MICROCLIMATIC RELATIONS ON THE GROWTH, YIELD AND QUALITY OF ANTHURIUM (*Anthurium andreanum* Linden) UNDER DIFFERENT GROWING SYSTEMS

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THESIS

Submitted in partial fulfilment of the requirement for the degree of

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2006

DECLARATION

I hereby declare that the thesis entitled **Microclimatic relations on the growth, yield and quality of anthurium (*Anthurium andreanum* Linden) under different growing systems** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, fellowship, associateship or other similar title of any other University or Society.

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Certified that the thesis entitled **Microclimatic relations on the growth, yield and quality of anthurium (*Anthurium andreanum* Linden) under different growing systems** is a record of research work done independently by **Ms. Femina** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

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CERTIFICATE

We, the undersigned member of the Advisory Committee of **Ms. Femina**, a candidate for the degree of Master of Science in Horticulture, agree that the thesis entitled ' **Microclimatic relations on the growth, yield and quality of anthurium (*Anthurium andreanum* Linden) under different growing systems** may be submitted by Mrs. Femina in partial fulfilment of the requirement for the degree.

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EXTERNAL EXAMINER

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Introduction

1. INTRODUCTION

Anthurium cultivation is becoming increasingly important in global ornamental plant production both for cut flower and pot plant. *Anthurium andreanum*, as a cut flower, is much valued for the attractive long lasting spikes. It is a semi terrestrial evergreen plant, which can produce flowers all year long. The plant can produce a flower from every leaf axil under favourable conditions.

Most anthurium species are native to tropical rain forests and are primarily epiphytic in nature. In their natural habitat they receive filtered light, ample aeration and good drainage. Anthuriums grow best with day temperature of 25-32^{0}C and night temperature of 21-24^{0}C. Temperature above 35^{0}C may cause foliar burning, faded flower colour and reduced flower life. Night temperature between 4-10^{0}C can result in slow growth and yellowing of lower leaves. Anthurium will not tolerate frost or freezing conditions. The best relative humidity for growth is 70-80 per cent.

Anthuriums grow under a wide range of light intensities but their actual performance is dependent on the cultivars, elevation, temperature and nutrition. Generally, most anthurium types grow well at light intensities ranging from 11,000 – 16,000 lux. Light intensities higher than 27,000 lux may result in faded flower and leaf colour.

Kerala is identified as one of the best places for growing anthurium because of the congenial climatic conditions. Anthurium cultivation is expensive requiring extensive investment. Growth and development of the crop depends on many factors of which environment plays an important role. It is sensitive to high light intensity, temperature, rainfall and poor aeration.

The system of growing is very important in anthurium, which determines the yield and quality of flowers. Practically high temperature combined with poor aeration delays the emergence of flower buds and the plants become susceptible to diseases. Location specific growing system is essential for the production of quality flowers along with reduction in the cost of production.

Anthurium is grown under 75-80 per cent shade provided by UV stabilized shade commercial growers. Microclimate (temperature, relative humidity and light intensity) inside the growing system may drastically influence the growth, flowering and quality of flowers. A slight modification of the system to suit the resource availability may drastically improve the production and quality of flowers. Moreover, a reduction in the cost of construction of the growing system would be highly beneficial to anthurium growers.

With this background, investigations on "Microclimatic relations on the growth, yield and quality of anthurium (*Anthurium andreanum* Linden) under different growing systems" were taken up with the following objectives.

a) To understand the effect of microclimate (temperature, relative humidity and light intensity) on growth, flowering and quality of anthurium grown under four systems of growing.

b) To evaluate the influence of planting time on anthurium varieties under four growing systems.

c) To evaluate the performance of four varieties of anthurium under four systems of growing and the variations in their response to microclimate.

d) To evaluate the influence of growing environment on post harvest quality of anthurium.

Review of literature

2. REVIEW OF LITERATURE

Anthuriums have been cultivated for many decades for cut flower production. It is the signature flower of Hawaii and this heart- shaped flower reminds people of Valentine's Day year round. The popularity of growing anthurium as a cut flower has risen in the past few years and it has now become an important export oriented crop. The global market size for floriculture products was estimated at around US$ 10 billion for the year 2004. With an 8 per cent annual growth, this is expected to grow to $ 16 billion by 2010. Fresh cut flower accounts for around two third of the world trade in floriculture. The demand for anthurium is rising annually. In recent years there has been 38 per cent increase in demand for anthurium as against 18 per cent in rose and carnation. (Muthukumaran *et al.*, 2005).

Anthuriums can be divided into four basic groups; *A. andreanum* cultivars, inter specific hybrids between *A. andreanum* cultivars and dwarf species currently referred to as '*Andreacola*' types, *A. scherzerianum* hybrids, and foliage anthuriums. *Anthurium andreanum*, a generally large, somewhat open structured plant with large flowers, is commonly grown for cut flower production and sometimes adaptable to pot culture. New *andreanum* cultivars, selected specifically for pot culture are more compact. In *A. andreanum* primary flower colours are white, pink, red, orange and green. *'Andreacola'* cultivars are small to intermediate in overall size, more compact and generally produce smaller but more numerous flowers than *andreanum* cultivars. *'Andreacola'* cultivars tend to have thicker, dark green leaves and many times show resistance to more aggressive anthurium diseases. Primary flower colours are white, pink, red and lavender. *A. scherzerianum*, the first widely cultivated anthurium pot plant, is a small compact plant. Primary flower colours are white, pink and red. Foliage anthuriums come in numerous shapes and size and represent a minor proportion of the total anthurium pot market.

Anthurium cultivation is mainly concentrated in Hawaii, Netherlands and Mauritius. USA, Canada, Japan, Germany and other European countries import a lot of these flowers. Japan is the most profitable floral market in East Asia. The Japanese are so quality – sensitive that the price of flowers in the Japan market is mainly decided by quality. India is a negligible player in the international trade of fresh cut flowers, which is dominated by the Netherlands, Columbia and Italy, accounting for about 59 per cent, 10 per cent and 6 per cent of the world trade, respectively, followed by African countries (Kenya, Tanzania, Zambia, Zimbabwe, Ethiopia and Uganda put together), South Korea and Israel. There is tremendous potential for India to exploit the high

demand for anthurium both in the domestic and world market. (Gutgutia, 2005; Muthukumaran *et al.*, 2005).

