.3	6.2
Jewel	10.1	10.6	10.8	10.9	11.2	11.7	10.1	10.0
Titicaca	6.9	7.2	7.6	8.3	8.6	8.9	6.9	6.7
Esmeralda	14.8	15.2	15.8	16.5	16.9	17.3	14.7	14.5
Chias	8.2	9.0	9.5	10.0	10.3	11.0	8.1	7.9
Mean	8.1	8.5	8.8	9.3	9.7	10.1	8.0	7.9
S.Em $\pm$	0.01	0.05	0.07	0.07	0.04	0.06	0.03	0.05
CD at 5%	0.03	0.15	0.21	0.21	0.11	0.16	0.09	0.14

**Table 9. Spathe breadth (cm) during different months in cut flowers of anthurium varieties**

Variety	Spathe breadth (cm)							
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Flame	9.8	9.9	10.2	10.5	10.8	11.2	9.7	9.5
Caesar	8.8	8.9	9.3	9.8	10.3	10.8	8.7	8.5
Aymara	8.8	9.0	9.4	9.9	10.6	11.1	8.4	8.1
Grace	8.6	8.9	9.2	9.5	9.8	10.2	8.3	8.0
Ivory	7.0	7.2	7.4	7.8	8.4	8.9	6.9	6.7
Acapana	11.5	11.7	11.9	12.3	12.8	13.4	10.8	10.3
Jewel	15.9	16.1	16.4	16.8	17.1	17.3	15.3	14.5
Titicaca	10.1	10.4	10.7	11.1	11.5	11.9	9.7	9.5
Esmeralda	13.5	13.7	13.9	14.3	14.8	15.3	13.2	12.9
Chias	9.0	9.2	9.5	9.9	10.3	10.5	8.9	8.9
Mean	10.3	10.5	10.8	11.2	11.6	12.1	10.0	9.7
S.Em $\pm$	0.02	0.01	0.04	0.02	0.05	0.04	0.10	0.08
CD at 5%	0.07	0.04	0.11	0.07	0.15	0.12	0.31	0.23

**Table 10. Spadix length (cm) in different months in anthurium varieties**

Variety	Spadix length (cm)							
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Flame	5.2	5.3	5.4	5.6	5.7	5.9	5.7	5.5
Caesar	6.1	6.1	6.3	6.6	6.8	6.9	6.4	6.1
Aymara	6.1	6.1	6.3	6.6	6.8	6.9	6.4	6.1
Grace	3.0	3.0	3.3	3.5	3.7	3.9	3.4	3.0
Ivory	3.9	3.9	4.1	4.5	4.7	4.9	4.3	3.8
Acapana	3.0	3.3	3.5	3.8	4.1	4.3	4.0	3.7
Jewel	6.9	6.9	7.2	7.6	8.0	8.2	7.8	7.2
Titicaca	3.9	3.8	4.1	4.5	4.6	4.5	4.4	4.1
Esmeralda	8.0	7.9	8.2	8.4	8.6	8.7	8.2	7.9
Chias	5.0	5.0	5.3	5.5	5.6	5.8	5.4	5.0
Mean	5.1	5.1	5.4	5.7	5.9	6.0	5.6	5.2
S.Em $\pm$	0.06	0.02	0.03	0.05	0.03	0.03	0.08	0.04
CD at 5%	0.18	0.06	0.10	0.15	0.08	0.08	0.23	0.10

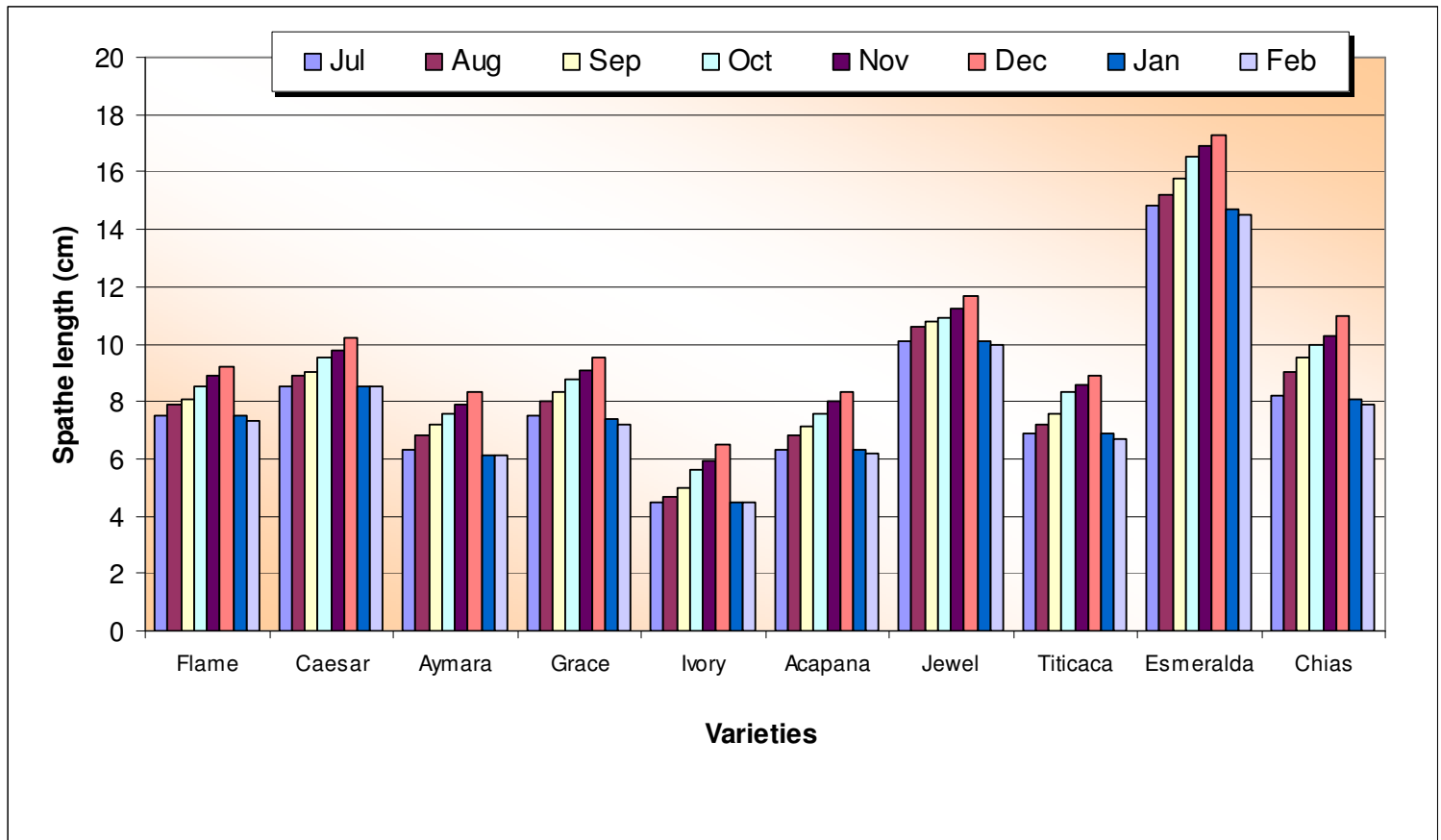


Fig.8 Spathe length (cm) during different months in cut flowers of anthurium varieties