Kerala is identified as a suitable area for growing anthurium. There are many small scale and a few medium to large scale growers in the State. Floriculture may become an important economic activity in the state in the coming years. It is a dynamic market that needs a production system based on climatic conditions, commercial distribution and post harvest technology. Taking into account of the changing scenario of floriculture, Kerala Agricultural University strengthened research in this area. Fundamental and practical oriented research on different aspects of anthurium including post harvest technology has produced significant results .

Environmentally sound production system is one of the weapons to assure quality in the export market. Anthurium is a crop which is sensitive to high temperature, high light intensity, rainfall and poor aeration. Experience has shown that the system of growing is very important in anthurium which determines the growth, flowering, yield and quality of flowers (Rajeevan *et al.,* 2002). The investigations on “Microclimatic relations on the growth, yield and quality of anthurium (*Anthurium andreanum* Linden) under different growing systems” was taken up with an ultimate objective to evolve a low cost production system with no compromise on quality. Studying the response of commercially acceptable varieties to the micro climate in which they are grown forms the first step towards fulfilling this objective. Literature pertaining to various aspects of the present investigations is reviewed in this chapter.

2.1. ENVIRONMENT

Most *Anthurium* species are native to tropical rain forests and are primarily epiphytic in nature. Thus, in their natural habitat, they receive ample, frequent water with good drainage. In cultivation, anthuriums prefer evenly moist media especially when actively growing. Overall, it is better to slightly underwater than over water. Drying out may cause tip burn, root damage and reduced growth rates while over watering can also cause root damage and sudden yellowing of older leaves. Anthurium will not tolerate saturated, poorly drained growing medium. Soil pH should be maintained between 5.5 and 6.5.

Anthurium andreanum grows best with day temperature of 25-32^{0}C and night temperat 21-24^{0}C. Temperature above 35^{0}C may cause foliar burning, faded flower colour and reduced flower life. Night temperature between 4-10^{0}C can result in slow growth and yellowing of lower leaves. The plant will not tolerate frost or freezing conditions. The best relative humidity for growth is 70-80 per cent.

Anthuriums grow under a wide range of light intensities but their actual performance is dependent on the cultivars, elevation, temperature and nutrition. Generally, most anthurium types grow well at light intensities ranging from 11,000 - 16000 lux. Light intensities higher than 27,000 lux may result in faded flower colour and leaf colour.

2.1.1. Growing system

Anthurium requires warm greenhouse with shading from direct sunshine and a humid condition. Green house technology has been developed in tropical countries in order to improve yield and flower quality and to reduce phyto-sanitary problems. It is highly relevant under Indian conditions keeping in view of the extreme variations in the climate. A green house system mainly consists of three aspects, viz., structure, environment control system and crop management system. The first two aspects provide favourable environment for successful growth of the crops, whereas, the third one facilitates production of large quantity of high quality produce. The present requirement is environmental control and crop management suitable for a particular region. A thorough knowledge of response of plant to various environnental factors such as temperature, light, and humidity is essential for the proper environmental control within the green house. It must also be recognized that the degree of sophistication and level of investment per square meter of green house must be appropriate for the application of the technology to be economically feasible (Chandra, 1985; Smith, 1998). Various factors such as type of crop to be cultivated, climatic conditions, site location, plant layout and operating costs are to be considered while constructing a green house (Misra, 2000).

Proper selection of green house covering material is the most important factor for successful cultivation of plants. Depending on the need and situation, particular type of covering material can be preferred. The decision on selecting particular glazing system must include physical properties of radiation transmission as well as construction, maintenance and operational requirements. Thermometric and radiometric properties of various covering materials should form the basis of covering material selection (Hanan, 1998). Basically, the material should have resistance to the ultraviolet and infrared radiations, maximum transmission of photosynthetic active radiation (PAR) and low transmission of heat. It should resist tears, punctures and photo degradation. Resistance to wind, retention of clarity and reduced condensation build up for improved sunlight transmission are the other requirements. Optimum thickness should preferably be greater than 2100 micro (FAO, 1999).

There are different films showing very different characteristics that can be used as covering material for the green house for anthurium. UV stabilized shade net and polyethylene film are commonly used as covering material for the green house.

2.1.2. Environmental control in green houses

The distinctive feature of green house cultivation as compared to outside cultivation is the presence of a barrier between the crop and the environment. The presence of a cover, characteristic of green houses, causes a change in the climatic condition as compared to that outside by reducing radiation and air velocity; increasing or decreasing the temperature and vapour pressure of air and by making the fluctuations in CO2 concentrations stronger. Each of these changes has its own impact on growth, production and quality of the green house crop, some of them being detrimental.

Many of the scientist have developed different models that describe the variation of environmental condition of green house with different climatic parameters. Undick ten Cate (1985) presented a general model for green house climate control., in which soil temperature was also incorporated as a essential variable.

Tantau (1985) developed a microcomputer system for green house climate control. A simplified mathematical model of green house was presented to calculate the influence of outside weather condition on the inside climate.

Bot (1989) proposed a dynamic model for climate control in the green house implementing continuous optimization which included sub models namely-radiaiton transmission model for modification of the outside to inside radiation; ventilation exchange between different parts of

house; quantification of the convective exchange processes between the green house air and

All these models were simulated and validated.

Anthuriums are not grown in tropical countries under environmentally controlled green houses. A shade hall is a much used green house construction with shade net to divert 75 per cent light intensity. A rain screen is provided with UV stabilized polyethylene film to protect the plants from rain. Micro sprinklers are provided in the shade house for irrigation and to reduce temperature.

2.3. LIGHT INTENSITY

Light is the most important environmental factor in the green house culture, as it influences a wide range of processes related to photosynthesis, energy balances including transpiration, phase transitions and morphology. The light is the solar radiation filtered by the atmosphere and reaching the ground. The composition of solar radiation and their percentage distribution is given by Zanon (1990).

Ray	Wavelength (nm)	% distribution
UV rays	200 to 400	7%
Visible rays	400 to 700	71%
Short infrared rays	700 to 800	22%

The visible rays or photosynthetically active radiation (400-700 nm) is necessary for photosynthesis, which is the basic process for the crop production (McCree, 1972) whereas the rest of the solar spectrum is the major factor affecting crop transpiration (Gates, 1976). The UV radiation is further composed by UV-C (200-280 nm); UV-B (280-315 nm) and UV-A (315-400 nm) rays. The UV-C radiation is highly phototoxic and UV-B is detrimental to most of the plants whereas UV-A has formative effects. UV-A has bactericide effects and has a strong effect over the organoleptic qualities of the plant; colour, taste, smell and turgidity (Zanon, 1990). The relative amount of UV-B plays an important role on the development of some fungi (Kittas and Baille, 1998).

The infrared radiation is supposed to have only a heating effect on the plants. From these considerations it derives that the plastic sheet should be as

Selective as possible with respect to the various types of radiation. This means that both UV-
UV-C radiation should be filtered as much as possible, but most of the UV-A should be allowed to pass through the film. Only very few transparent films approach this target. All the mineral salts added to the plastic to increase their thermal retention have a detrimental effect over UV-A transmission, cutting the UV-A passage down to 7-10% (Zanon, 1990).

In order to attain good growth of plants inside the green house, there should be sunshine of desired quantity and intensity. The low light intensity is the most important environmental restraint to maximize photosynthesis and growth. Opening and closing of stomata, there by the transpiration is also affected by the light intensity (Bakker, 1995).

Light duration plays an important role in photoperiodism, which is the response of the organism to the day – night cycle. The relative length of the light and dark periods control a number of responses including flowering, leaf shape, stem elongation, bulb formation and pigmentation. Based on the response of the plants to the light periods, plants are classified into long day plant (requiring 7-10 hr of continuous of dark periods), short day plant (requiring 10-14 hr of dark periods) and day neutral plants (photo insensitive). The intensity, quantity as well as duration of light in a day influence many physiological processes in the plants. Flowering is influenced to a great extent by the day length in many plants. In addition to the effect on flowering responses, photoperiod also influences pigmentation, partitioning of photosynthates, quantity and quality of flowers produced (Prasad, 1997). Light control, in addition to other parameters can be employed for enhancing and delaying the maturity of crops (Bakker, 1995; Suseela, 2002).

Anthurium is a crop which is highly influenced by light intensity. Various scientists have reported the influence of light intensity on growth, flowering and quality of flowers in anthurium.

2.3.1. Influence on morphological characters

In the commercial practice, anthurium is grown under partial shade. The intensity of light affects the morphological characters, flower production and quality of flowers. Nakasone and Kamemoto (1962) pointed out that optimum plant growth was obtained with 63 to 75 per cent shading using a saran cloth house in preference to lath house.

Singh (1987) and Antoine (1994) observed that shade requirements of anthurium ranges fror

80 per cent of full sunlight. Anthurium plants can be shaded with saran for uniform shade and these plants give more flowers per unit area. Some growers utilize the shade of coffee, citrus and other trees for growing anthuriums.

Henley and Robinson (1995) have studied the performance of 21 potted anthurium cultivars under shade after 38 weeks of growth. Vonk Noordegraff (1968) has pointed out that at low temperature (<20^0C) associated with heavy shade, leaf growth was slow, the leaves were smaller in size, dark green in colour with thinner, longer stalks and the plants were more flaccid. It was also necessary to protect the plants from excessive rains.

Three different systems of glass house shading were compared by Meij (1976). Flower yield was better in a house with whitewash. Berg and Valentin (1977) suggested plastic film and cloth screening for saving energy. Croat (1980), Breedveld and Glass (1984) and Cherevchenko and Kushmir (1983) have also observed flowering behaviour, biology and production of *A. andreanum* in protected cultivation.

Bosse (1969), Cherevchenko and Kushmir (1983), Fericks (1984), Higaki and Imamura (1985), Han *et al*. (1986), Henny *et al.* (1988), Kuruppu and Yogaratnam (1989), Candura and Guesman (1991), Cruz (1993) and Bridley

(1993) have emphasised the importance of the use of plastic shading for cut flower production of anthurium and some other flower crops.

Based on the study using 27, 43, 57 or 73 per cent shade. Poole and McConnel (1971) opined that decrease in shade level did not affect flower production but reduced flower stem length. Leaves of plants kept under 27 per cent shade became chlorotic. In another experiment with 75, 50 or 25 per cent shade of full sunlight, the largest number of flowers were produced with the least shading, but flower quality was better under higher intensity of shade (Poole and McConnel, 1971).

Plants from cuttings without the apical bud showed less vegetative growth and did not show a marked response to light intensity (Boula *et al*., 1973). Leffering (1975) reported that the growth rate increased and average flower production rose from 5 to 12 flowers per plant per year when plants received at least 45 per cent of the available light by means of an automatic system outside the green house. Overhead sprinklers were also used to prevent leaf scorch on sunny days. Reports of Steen and Holsteyn (1975) advised to keep the shaded glass moist, in dry dull weather, to p leaf damage.

Hetman and Pudelska (1984) have reported the effect of rooting preparation and method of transpiration reduction on the rooting of cuttings of *A. andreanum* under shade. Schmidt and Lauterbach (1985) have presented data on plant height and diamater of 10 cultivars of anthurium under shade.

The response of anthurium 'Lady Jane' to different light and fertilizer levels was reported by Henny and Fooshee (1988). Klapwijk and Spek (1988) observed that leaf plastochron duration was fairly constant from March until September, with an average of 72 days. Around 10th October, the duration was more than double. Subsequently, it decreased linearly to 72 days again, resulting in high leaf production around April. Leaf plastochron seemed to be related to radiation. Day length is probably not involved, as leaf emergence continued during winter. Klapwijk and Spek (1988) have also reported the influence of light intensity on development rate, flower growth and production of anthurium.