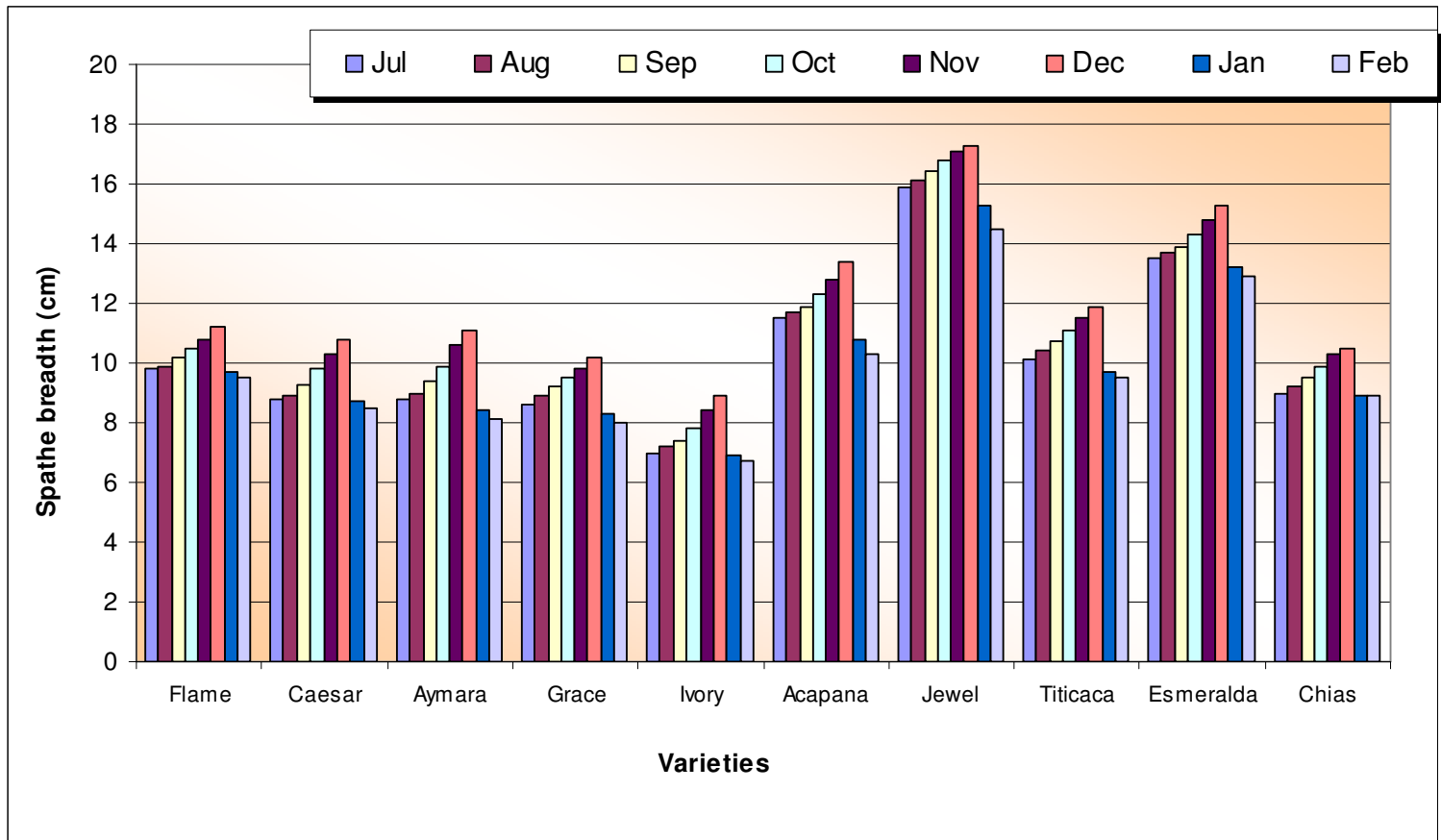


Fig.9 Spathe breadth (cm) during different months in cut flowers of anthurium varieties

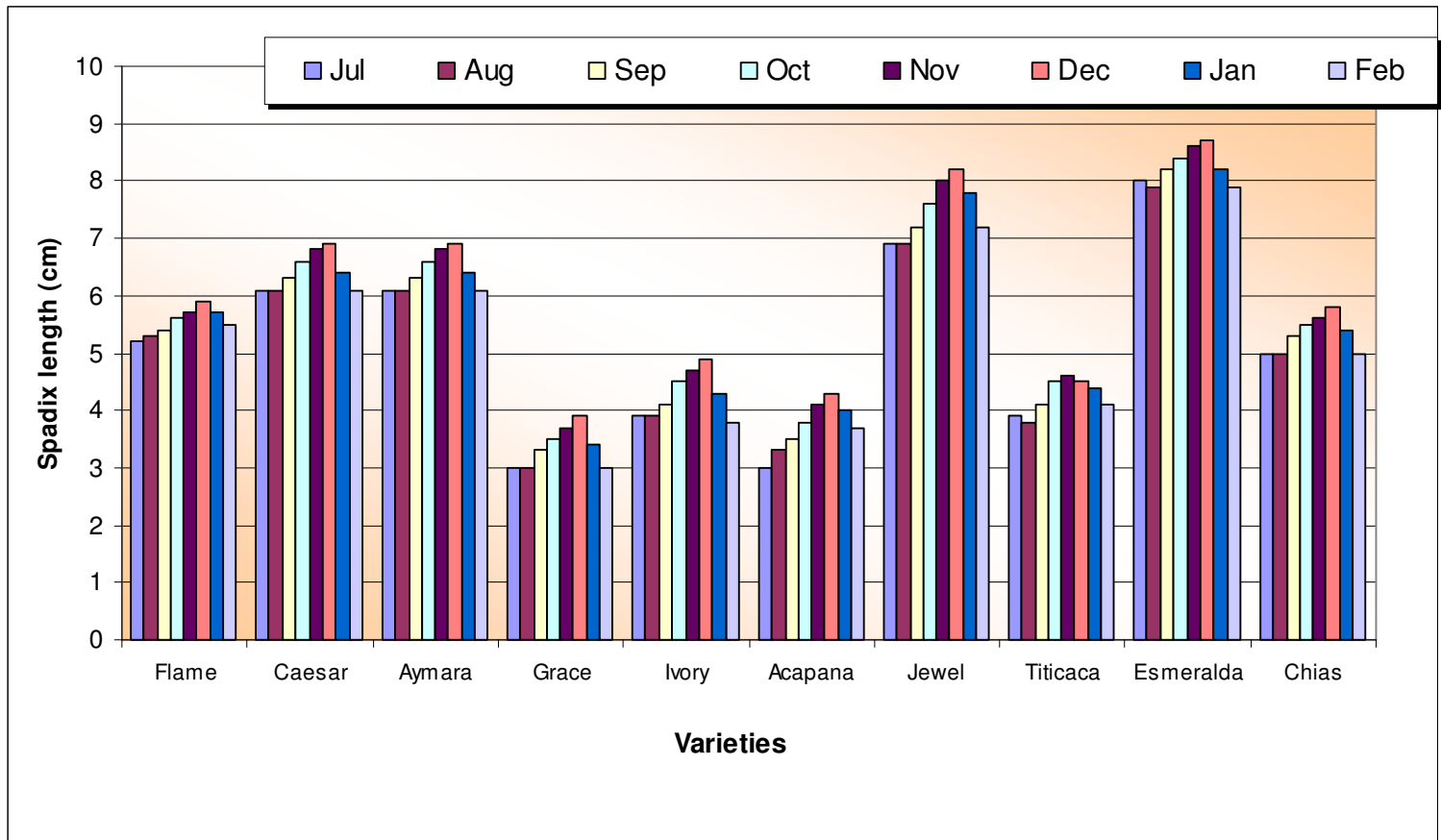


Fig. 10 Spadix length (cm) during different months in cut flowers of anthurium varieties