Investigations conducted in Kerala Agricultural University showed that in anthurium height, spread, number of leaves, leaf area and number of suckers were influenced by light intensity. The overall performance of the plants was the best under 80 per cent shade. Linear growth rate was consistent and positive under 80 per cent shade. Dry matter production was also significantly superior under this shade level (Salvi, 1997). A model was developed describing the influence of irradiance and temperature in the green houses on the size of flowers (Nothuagal *et al.*, 2004).

2.3.2. Influence on flowering

Light intensity associated with shade and temperature has profound influence on flower production in anthurium. Nakasone and Kamemoto (1962) have reported that increasing shade, increased stem and spathe size but reduced flower production.

Otto (1967) observed that, in *A. scherzerianum,* reduction in night temperature had little effect on flowering. Flower yield decreased, however, if the night temperature was reduced from 22^0C to 13^0C. The best flower yields were obtained by reducing night temperatures by 3^0, 6^0 and 9^0C during January, February and March, respectively. Optimum night temperature was 16^0C. A simultaneous short day treatment delayed flowering by 10 days.

According to Vonk Noordegraff (1968), when *A. scherzerianum* plants were grown in shade, compared to full light, flowers were smaller and less in number. Light had the greatest effect on flower production, followed by temperature. He has also pointed out that while producing *A. scherzerianum* at a temperature above 18^0C, the number and size of flowers are generally reduced to some extent.

Vonk Noordegraff (1973) was of the opinion that at temperature 18-21^{0}C, anthurium flowers were most abundant in spring time. Splitting of the leaves and flower initiation go together. From a certain stage of the plant, each leaf can produce a flower. Flower development is irregular, but could be promoted by lowering the temperature.

The time required for buds to develop into blooms ready for harvest, ranged from 45 to 53 days from May to October and from about 65 to 75 days, from December to March (Klapwijk and Spek, 1984). In theory, one bloom could be produced for every leaf, but bud death could reduce the yield by upto 50 per cent. Some cultivars such as 'Hawaii' showed very slow bloom development. Schmidt and Lauterbach (1985) presented data on the number of inflorescence produced and diameter of spathe of 10 cultivars.

Kalpwijk and Spek (1988) reported that in winter, the maximum period between emergence and harvest of flowers was around 21 in December. The flower production fluctuated strongly with a minimum in March and a maximum, in the second half of June. The year round flower bud abortion rate was approximately 50 per cent.

Different flowering responses of *A. scherzerianum* types have been reported by Schaper and Zimmer (1991). Dai and Paull (1991) have reported about the inter relationship of leaf development and flower growth in anthurium. Armitage and Son (1992) stated that plants grown under 67 per cent shade, had the longest stems and could be harvested three weeks earlier than field grown cut flower species.

In a study conducted using different shade levels for anthurium (50, 60, 70 and 80 pe earliest flowering was observed under 70 per cent shade. But the flower quality in terms of size, colour and length of stalk was highest under 80 per cent shade. (Salvi, 1997).

In a study conducted to investigate the effects of different light intensities on plant growth, development, yield and flower quality of tissue cultured *Anthurium andreanum* var. Cancan viz., 3.6, 8.5, 10.2 and 14.6 mol of photons/day per m, the largest leaves and flowers and the highest photosynthesis rate ere observed under the lowest light intensity (Dufour and Guerin, 2003 a).

2.3.3. Influence on nutrient uptake

In general, the mineral nutrient status of plants has been found to improve under shading as in the case of apple, cocoa, spinach and tea. Kraybill (1922) observed higher contents of moisture and nitrogen in shaded apple leaves.

Guers (1971) reported that cocoa leaves exposed to direct sunlight contained less moisture and nitrogen than shade leaves. Cantiliffe (1972) observed in spinach, the concentration of potassium in the tissue increased with reduction in the light intensity. In *Dracaena sanderiana*, on the other hand, shade had little effect on the leaf nutrient content, except that high shade intensity increased potassium and magnesium, especially in young leaves (Rodriguez *et al.,* 1973).

Wahua and Miller (1978) reported that in soyabean total leaf and stem nitrogen content were highly and negatively correlated with shade. According to Radha (1979) the uptake pattern of major nutrients in pineapple was not greately influenced by shading. In the case of coffee, Oladokun (1980) observed that shade significantly affected the nitrogen, phosphours and pottasium contents in plants. According to Wong and Wilson (1980), nitrogen accumulation in all the plant components of green peas was markedly improved by shading. Trang and Giddins (1980) were of the opinion that soyabean plants without shade had higher nitrogen content.

In cocoa, Gopinathan (1981) noticed higher percentage of N, P and K in plants grown under direct sunlight. Lalithabai (1981) reported that due to shading

N, P and K contents increased in all the components of colocasia, sweet potato, turmeric and ginger when grown as intercrops. The uptake of all the nutrients followed an identical pattern as that of dry matter accumulation in all the

crops. On the other hand, Swapna (1996) reported that, in *Philodendron Wena* concentration of N, P and K in plants was not subjected to variations when different shade levels were provided.

In anthurium nutrient content of leaves and uptake of nutrients were significantly influenced by different shade levels. The highest values for these were reported under 80 per cent shade compared to 50, 60 and 70 per cent (Salvi, 1997).

2.3.4. Influence on pigment content

Spathe colour in anthurium is due to the presence of various anthocyanin pigments (Iwata *et al.*, 1979). Anthocyanin and chlorophyll contents of plants are, in turn, influenced by light intensity (Kunisaki, 1982). Kamemato *et al*. (1988) had given a description of the genetics of the major spathe colours in anthuriums. The histological distribution of anthocyanins in anthurium spathes was studied by Wannakrairoj and Kamemoto (1990).

Most of the reported evidences show that the concentration of chlorophyll per unit weight of leaf increases with shading in anthurium as reported in the case of plants like cocoa, tea and strawberry. But the chloroplast content per unit leaf surface has been found to decrease with shading as in alfa-alfa and some other plants. In crops like cowpea, wheat etc., increasing shade intensities have been found to decrease the chlorophyll content per unit leaf weight.