**Table 11. Candle position ( $\angle^{\circ}$ ) and spathe angle ( $\angle^{\circ}$ ) in cut flowers of anthurium varieties**

Variety	Candle position ( $\angle^{\circ}$ )	Spathe angle ( $\angle^{\circ}$ )
Flame	55.00	130.67
Caesar	41.67	141.33
Aymara	31.67	152.03
Grace	45.00	140.00
Ivory	36.67	145.30
Acapana	38.33	144.67
Jewel	70.00	105.00
Titicaca	63.33	120.00
Esmeralda	56.67	130.67
Chias	48.33	135.33
Mean	44.67	134.10
S.Em $\pm$	2.37	3.16
CD at 5%	6.75	9.39

**Table 12. Vase life (days) of cut flowers of anthurium varieties**

Variety	Vase life (days)
Flame	15.00
Caesar	11.67
Aymara	15.00
Grace	16.00
Ivory	10.00
Acapana	19.00
Jewel	12.33
Titicaca	15.00
Esmeralda	21.00
Chias	11.67
Mean	14.67
S.Em $\pm$	0.41
CD at 5%	1.21



**Plate 5: General view of vase life studies**

#### 4.3.2 Number of flowers per meter square area

Different varieties showed significant effect on number of flowers per meter square area per year (Table 13)

The maximum number of flowers per meter square area per year was recorded in Variety 'Esmeralda' and 'Chias' (138 and 135 respectively) and were found to be on par. Minimum numbers of flowers were recorded in Variety Ivory (50).

#### 4.3.3 Number of flowers per hectare

Different varieties showed significant effect on number of flowers per meter square area per year (Table 13).

The maximum number of flowers per hectare area per year was recorded in variety 'Esmeralda' and 'Chias' (453426 and 446757 respectively) and were found to be on par. Minimum number of flowers were recorded in variety Ivory (160034).

#### 4.3.4 Number of flowers produced at different months

The different varieties significantly influenced on number of flowers produced at different months, which are presented in Table 14 and Fig.12.

From the data it is observed that maximum numbers of flowers were recorded in the month of September, November and February (38.33, 34.67 and 33.34 respectively) and minimum was recorded in the month of July (19.64).

#### 4.5 Grade wise yield of flowers

Flowers were graded into five classes depending on their flower size in Caribbean and Hawaii markets. Results pertaining to grades were presented in Table 15 which showed significant difference among different varieties.