Clark (1905) observed that in the case of strawberry, direct sunlight of high intensity resulted in the destruction of chlorophyll. Increase in chlorophyll content was noticed in the leaves of shaded cocoa plants (Evans and Murray, 1953 and Guers, 1971). Similar observations were made by Ramaswami (1960) and Venkataswami (1961) in the case of tea.

In the case of cowpea, Higazy *et al.* (1975) observed that the concentration of total chlorophyll as well as its components 'a' and 'b' decreased by increasing shade intensity. In wheat, Moursi *et al*. (1976) observed that all the pigments decreased significantly with increasing shade intensities, viz., 100, 60, 40 or 20 per cent full sunlight; but the ratio of chlorophyll a:b remained constant at all the shade intensities. Radha (1979) observed that chlorophyll 'a', 'b' and 'total' content of leaves increased with the increased shade intensity in pineapple. The reason for the drop in chlorophyll concentration in plants subjected to low temperatures seemed to be due to the photo

oxidative damage to the membranes of the chloroplast (Levit, 1980). There was a de
in chlorophyll content of leaf in anthurium with decrease in intensity of shade from 80 per cent to 50 per cent as reported by Salvi (1997).

2.4. TEMPERATURE AND RELATIVE HUMIDITY

Temperature plays an important role in the vegetative and photosynthetic activity of the plants. The maximum activity is obtained in a defined range of temperatures. Below and above this range the activity slows down. Soil temperature influences the availability, absorption and utilization of mineral elements and water, seed germination and rooting system of the plant. Leaf temperatures affect the transpiration rates of the plant. Temperature also affects the quality of the products and maturity rate of the plants and has an important role virtually in all plant responses including photosynthesis, transpiration and respiration. It influences initiation and development of reproductive organs. Temperature influences plant growth from sowing to flowering in three distinct ways. In crops of temperate region there may be specific cold temperature hastening of flowering known as vernalization. The rate of progress of flowering increases with increase in temperature to an optimum temperature at which flowering is most rapid. At supra-optimal temperature, flowering is progressively delayed as temperature increases (Kachru, 1985; Prasad, 1997).

The optimum temperature for growth of anthurium is 18-21^{0}C and the minimum temperature should not be less than 10^{0}C for a short period. The relative humidity, which also plays an important role in the growth and development of anthuriums, should be around 80 per cent (Ignasse, 1984; Otto, 1967 and Vonk Noordegraff, 1968 and 1969). Higher humidity has, however, marginal effect on the plants (Papenhagen, 1986). Bright, but filtered, light is essential for abundant flowering (Singh, 1987).

Maatsch and Bachthaler (1964) observed that plant vigour increased with increase in temperature. The unsuitable growing conditions stimulated the development of abnormal spathe and/or spadix and reduced the productivity of plant (Steen and Vijverberg, 1973 a).

Influence of temperature and light intensity in summer on growth and flowering in anthurium was studied. High temperature in summer hardly influenced vegetative growth, but restrained the growth of flower bud and increased the abortion of it. Effect of light intensity to the flowering was

quite different in varieties. Light intensity hardly influenced the rate of vegetative

(Suda and Fukuda, 1999).

Temperature influences the incidence of bacterial blight in anthurium as reported by Chase (1988). Severity of blight was greatest for plants maintained at 30^{0}C, whereas no symptom developed at temperature $< 26^0$C.

2.4.1 Influence of growing environment on post harvest quality of flowers

Post harvest behaviour of cut flower is determined by the pre harvest conditions under which the crop is grown. It may be emphasized that the post harvest behaviour of the flower is determined by the pre harvest growing conditions which account for 30-70 per cent of vase life of the flower. The pre harvest conditions which have an important bearing on vase life of flowers are selection of variety, environmental factors viz., light, temperature, relative humidity, fertilization, irrigation, diseases and pests and presence of pollutants (Valsalakumari *et al.,* 2003; Rajeevan *et al.,* 2004).

Light intensity received during the growing period affects the inherent carbohydrate levels. Insufficient light conditions result in flowers with low vase life besides causing blueing of petals and bend neck in roses due to formation of anthocyanins in petals and insufficient lignification of the neck region, respectively. Too high light intensities cause scorching of the foliage and flower buds, drooping of leaves and abscission of petals (Singh *et al.,* 2001).

In *Dendrobium nobile* cultivars it was found that carbohydrate accumulates in shoots after the emergence of last leaf and during the elongation of floral axis. Insufficient light conditions result in flowers with low vase life. Too high light intensities cause yellowing of the foliage, discoloration of flower, dropping of leaves and abscission of buds (Hew, *et al.*, 1987)

Under the different shade levels tried in anthurium viz., 50, 60, 70 and 80 per cent, post harvest longevity of flowers was maximum when produced under 80 per cent shade (Salvi, 1997)

Temperature during the growth period influences the size and post harvest quality of flowers. Flower crops are highly specific in their temperature requirements. Lower night temperatures are always advantageous because at night when the plant does not manufacture food due to photosynthesis, the low respiration rates at lower temperatures lower the burning of food. Carnation blooms produced at Ludhiana during February-March possessed longer vase life (8 to 10 days) as

compared to those produced in April-May (4-5 days). Too low temperatures also cause freezing injury to the buds. Spring flower of field grown Super Star cut roses performed better in respect of longevity, flower diameter, fresh and dry weight over those of winter, summer and rainy season flowers. This is attributed to optimum temperature, sunshine hours and relative humidity that existed during spring (Singh, *et al.,* 2001).

In Petunia, flowers produced at high temperature 32/27^{0}C (day/night) were half in size of flowers produced at 17/12^{0}C (Shvarts, *et al.,* 1997). Within a rage of 5-13^{0}C higher temperature hastened flower bud development and resulted in earlier flowering in *Ornithogalum arabicum* (Shimada, *et al.*, 1995).

High humidity enhanced the plant dry weight of poinsettia and *Kalanchoe*, decreased it in *Begonia* and had no significant effect in chrysanthemum. The highest plant quality was generally produced under the lowest humidity, with the development of more compact plants. Keeping quality as tested under indoor conditions was the same irrespective of humidity in *Begonia*, poinsettia and pot chrysanthemum (Mortensen, 2000).