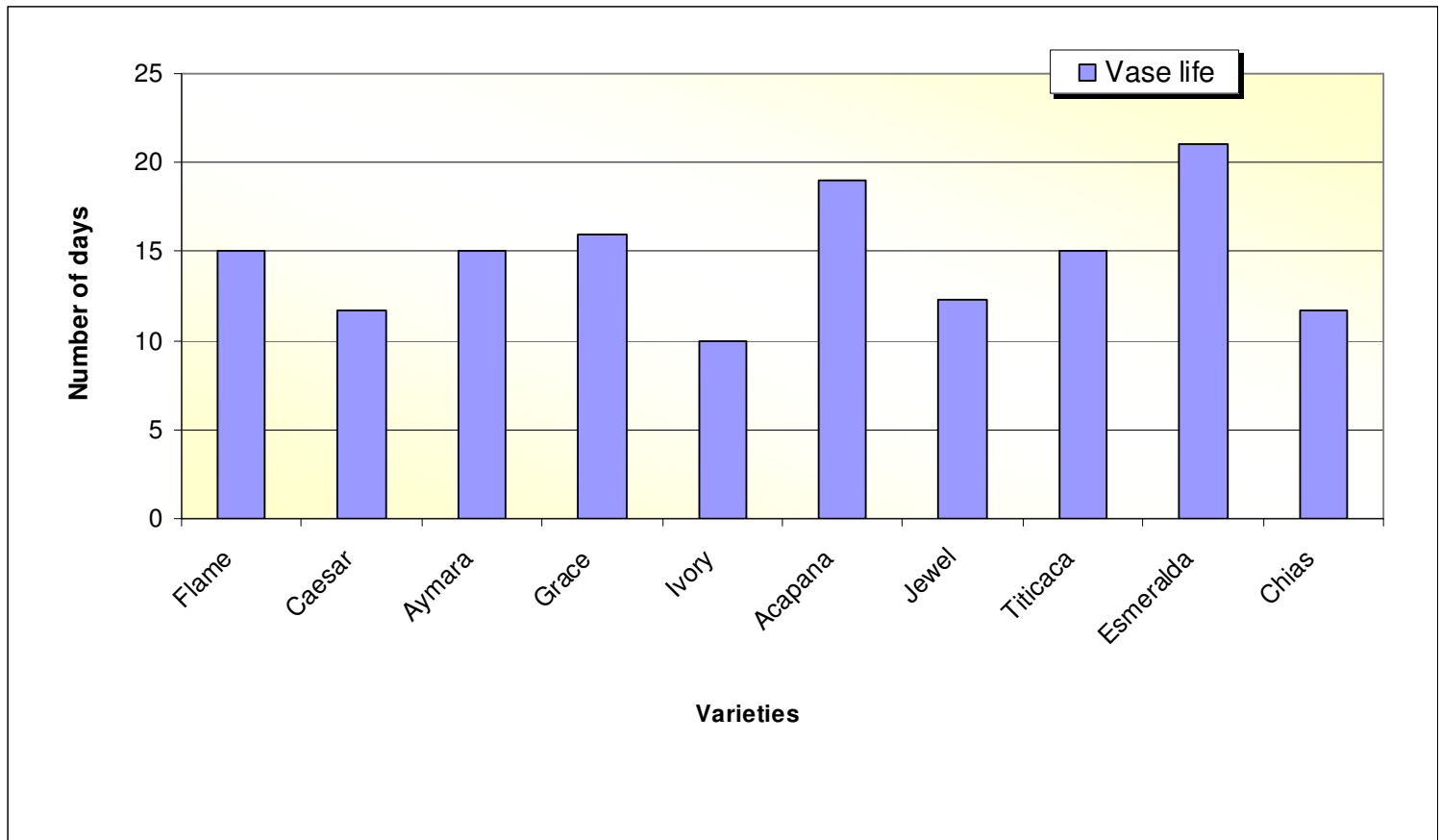


Fig. 11 Vase life (days) of cut flowers of anthurium varieties

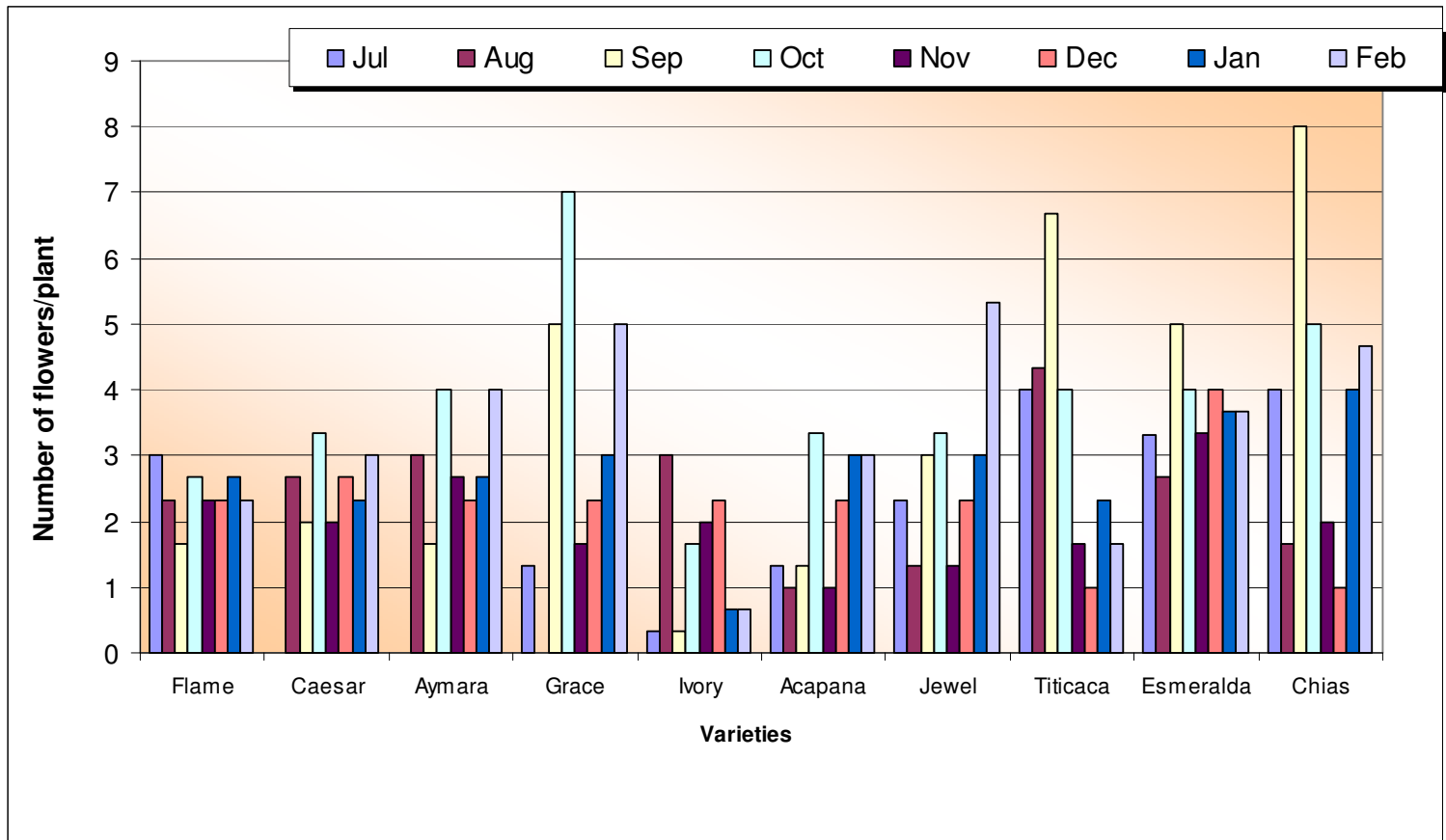


Fig. 12. Number of flowers produced in different months in anthurium varieties

**Table 13. Flower yield per plant, per year and per hectare in anthurium varieties**

Variety	No. of Flowers/plant/year	No. of Flowers/m <sup>2</sup> /year	No. of Flowers/hectare/year
Flame	5.83	86	283391
Caesar	5.43	82	266722
Aymara	6.17	92	306728
Grace	7.43	112	383407
Ivory	3.33	50	160034
Acapana	4.83	72	233382
Jewel	6.67	98	286736
Titicaca	7.83	116	393410
Esmeralda	9.33	138	453426
Chias	9.00	135	446757
Mean	6.59	98.10	981000.00
S.Em <sub>±</sub>	0.21	2.92	29192.85
CD at 5%	0.63	8.67	86736.39

**Table 14. Number of flowers produced during different months in anthurium**

Variety	No. of Flowers/ month							
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Flame	3.00	2.33	1.67	2.67	2.33	2.33	2.67	2.33
Caesar	0.00	2.67	2.00	3.33	2.00	2.67	2.33	3.00
Aymara	0.00	3.00	1.67	4.00	2.67	2.33	2.67	4.00
Grace	1.33	0.00	5.00	7.00	1.67	2.33	3.00	5.00
Ivory	0.33	3.00	0.33	1.67	2.00	2.33	0.67	0.67
Acapana	1.33	1.00	1.33	3.33	1.00	2.33	3.00	3.00
Jewel	2.33	1.33	3.00	3.33	1.33	2.33	3.00	5.33
Titicaca	4.00	4.33	6.67	4.00	1.67	1.00	2.33	1.67
Esmeralda	3.32	2.67	5.00	4.00	3.33	4.00	3.67	3.67
Chias	4.00	1.67	8.00	5.00	2.00	1.00	4.00	4.67
Total	19.64	22	34.67	38.33	20	22.65	27.34	33.34
Mean	1.96	2.2	3.26	3.83	2	2.26	2.73	3.33
S.Em <sub>±</sub>	0.06	0.05	0.11	0.11	0.05	0.07	0.08	0.09
CD at 5%	0.19	0.16	0.31	0.31	0.16	0.21	0.23	0.28

**Table 15. Grade wise flower yield in anthurium varieties**

Variety	Grades						
	Pee Wee	Mini	Small	Medium	Large	Extra large	Premium
Flame	6.33	12.17	42.83	2.93	11.53	8.33	2.00
Caesar	3.67	15.07	24.67	18.50	10.13	6.33	3.00
Aymara	5.00	9.67	30.67	24.50	11.53	4.67	3.33
Grace	12.33	23.67	45.67	23.67	5.10	0.50	0.23
Ivory	8.00	9.67	20.00	7.17	3.90	0.60	0.47
Acapana	6.00	13.00	27.67	15.17	5.03	1.50	0.47
Jewel	9.33	11.67	14.83	30.67	21.67	5.33	1.77
Titicaca	0.67	0.80	4.77	17.53	33.00	42.67	14.67
Esmeralda	0.20	0.83	6.00	7.50	30.67	42.33	42.67
Chias	2.07	14.00	37.00	44.67	23.00	8.67	0.73
Mean	5.36	11.05	25.41	19.23	15.56	11.69	6.93
S.Em <sub>±</sub>	0.88	0.84	0.28	0.32	0.62	1.05	0.82
CD at 5%	2.63	2.49	0.84	0.96	1.85	3.11	2.85

In Grade 'Peewee', variety Grace (12.33) gave maximum number of flowers followed by variety Jewel (9.33) and minimum numbers of flowers were recorded in varieties Esmeralda, Titicaca and Chias (0.20, 0.67 and 2.07 respectively) which were found to be on par with each other.

In Grade 'Mini', Variety Grace (23.67) recorded maximum number of flowers followed by variety Caesar and Chias (15.07 and 14 respectively) which were found to be on par and minimum numbers of flowers were recorded in Variety Titicaca and Esmeralda (0.80 and 0.83 respectively) which were found to be on par with each other.

In Grade 'Small', variety Grace (45.67) produced maximum number of flowers followed by variety Flame (42.83) and minimum numbers of flowers were recorded in varieties Titicaca and Esmeralda (4.77 and 6 respectively).

In Grade 'Medium', Variety Chias (44.67) produced maximum number of flowers followed by variety Jewel (38.67) and minimum numbers of flowers were recorded in varieties Ivory and Esmeralda (7.17 and 7.50 respectively).

In Grade 'Large', variety Titicaca (33) gave maximum number of flowers followed by variety Esmeralda (30.67) and minimum number of flowers was recorded in variety Ivory (3.90).

In Grade 'Extra Large', varieties Titicaca and Esmeralda (42.67 and 42.33 respectively) yielded maximum number of flowers and were on par with each other and minimum number of flowers was recorded in varieties Grace and Ivory (0.5 and 0.6 respectively) were on par.



**Plate 6: Packaging of anthurium cut flowers**

In Grade 'Premium', variety Esmeralda (42.67) had maximum number of flowers followed by variety Titicaca (14.67) and minimum number of flowers was recorded in varieties Grace, Ivory, Acapana and Chias (0.23, 0.47, 0.47 and 0.73 respectively) were on par.

#### 4.4 Economics

The different varieties significantly influenced on B: C ratio, which are presented in Table 16 and details of cost of cultivation in Appendix III.

Heavy investment was needed in the establishment of anthurium crops. Total cost of cultivation was Rs. 160670.7 and revenue (130 flowers/560m<sup>2</sup>/years @ Rs. 15/flower) was Rs. 1134000. Net profit was Rs. 973329.3 for 560m<sup>2</sup> area. Highest benefit cost ratio was recorded in Varieties Esmeralda and Chias (3.8 and 3.7 respectively) and lowest in case of Ivory and Acapana (0.7 and 1.9 respectively).

**Table 16. Economics of cut flower production of different anthurium varieties under greenhouse**

Cultivars	Total cost (Rs.)	Flower yield/560 m <sup>2</sup>	Gross returns (Rs.)	Net returns (Rs.)	B:C ratio
Flame	160670.7	48160	481600	320929.3	2.0
Caesar	160670.7	45920	459200	298529.3	1.9
Aymara	160670.7	51520	515200	354529.3	2.2
Grace	160670.7	62720	627200	466529.3	2.9
Ivory	160670.7	28000	280000	119329.3	0.7
Acapana	160670.7	40320	403200	242529.3	1.5
Jewel	160670.7	54880	548800	388129.3	2.4
Titicaca	160670.7	64960	649600	488929.3	3.0
Esmeralda	160670.7	77280	772800	612129.3	3.8
Chias	160670.7	75600	756000	595329.3	3.7

## 5. DISCUSSION

Today, floriculture is a lucrative profession with higher potential for returns than most of the field and other horticultural crops. Anthurium ranks ninth in the global flower trade and commands respectable price both for its cut flower and whole plant. Anthurium (*Anthurium andreanum* Linden Ex André) is a slow-growing perennial that requires shady, humid conditions as found in tropical forests. Anthurium is the most favored tropical cut flower next to orchids in the world market. The demand for flowers both in India and International markets is increasing at a faster rate owing to the liberalization and opening of economy. The present studies were intended to find out the good variety for growth, quality of flower and to study the economics of flower production.

### 5.1 Varietal studies

Floriculture is the most frequently changing industry according to the consumers' preference. The introduced cultivars of anthurium which include the various local red, local pink and local white cultivars are complex interspecific hybrids involving *A. andreanum* Linden Ex André. A wide range of cultivars exists but only a few are acceptable commercially because they should possess a specific characteristics suited for commercial cultivation.

The higher yield is reflected by better growth and environmental conditions under which the crop is raised. Even the genetic constituents of the cultivar will govern the growth and flower yield. It is the genetic factor that expresses their morphological differences when different cultivars are grown under identical conditions. The selection of a cultivar for a particular region is of much significance as it grows considerable variability in several characters when grown under a particular environment.

In different parts of the world, some investigations were made in order to select suitable cultivars. Among 20 lines evaluated by Aswath *et al.* (1998), PN 18, PN 16, PN 1 and KP5 were selected for cultivation. Binodh *et al.* (2005) evaluated 50 anthurium genotypes in Vellayani, Thiruvananthapuram, Kerala, India to study various morphological characters and selection index for improvement of anthurium. The highest selection index values were observed in genotype LR x DT followed by FR x MW. In an evaluation conducted by Srinivasa and Reddy (2005) in Madikeri, concluded that the cultivars significantly influenced all the vegetative and flower parameters. Hondura was the most superior cultivar followed by Senator, Pasricha, Tinora and Tropical.

Investigations were conducted to study performance of 50 Anthurium (*A. andraeanum*) genotypes by Paiva (2004). Cultivars Astral, Netuno, Iguape, Cananeia and Isla were considered to be suitable in Ceara, Brazil. By taking these factors into consideration, ten varieties *viz.*, Flame, Caesar, Aymara, Grace, Ivory, Acapana, Jewel, Titicaca, Esmeralda and Chias were evaluated in the present study.

#### 5.1.1 Vegetative characters

Plant parameter such as number of leaves, leaf length, leaf breadth, leaf area and number of suckers determined the overall quality and productivity of anthurium plant. These characters were influenced by different varieties in the present study.

Different varieties significantly influenced the production of leaves. Variety 'Esmeralda' produced the maximum number of leaves per plant (4.43) which was significantly superior to other varieties. The minimum number of leaves per plant (2.80) was recorded in variety 'Grace' in rainy season. In winter, maximum numbers of leaves were recorded in varieties 'Esmeralda' and 'Titicaca' (6 and 5.7 respectively) which were on par with each other and minimum was recorded in variety 'Grace' (3.3) followed by variety 'Ivory' (3.7).

Variations in leaf production could be expected among the cultivars as the attribute to a genetic character. Even the environmental factors *i.e.* temperature, relative humidity and light intensity also determines the production of leaves. In rainy season production of leaves was less compared to winter as ideal environment prevails during winter.

These results are in conformity with the reports of Femina *et al.* (2006) who conducted studies on four anthurium cultivars namely, Tropical, Pistache, Mauritius orange and Passion. Cultivar Pistache was the best in leaf number (5.68) compared to other cultivars.

In anthurium variety 'Hondura' produced maximum number of leaves (9.63) (Srinivasa and Reddy, 2005). Palai *et al.* (1999) recorded maximum number of leaves in chrysanthemum variety 'ACC-13' compared to 33 accessions. Gladiolus Cv. Watermelon produced maximum number of leaves per plant compared to other 25 cultivars (Neeraj *et al.*, 2000).

Different varieties showed significant influence on leaf length. In both rainy season and winter season, variety Esmeralda produced maximum leaf length compared to variety Flame which recorded minimum leaf length throughout the experimental period. Variety Esmeralda recorded the maximum leaf length (20.69 cm in winter and 16.28 cm in rainy season) as against lowest (13.37 cm in winter and 12.10 cm in rainy season) in variety Flame. Mean temperature and relative humidity prevailed in winter were 15-28<sup>o</sup> C and 60-82% respectively which is ideal for the growth of anthurium.

These results are in accordance with the data provided by variety 'Agnihotri' which had measured 26 cm of leaf area (Nirmala, 1996). Henny (1999) had reported similar results in Cultivar 'Red Hot'.

Leaf breadth was significantly influenced by different varieties. Variety Esmeralda had the maximum breadth (17.27 cm) and minimum was recorded in variety Chias (9.31 cm) in winter compared to rainy season. The difference in leaf breadth is a varietal trait as it is governed by the genetic make up and also due to ideal environmental conditions during winter. Nirmala (1996), Henny (1999) and Henny and Norman (2001) had reported similar results.