The climatic conditions desired for anthurium, however, are very close to tropical conditions. Certain climatic conditions can speed up the plant's growth. For example, higher temperatures combined with lower humidity stimulate growth, since the plant needs more evaporation. The temperature at which the anthurium is grown depends heavily on the other climatic conditions. The relation between temperature and light is very important. To the extent that more light is available for the plant, the temperature may be higher to obtain maximum production. Roughly speaking, the temperature on dark days should be between 18-20^{0}C, with a humidity between 70-80 per cent. On sunny days, the temperature should be between 20-28^{0}C, with a humidity of around 70 per cent. In general, the temperature should remain below 30^{0}C and the humidity, at least 50 per cent.

2.4.2 Influence of variety and planting time

Today, hundreds of varieties are known in different colours in anthurium. Bright red and bright orange colours have greatest demand all over the world, followed by white and pink. Double coloured varieties and varieties with pastel colours are gaining more and more importance now and they are also fetching higher price in the international market (Rajeevan *et al*., 2002). An ideal anthurium variety should have compact plants with short internodes; producing suckers profusely; bright clear coloured, showy, heart shaped spathe with plenty of blisters and symmetrical overlapping of basal lobes; spadix shorter in length than the spathe, reclining to the spathe, oriented at an angle less than 30^0; an erect, long flower stem, about five times the length of the spathe and resistance to common diseases and pests (Rajeevan *et al.,* 2002).

Varietal differences in plant and flower characters, growth, production and post harvest qualities of anthurium have been reported earlier by several scientists. Morphological studies conducted by Chirstensen (1971) showed that *A. andreanum* had a long juevnile phase followed by a generative phase in which flower buds are produced. It produces flowers all round the year, one flower from each leaf axil. The sequence of leaf, flower and new leaf is maintained throughout the life of the plant. On comparing the productivity and inflorescence quality of 120 individual anthurium plants, Steen and Vijverberg (1973 b) found that their productivity was highly variable ranging between 4 to 16 flowers over two years.

Mercy and Dale (1994) observed that anthurium produced only five to eight new leaves on a stem axis per year and five to eight spadices per year. Sindhu (1995) has recorded that the number of spadices produced annually by an anthurium plant varied from four to eight. According to Rajeevan *et al.* (2002) the number of leaves and spikes per plant per year varied from 4-9 in anthurium.

In a study of five varieties of *A. andreanum,* Bindu and Mercy (1994) observed the largest spathe size for ‘Pink’ (10.4 x 9.7 cm) and the smallest for 'Lady Jane' (6.5 x 3.5 cm). In a similar study, Sindhu (1995) found that the varieties 'Pink' and 'Kalimpong Red' produced super large flowers and the smallest flower were produced in the variety 'White'. The variety 'Ruth Mort' had spathes larger than those of 'Lady Jane', with a mean width and length of 5.01 and 7.68 cm, respectively (Oglesby Plant Laboratory Inc., 1996).

Renu (1999) compared 10 varieties, which showed significant variation in height ranging from 29.7 cm in 'Midori' to 70.9 cm in 'Pompon Red'. Henny (1999) recorded that the new variety 'Red Hot' had 6 to 7 cm long and 4 to 5 cm wide spathes. The spathe size of 10 varieties studied by Renu (1999) revealed variation in size ranging from 17.12 cm in 'Pompon Red' to 30.74 cm in

'Dragon's Tongue Red'. According to Rajeevan *et al.* (2002) the spathe size range

cm in 'White Alba' to 17 cm in 'Pink' and 'Kalimpong Red'.

Characterization of six anthurium varieties was done by Ravidas (2003). The results showed significant variation with respect to the morphological characters. The variety 'Lima' was the tallest, with long internodes. The shortest varieties were 'Agnihothri' and 'Red Dragon'. The productivity of plants ranged from 6-9 spikes per plant per year. Seasonal variation was noticed in the flowering behaviour. Flower production was high during February to March and low during November to January. The magnitude of variation and heritability were estimated. In most of the characters studied the PCV was slightly higher than GCV indicating the influence of environment.

The significant influence of planting time on growth in terms of shoot production, plant height, first leaf production, leaf area and flower yield in anthurium and other flower crops were reported by several scientists like Kalasareddi *et al.* (1997) and Salvi (1997) in gladiolus and Dubey and Shukla (2002) in tuberose.

The influence of planting time on cut flower quality is also well established. In *Alstroemeria* cultivars delaying planting after November, the traditional planting time for the crop, delayed flowering by three weeks (Lisiecka, 1993). Better quality of flowers was also reported in *Lilium spp* by early planting (Su *et al.*, 1999). Cut flower quality was highest in chrysanthemum when potted between February and September that flowered between April and November (Bres and Jeizy, 2004). Flowering could be advanced and longer flower stems with more flowers per inflorescence were obtained in *Lathyrus latifolius* from seeds that were sown earlier in January than in June (Koike *et al.*, 2004).

Materials and methods

3. MATERIALS AND METHODS

Investigations on "Microclimatic relations on the growth, yield and quality of anthurium (*Anthurium andreanum* Linden) under different growing systems" were carried out at the Department of Pomology and Floriculture, College of Horticulture, Kerala Agricultural University, Vellanikkara, Thrissur during 2003-05. The details of the experiments conducted and the methods followed for analysis of the data are presented in this chapter.

Four cut flower varieties of *Anthurium andreanum* were grown under four growing structures adopting three times of planting at an interval of four months. Weather parameters, viz., temperature, relative humidity and light intensity were recorded daily both inside and outside the four growing structures.

Observations were recorded on vegetative characters, days to flowering and floral characters of the plant. The influence of variety, planting time, growing structure and their interactions on growth and flowering of *Anthurium andreanum* was worked out from the observations recorded. Correlations and regression between the growth parameters and weather parameters in all the growing structures were also worked out. Post harvest studies were conducted to understand the influence of variety and growing structure on the post harvest longevity.