Different varieties had significant influence on leaf area. In variety 'Esmeralda' had the maximum leaf area (303.24 cm<sup>2</sup>) and variety 'Chias' recorded the minimum leaf area (110.05 cm<sup>2</sup>). These results are in agreement with the reports of Chandrappa (2002) in anthurium. Similar results were recorded by Femina *et al.* (2006) in Cultivar 'Pistache' with leaf area (80.22 cm<sup>2</sup>). Nirmala (1996), Palai *et al.* (1999) and (Srinivasa and Reddy, 2005) had shown similar results in case of leaf area. Even the environmental factors *i.e.* temperature, relative humidity and light intensity also determines the leaf area.

The number of suckers produced per plant through out the experiment was significantly influenced by varieties. Varieties 'Acapana' and 'Ivory' recorded maximum number of suckers (2.60) which was superior over other varieties, while variety 'Jewel' recorded minimum number of suckers per plant (0.30) in rainy season while in winter variety Ivory produced maximum number of suckers (5.67) which was followed by variety Acapana (4.33) superior over other varieties with respect to vegetative character while variety Jewel produced minimum number of suckers per plant (0.67).

Production of suckers is highly cultivar dependent. Being genetically controlled factor, the suckers' production varied among the cultivars. These results are in line with that of Jawaharlal *et al.* (2001), Nirmala (1996) and Smitha (1999) in anthurium.

### 5.1.2 Flower characters

The anthurium cut-flower comprises an inflorescence (spadix) subtended by a modified leaf (spathe) borne on a long stalk (peduncle). Anthurium inflorescence is normally produced by a dominant central stem initially and later, by lateral stems. Stimulating earlier flowering of lateral shoots could result in early production and higher flower count. Therefore there are variations in the number of flower produced per plant, color, shape and firmness of the spathe varying from flat to cup-shaped and firm to floppy and spathe and spadix size.

Present study showed that there is significant difference in stalk length with respect to varieties and months. Variety Esmeralda had the maximum flower stalk length (45.1cm and 45.1cm respectively) in the month of November and December followed by variety Titicaca (33.9cm and 33.7cm) and Chias (33.7cm and 33.4cm) respectively. Varieties Titicaca and Chias were on par with each other. Minimum stalk length was recorded in the month of July in Variety Jewel (13.7cm).

During this period the minimum temperature of 15<sup>0</sup>C to maximum of 30<sup>0</sup> C and relative humidity of 60-70 % was observed which is more ideal for the growth. Jawaharlal *et al.* (1998) revealed that maximum stalk length in variety Amazonica compared to other six varieties. Similar results were recorded by Nirmala (1996), (Srinivasa, 2006) and Femina *et al.* (2006). Henny (1999) recorded similar results in cultivar 'Red Hot'.

Variety Esmeralda produced maximum flower stalk diameter (6.83mm) followed by varieties Acapana and Titicaca (5.37mm and 5.37mm respectively) which found to be superior but on par with each other. Variety Flame (2.73mm) recorded minimum stalk diameter. Similarly, variety Esmeralda produced maximum flower stalk girth (18.33mm) followed by variety Acapana (15.96mm) which found to be superior. Variety Flame (7.86mm) yielded minimum stalk girth. This is a varieties trait as it is governed by the genetic make up.

The spathe length was significantly influenced by different varieties in different months. Variety Esmeralda had the maximum flower spadix length (8.7cm and 8.6cm respectively) in the month of December and November followed by Variety Acapana (8.2cm and 8.0cm respectively). Minimum spadix length was recorded in the month of July and August in variety Grace (3cm and 3cm respectively) which was inferior to other varieties.

Shriram *et al.* (2008) also reviewed the similar results in variety 'Esmeralda'. The difference in the spathe length can be attributed to genetic makeup of the varieties and during this period the minimum temperature of 15<sup>0</sup>C to maximum of 30<sup>0</sup> C and relative humidity of 60-70 % was observed which is more ideal for the growth. These findings confirm the reports of Jawaharlal *et al.* (2001), Aswath *et al.* (1998), Smitha (1999) and Femina *et al.* (2006).

Different varieties showed significant effect on spathe breadth. The maximum spathe length was recorded in month of December followed by November in the variety Esmeralda (17.3 cm and 16.9 cm respectively) whereas minimum was recorded during the month of July and August in the variety Ivory (4.5 cm and 4.7 cm respectively).

In the similar way, the maximum spathe breadth (17.3 cm and 17.1 cm) was recorded in the month of December and November in Variety Titicaca followed by Esmeralda (15.3 cm and 14.8 cm respectively) found to be superior over others. Minimum spathe breadth was recorded in the month of July and August in Variety Grace (7.0 cm and 7.2 cm respectively).

Mean temperature and relative humidity prevailed in winter (November and December) were 15-28<sup>0</sup> C and 60-82 % respectively which is ideal for the growth of anthurium. Talia *et al.* (2003) conducted an experiment to evaluate different varieties and had opined that variety 'Queen' had shown a bigger spathe. These results are in line with that of Jawaharlal *et al.* (2001), Nirmala (1996) and Smitha (1999).

Data pertaining to the spadix length variety Esmeralda had the maximum flower spadix length (8.7 cm and 8.6 cm respectively) in the month of December and November followed by variety Acapana (8.2 cm and 8.0 cm respectively). Minimum spadix length was recorded in the month of July and August in Variety Grace (3 cm and 3 cm respectively). During this period the minimum temperature of 15<sup>0</sup>C to maximum of 30<sup>0</sup> C and relative humidity of 60-70 % was observed.

Cultivar 'Red Hot' is a new interspecific hybrid pot plant developed by Henny (1999) recorded spadix length of 3-4 cm, Similarly Jawaharlal *et al.* (1998) recorded maximum spadix length in variety 'Lady Jane'.

Variety 'Esmeralda' had maximum spathe angle (70<sup>0</sup>) whereas variety 'Aymara' showed minimum spathe angle (31.67<sup>0</sup>) which is considered to be superior over other varieties. Similarly variety Aymara, Ivory and Acapana possessed maximum spathe angle (152.03<sup>0</sup>, 145.30<sup>0</sup> and 144.67<sup>0</sup> respectively) which were considered to be superior and were in accordance with the results of Femina *et al.* (2006) and Nirmala (1996).

The variation in spathe and spadix color in different varieties was significantly varying among cultivars. Variety Flame has red color spathe with cream-yellow spadix. Variety Caesar has purple spathe with dark purple spadix. Variety Aymara has pink color spathe with greenish yellow spadix. Variety Grace has cream white spadix with Creamish green spathe. Variety Ivory is having ivory color spathe with greenish ivory spadix. Variety Acapana has pink spadix with Creamish green spathe. Variety Jewel is having spathe of red-Obake color and spadix of cream-yellow. Variety Titicaca appears to be cream- Obake with spadix pinkish red. Variety Esmeralda is having green colored spathe and greenish yellow spadix. Variety Chias has chocolate spathe and cream yellow spadix.

Varieties Flame and Aymara were highly preferred, where as Varieties Ivory, Titicaca, Jewel were moderately preferred and less preferred varieties were Esmeralda, Acapana, Grace Chias and Caesar mainly with respect to color and attractiveness by the people These results were in accordance with Arndt (1991), (Anthura, 1997) and Rajeevan *et al.* (2007).

The number of flowers per plant was influenced by different varieties. It is observed that maximum number of flowers was recorded in variety 'Esmeralda' (9.33) and minimum in case of variety 'Ivory' (3.33). Similarly the maximum number of flowers per meter square area was recorded in variety Esmeralda (138) and minimum in case of Ivory (50).

Similarly, the maximum numbers of flowers were recorded in the month of September, November and February (38.33, 34.67 and 33.34 respectively) and minimum was recorded in the month of July (19.64).

Being genetically controlled factor and also with the minimum temperature of 15<sup>0</sup>C to maximum of 30<sup>0</sup> C and relative humidity of 60-70 % is going to be more ideal for the growth, the number of flower production varied among the cultivars. Srinivasa (2006) recorded similar results in cultivar 'Hondura' in cut flower production. Binodh *et al.* (2005), Srinivasa and Reddy (2005), Rajeevan *et al.* (2007), Shiva and Nair (2008) and Shriram *et al.* (2008) had reviewed similar results with respect to flower production.

Vase life of flowers was significantly differing among different varieties. Data showed that maximum vase life was observed in variety Esmeralda (21 days) followed by Acapana (19 days), Grace (16 days), Aymara, Flame and Titicaca (15 days), Jewel (12.33 days), Chias and Caesar (11.67 days) and at last Ivory (10 days). Vase life of flower is seems to be an inherent capacity of the cultivar. These results are in line with that of Shriram *et al.* (2008) who shown similar results in variety 'Esmeralda'. Similar results were recorded by Paull and Chantrachit (2001), (Thawiang *et al.*, 2007) and Elibox Winston and Umaharan Pathmanathan (2008).

In the same line of investigation, Archana *et al.*, (2004) reported that carnation cultivar 'Gaudina' exhibited significantly superior results in case of vase life; Mukund *et al.* (2004) and Krishan and Sangama (2005) recorded vase life in carnation cultivars 'Amla' (16.33 days) and Cv. Sunrise (12.60 days) respectively.

### 5.1.3 Economics of cultivation of anthurium

Recognizing the potential for low cost production for export, in view of abundant land, labor and other resources, several export oriented units are being set up in the country. Heavy investment was needed in the establishment of anthurium crops. Total cost of cultivation was Rs. 160670.7 and revenue (130 flowers/560m<sup>2</sup>/years @ Rs. 15/flower) was Rs. 1134000. Net profit was Rs. 973329.3 for 560m<sup>2</sup> area. Highest benefit cost ratio was recorded in Varieties Esmeralda and Chias (3.8 and 3.7 respectively) and lowest in case of Ivory and Acapana (0.7 and 1.9 respectively). These findings are in agreement with the reports of Gajanana and Subrahmanyam (1999), Shivaprasad (2002) and Beena (2003).

## 6. SUMMARY AND CONCLUSIONS

Anthuriums are grown primarily as a cut flower crop. They are valued for their colorful long lasting spathe and spadix. The cultivars contribute elegance and attractiveness, which are pre-requisite for quality and floral design. They are very popular with flower arrangers because of the bold effect, bright color and long keeping quality. Large number of varieties are now grown luxuriantly under the shade-nets and greenhouse. Because of its long shelf life, anthurium is an excellent export product. Known for its massive effect, elegance and variety of colors, anthuriums still attract vast majority of growers and hence there is a need to standardize the growing techniques.

Experiments were conducted to evaluate varieties, vase life studies and the economics. The results obtained from these investigations are summarized below:

### Evaluation of varieties:

The mean number of leaves per plant was significantly different among the varieties tested. Maximum number of leaves per plant was produced in variety 'Esmeralda' (4.43) while minimum was produced in variety 'Grace' (2.80) respectively in rainy and in winter, maximum numbers of leaves were recorded in varieties 'Esmeralda' and 'Titicaca' (6 and 5.7 respectively) which were on par with each other and minimum was recorded in Variety 'Grace' (3.3) followed by variety 'Ivory' (3.7).

Maximum leaf length of 20.69 cm and 16.28 cm was recorded with variety Esmeralda in winter and in rainy season respectively, lowest was recorded in variety Flame (13.37 cm) in winter and (12.10 cm) in rainy season respectively.

Leaf breadth was significantly different among the varieties tested. Variety 'Esmeralda' recorded the maximum breadth (17.27 cm) in winter and (12.41 cm) in rainy season and minimum was recorded in variety Chias (9.31 cm) in winter and (8.37 cm) in rainy season respectively.

The leaf area was significantly different among the varieties tested. Variety Esmeralda had the maximum leaf area (171.24 cm<sup>2</sup> in rainy and 303.24 cm<sup>2</sup> in winter) and variety Chias recorded the minimum leaf area (90.14 cm<sup>2</sup> in rainy and 110.05 cm<sup>2</sup> in winter) respectively.

The number of suckers produced per plant during the experimental period was significantly influenced by different varieties. Varieties Acapana and Ivory produced maximum number of suckers (2.60) which was superior over other varieties, while variety Jewel gave minimum number of suckers per plant (0.30) in rainy. Similarly, in case of winter, variety Ivory yielded maximum number of suckers (5.67) while variety Jewel produced minimum number of suckers per plant (0.67).

There was significant difference with respect to stalk length. Variety 'Esmeralda' had the maximum flower stalk length (45.1 cm) during November and December which was superior to other varieties. Variety 'Jewel' gave minimum flower stalk length (13.37 cm) in July.

Variety Esmeralda yielded maximum flower stalk diameter of 6.83 mm and variety Flame (2.73 mm) gave minimum stalk diameter. Similarly, variety Esmeralda produced maximum flower stalk girth of 18.33 mm followed by variety Acapana (15.96 mm) which found to be superior. Variety Flame (7.86 mm) resulted in minimum stalk girth.

The spathe length significantly different among the varieties tested. The maximum spathe length was recorded in variety Esmeralda (16.33 cm) whereas minimum was recorded in variety Aymara and Ivory (7.00 cm).

Variety Esmeralda had the maximum flower spadix length (8.7 cm and 8.6 cm respectively) in the month of December and November and minimum spadix length was recorded in the month of July and August in variety Grace (3 cm and 3 cm respectively).

In the similar way, the maximum spathe breadth (17.3cm and 17.1cm) was recorded in the month of December and November in variety 'Titicaca' and minimum spathe breadth was recorded in the month of July and August in variety Grace (7.0cm and 7.2cm respectively).

Variety 'Esmeralda' yielded maximum spathe angle ( $70^{\circ}$ ) where as variety 'Aymara' had minimum angle ( $31.67^{\circ}$ ) which is considered to be superior over other varieties. Similarly varieties Aymara, Ivory and Acapana produced maximum spathe angle ( $152.03^{\circ}$ ,  $145.30^{\circ}$  and  $144.67^{\circ}$  respectively) which were considered to be superior.

The number of flowers per plant was influenced by different varieties. It is observed that maximum number of flowers recorded in variety 'Esmeralda' (9.33) and minimum in case of variety 'Ivory' (3.33). Similarly the maximum number of flowers per meter square area was recorded in variety 'Esmeralda' (138) and minimum in case of 'Ivory' (50).

The different varieties had significant influence on number of flowers produced at different months. The maximum numbers of flowers were recorded in the month of Feb (3.33) and minimum in the month of July (1.96) respectively.

Vase life of flowers was significantly differing among different varieties. Data showed that maximum vase life was observed in variety Esmeralda (21 days) and minimum was recorded in Ivory (10days).