3.1. PLANTING TIME

Three times planting were done at an interval of four months as follows.

P_1 - May 2004

P_2 - October 2004

P_3 – February 2005

3.2. VARIETIES

The varieties used for the study were the following (Plate 1&2)

V_1 – Tropical

V_2 – Pistache

V_3 – Mauritius Orange

V_4 – Passion

3.3. GROWING STRUCTURES (Plate 3)

S_1- Poly house, top air vent type with vent on one side, roof covered with 120 gsm UV film and 75% shade net below, side covering with 25% shade net, with side walls of 0.5 m height.

S_2- Poly house, top air vent type with vents on both sides, roof covered with UV film and 75% shade net and with side curtains of UV film.

S_3 - Low cost shade house, roof covered with UV film and 75% shade net, side covering with 25% shade net, without side walls.

S_4 - Shade house with top air vent on one side, roof covered with 75% shade net and side covering with 25% shade net, with side walls of 0.5 m height.

3.4. PLANTING MATERIAL

Two month old tissue culture plants were used as the planting material in all the three months of planting. Thirty plants were used in a variety for every planting in each growing structure.

3.5. CULTURAL PRACTICES

Plants were potted in earthen pots of 6 cm size. A medium consisting of coarse sand, well rotten cow dung, charcoal, earthen crocks and brick pieces was used for growing plants. The cultivation practices standardized in the Department were adopted uniformly (Salvi, 1997). UV stabilized shade nets were used as growing structure so as to provide 75-80 per cent shade.

3.6. POST HARVEST STUDIES

Post harvest longevity of anthurium flowers was studied in the laboratory using two varieties namely Tropical (V_1) and Pistache (V_2) grown under four growing structures.

For this, uniform spikes were harvested when one third of true flowers on the spadix opened (Salvi, 1997). The flowers were harvested in the morning and a fine slanting cut was given to the base of the stalk to expose more surface area and to facilitate easy absorption of water.

3.7. DESIGN OF THE EXPERIMENT

Thirty plants in a variety in each planting time were arranged randomly in each growing structure. There were 3 main factors (planting time, variety and growing structure) of which variety

and growing structures, each at four levels and one factor planting time at three levels. Th interaction consisted of planting time x variety (12 levels), structure x variety (16 levels) and planting time x structure (12 levels). The 3 factor interactions consisted of structure x planting time x variety (48 levels). The following were worked out.

3.7.1. Effects of planting time, variety, growing structure and their interactions on growth parameters, flowering, flower characters and longevity of *Anthurium andreanum*.

3.7.2. Effect of variety and growing structure on post harvest longevity of flowers.

3.7.3. Correlations between the weather parameters and plant characters in four growing structures.

3.7.4. Regression analysis between weather parameters and plant characters in four growing structures and four varieties

3.8. OBSERVATIONS

The following observations were recorded during the course of the experiment.

3.8.1. Plant characters

The following plant characters were studied.

3.8.1.1 Plant height

The height of the plant was measured from the base to the tip of the shoot at monthly intervals and expressed in centimeters.

3.8.1.2. Plant spread

The spread of the plant in East West and North South directions were measured in centimeters.

3.8.1.3. Number of leaves

The total number of leaves present on the plant at the time of each observation was counted and recorded.

3.8.1.4. Length, breadth and area of leaves

The length of the leaf from the basal lobe to the tip and maximum leaf width at the centre of the leaf was measured in centimeters. The area for every newly emerged leaf was computed using the following equation (Salvi, 1995).

Leaf area = 0.72 x (leaf length x leaf breadth)

3.8.1.5. Petiole length

The length of the petiole from the point of its emergence to the base of the leaf lamina was measured and recorded in centimeters.

3.8.1.6. Leaf production interval

Time taken (days) for the emergence of successive leaves was counted and recorded.

3.8.1.7. Longevity of leaves

Number of days from the opening of the leaf to necrosis on the plant was recorded and expressed as the longevity of leaves in days.

3.8.2. Floral characters

3.8.2.1. Days to first flowering

Number of days taken for first flower bud to appear after planting was noted and recorded. The number of days required for the emergence of first flower bud after imposing the treatments was recorded and expressed on days to first flowering.

3.8.2.2. Length of peduncle

Length of peduncle from its point of emergence to the point of attachment of the spathe was measured and expressed as the length of peduncle in centimeters.

3.8.2.3. Girth of peduncle

The girth of peduncle at the base to tip was measured in centimeters and recorded.

3.8.2.4. Length and width of spathe

The length of the spathe from the joint of the peduncle to the tip and breadth at the centre were measured and recorded in centimeters.

3.8.2.5. Length of spadix

Length of the spadix from the base to tip was measured in centimeters and recorded.

3.8.2.6. Angle of orientation of spadix to spathe

Angle between the spathe and spadix was measured in centimeters and recorded.

3.8.2.7. Longevity of spike on plant

The number of days from the opening of the spathe to total necrosis of spathe and spac the plant was recorded.

3.8.2.8. Interval of flower production

The number of days taken for the emergence of successive spike was recorded.

3.8.2.9. Nature of peduncle (straight / bending)

Nature of peduncle such as straight or bending was observed and recorded.

3.8.2.10. Colour of spathe and spadix

Colour of spathe and spadix was recorded by visual observation.

3.8.3. Weather parameters

Daily readings of air temperature, relative humidity and light intensity were recorded using thermo-hygro meter and lux meter in all four growing structures. The observations were taken in the interval of 12.30 p.m to 1.00 p.m uniformly.

3.8.3.1 Temperature

Inside and outside temperature was recorded in all four growing structures and expressed in degree celsius.

3.8.3.2. Relative humidity

Relative humidity was recorded inside and outside in all four growing structures and expressed in percentage.

3.8.3.3. Light intensity

Light intensity was recorded inside and outside in all four growing structures and expressed in lux.

3.8.4. Post harvest characters

The following were the post harvest characters studied during the course of experiment

3.8.4.1. Water uptake (ml)

The spike was placed in a conical flask containing measured quantity of water. The qu of water in the flask after the removal of spike on the last day in vase was also measured. The difference gave the water uptake, which was expressed in milliliters.