Varieties Flame, Aymara and Esmeralda were highly preferred, where as varieties Ivory, Titicaca and Jewel were moderately preferred and less preferred varieties were Acapana, Grace, Chias and Caesar mainly with respect to color and attractiveness by the people. This conclusion was drawn based on the local market demand and also the interest of florists visiting the Hi-tech unit towards these varieties. 'Esmeralda' and 'Chias' were preferred more with respect to yield.

With respect to grading, 'Premium', grade is considered as superior one in which variety Esmeralda (42.67) recorded maximum number of flowers and minimum number of flowers was recorded in varieties Grace, Ivory, Acapana and Chias (0.23, 0.47, 0.47 and 0.73 respectively).

Heavy investment was needed in the establishment of anthurium crops. Total cost of cultivation was Rs. 160670.7 and revenue (130 flowers/560m<sup>2</sup>/years @ Rs. 15/flower) was Rs. 1134000. Net profit was Rs. 973329.3 for 560m<sup>2</sup> area. Highest benefit cost ratio was recorded in Varieties Esmeralda and Chias (3.8 and 3.7 respectively) and lowest in case of Ivory and Acapana (0.7 and 1.9 respectively).

## Practical application of the results

- By the present investigation it is noticed that, variety 'Esmeralda', 'Chias' and 'Titicaca' are highly preferred because of their attractive flowers, excellent flower size, high yield production, long shelf life and better B: C ratio.
- With respect to foliage, variety 'Esmeralda', 'Titicaca', 'Aymara' 'Caesar' and 'Acapana' are preferred because of their attractive lustrous and good size foliage having more leaf area with good keeping quality.
- With respect to colour, variety 'Aymara', 'Flame' and 'Ivory' are preferred.
- With respect to disease resistant, variety 'Esmeralda' is highly preferred.

## FUTURE LINE OF WORK

- Standardization of growing media for high yield and quality of cut flowers
- Growing of varieties under different structures (shadehouse, nethouse, Polyhouse etc.) for yield and quality of flowers
- Evaluation of varieties for disease resistant
- Standardization of the nutrients to different varieties
- Evaluation of varieties for pot culture, cut flower and foliage

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\* Original not seen

## APPENDIX I

Monthly meteorological data during the experimental year (2008-09) at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad

Months	Rainfall (mm)	Temperature (°C)		Relative humidity (%)
		Mean maximum	Mean minimum	
April	28.8	34.7	20.4	80.4
May	55.8	35.1	20.6	85.1
June	101.6	28.7	21.0	91.8
July	121.0	28.2	20.7	91.3
August	213.2	26.9	20.1	91.5
September	162.4	27.8	20.0	91.4
October	60.4	30.3	18.9	83.5
November	72.2	29.3	15.9	79.4
December	0.0	28.6	13.8	75.4
January	0.0	29.8	13.3	66.6
February	0.0	33.2	16.8	57.5
March	29.0	35.0	19.9	73.0
Total	844.4			

## APPENDIX II

The average of 58 years meteorological data (1950-2008) at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad

Months	Rainfall (mm)	Temperature (°C)		Relative humidity (%)
		Mean maximum	Mean minimum	
April	49.3	37.3	19.8	75.6
May	80.2	33.7	21.3	66.2
June	114.2	28.8	22.4	81.1
July	152.4	29.1	21.0	87.1
August	98.5	26.9	20.0	86.0
September	104.9	28.5	19.9	82.1
October	126.9	30.0	18.4	75.8
November	33.0	30.1	15.9	68.0
December	5.2	29.3	12.5	63.2
January	0.1	29.6	14.6	63.1
February	1.1	31.2	16.3	51.5
March	2.3	32.4	19.5	56.0
Total	768.4			

## APPENDIX III

### Economics of anthurium cultivation under greenhouse (560 m<sup>2</sup>) for one year

Sl. No.	Particulars	Amount in Rs.	
		Total costs	Depreciated costs
1	Fixed costs		
a)	Structure (Excluding cladding material) @ Rs. 600/m <sup>2</sup> for the life span of 20 years	336000	16800
c)	Irrigation and fertigation system @ Rs. 85/m <sup>2</sup> for the lifespan of 10 years	47600	4760
b)	Cladding material + shadenet @ Rs. 65/m <sup>2</sup> for the life span of 3 years	33600	11200
d)	Planting material @ Rs. 65/plant (13 plants/m <sup>2</sup> ) for the life span of 6 years	405600	67600.0
2	Repair and maintenance @ Rs. 900/year	-	900
3	Interest on fixed costs*	-	3410.72
4	Total appartitional cost**	-	104670.7
5	Cost of cultivation @ Rs.100 /m <sup>2</sup> / year	-	56000
6	Total cost of cultivation (4 + 5)	-	160670.7
7	Revenue (135 flowers/m <sup>2</sup> /years @ Rs. 15/flower)	-	1134000
8	Net profit (7-6)	-	973329.3

Note:

$$* \frac{(a) \times 0.12}{\text{No. of Yr. (20)}} + \frac{(b+d) \times 0.12}{\text{No. of Yr. (3)}} + \frac{c \times 0.12}{\text{No. of Yr. (10)}}$$

\*\* All depreciated costs (a+b+c+d) + 2+3

# EVALUATION OF ANTHURIUM VARIETIES UNDER GREENHOUSE FOR YIELD AND QUALITY OF CUT FLOWERS

AKKAMAHADEVI D. AGASIMANI 2009

Dr. V. S. PATIL  
MAJOR ADVISOR

## ABSTRACT

A study was conducted to evaluate the performance of ten anthurium varieties under greenhouse at Hi-Tech Horticulture Unit, Main Agricultural Research Station, Saidapur Farm, Dharwad during 2007-08. The varieties viz., Flame, Caesar, Aymara, Grace, Ivory, Jewel, Acapana, Titicaca, Esmeralda and Chias were taken for study.

The mean number of leaves per plant was significantly different among the varieties tested. Maximum number of leaves per plant was produced in variety 'Esmeralda' (4.43). Variety 'Acapana' and 'Ivory' recorded maximum number of suckers (2.60) which was superior over other varieties.

Variety 'Esmeralda' recorded the maximum leaf length 20.69 cm and 16.28 cm in rainy and winter, maximum leaf breadth (17.27 cm) in winter and (12.41 cm) in rainy season and also the maximum leaf area of about 171.24 cm<sup>2</sup> in rainy and 303.24 cm<sup>2</sup> in winter.

In case of flower parameters, variety 'Esmeralda' had the maximum stalk length 45.1 cm, diameter of 6.83 mm, spathe length 16.33 cm and spadix length 8.7. Variety 'Titicaca' recorded maximum spathe breadth 17.3cm.

Data showed that maximum vase life was observed in variety Esmeralda *i.e.* 21 days and it is also observed that maximum number of flowers was recorded in variety 'Esmeralda' (9.33).

Heavy investment was needed in the establishment of anthurium crops. Of the total establishment cost, seedlings and structure cost was higher. Total cost of cultivation was Rs. 1,60,670.7 and revenue (130 flowers/560m<sup>2</sup>/years @ Rs. 15/flower) was Rs. 11,34,000. Net profit was Rs. 9,73,329.3 for 560m<sup>2</sup> area. Highest benefit cost ratio was recorded in 'Esmeralda' (3.8).

Varieties Flame, Aymara and Esmeralda were highly preferred, where as varieties Ivory, Titicaca and Jewel were moderately preferred and less preferred varieties were Acapana, Grace, Chias and Caesar mainly with respect to color and attractiveness and 'Esmeralda' and 'Chias' were preferred more with respect to yield.