3.8.4.2. Days to total necrosis

Number of days from the date of harvest to the spathe and spadix necrosis was recorded.

3.9. STATISTICAL ANALYSIS

The data pertaining to the growth parameters and floral characters and post harvest studies were subjected to statistical analysis by applying the technique of analysis of variance (ANOVA) for randomized block design (Panse and Sukhatme, 1985).

Correlation studies were done between weather parameters and plant growth parameters using the software SPSS. Observation of characters viz., plant height, plant spread EW, plant spread NS, number of leaves, leaf length, leaf breadth, leaf area, petiole length were taken for the analysis (Panse and Sukhatme, 1985).

Multiple regression analyses were done between weather parameters and Plant growth parameters using the Software SPSS. Trend curves were fitted for growth parameters with weather parameters.

Results

4. RESULTS

The results of the investigations on "Microclimatic relations on the growth, yield and quality of anthurium (*Anthurium andreanum* Linden) under different growing systems'' are presented in this chapter.

4.1. EFFECTS OF PLANTING TIME, VARIETY, GROWING STRUCTURE AND THEIR INTERACTIONS ON PLANT CHARACTERS OF *Anthurium andreanum*

The effect of planting time, variety, growing structure and their interactions on growth parameters viz., plant height, spread, number of leaves, length of leaf, breadth of leaf, leaf area and petiole length of anthurium are presented in Tables 1 to 8.

4.1.1. Plant height

Table 1 shows the effect of variety, planting time, growing structure and their interactions on plant height of anthurium.

Plant height differed significantly among varieties, months of planting, growing structures and their interactions (Fig. 1).

Among the months of planting mean plant height was the highest (16.89cm) in P_1 (May planting) which was significantly superior to all other months of planting and the lowest (15.64 cm) in P_2 (October planting) which was on par with (15.77 cm) P_3 (February planting).

Among the varieties, the mean plant height was the highest (17.05 cm) in V_4 (Passion) (Fig. 2). This was on par with V_3 (Mauritius Orange) and V_2 (Pistache), 16.70 cm and 16.16 cm, respectively. Plant height was the lowest (14.48 cm) in the variety V_1 (Tropical).

Among the growing structures, mean plant height was the highest (18.06cm) in S_3 (low cost growing structure) which was significantly superior to all other growing structures (Fig. 3), and the lowest values were in S_1 and S_4 (15.03 cm and 14.59 cm, respectively).

All the interaction effects were significant with respect to plant height. The interaction effect of variety x planting time showed that P_1V_2, P_1V_4, P_3V_3 and P_3V_4 had higher values of 18.09 cm, 17.35 cm, 17.33 cm and 17.2 cm, respectively, which were on par. Plant height was the lowest (13.19 cm) in P_2V_1 which on par with P_3V_2 (13.78 cm).

The interaction effect of variety x structure showed that S_3V_4 had the highest value of cm with respect to plant height and this was on par with that of S_3V_3 (19.67 cm). The lowest was in S_4V_1 (12.60 cm).

The interaction effect of planting time x structure showed that P_1S_2 had the highest value (19.13 cm) and this was on par with P_3S_3 (19.08 cm). The lowest was in P_3S_1 (13.70 cm) which was on par with P_2S_4 (13.85 cm).

The interaction effect of variety x planting time x structure showed that the treatment combination of $S_3V_3P_3$ had the highest value of 22.90 cm with respect to plant height. The lowest was in $S_4V_1P_2$ (10.60 cm).

Table 1a. Effects of planting time, variety, growing structure and their interactions on plant height of *Anthurium andreanum* at monthly interval (Main effects)

Treatment	Plant height in cm. (months after planting)					
	1	2	3	4	5	6
Planting time						
P_1	9.63	12.09	13.03	14.10	15.24	16.89
P_2	10.07	11.37	12.00	13.60	14.62	15.64
P3	9.15	10.78	12.85	14.17	14.65	15.77
CD(0.05)	0.34	0.49	0.74	NS	NS	0.48
Variety						
V_1	8.02	10.43	11.43	12.86	13.62	14.48
V_2	9.32	11.55	12.49	14.10	14.36	16.16
V_3	10.68	11.59	13.08	14.67	15.73	16.70
V_4	10.45	12.09	13.51	14.63	15.63	17.05
CD (0.05)	0.40	0.24	0.86	0.84	0.75	0.55
Structure						
S_1	6.46	8.35	10.34	12.27	13.45	15.03
S_2	10.19	12.49	13.50	14.83	15.20	16.71
S_3	11.35	13.70	14.98	16.38	17.25	18.06
S_4	10.47	11.11	11.68	12.77	13.44	14.59
CD (0.05)	0.57	0.65	0.75	0.72	0.63	0.53

Table 1b. Effects of planting time, variety, growing structure and their interactions on plant height of *Anthurium andreanum* at monthly interval
(2 way interactions)

Treatment	*Plant height in cm. (months after planting)*					
	1	2	3	4	5	6
Planting time x variety						
P_1V_1	8.15	12.07	12.41	13.79	14.56	15.47
P_1V_2	10.13	12.64	13.55	15.10	15.01	18.09
P_1V_3	9.62	10.85	12.14	14.38	15.71	16.64
P_1V_4	10.61	12.81	14.01	14.35	15.69	17.35
P_2V_1	7.96	9.74	10.00	12.17	12.65	13.19
P_2V_2	9.91	11.78	12.60	13.64	15.15	16.62
P_2V_3	11.42	12.14	13.09	14.49	15.30	16.15
P_2V_4	10.99	11.81	12.33	14.18	15.35	16.59
P_3V_1	7.96	9.48	11.86	12.63	13.65	14.78
P_3V_2	7.92	10.22	11.32	13.56	12.91	13.78
P_3V_3	10.99	11.78	14.03	15.14	16.18	17.33
P_3V_4	9.75	11.65	14.18	15.35	15.85	17.2
CD (0.05)	0.70	0.97	1.48	NS	1.30	0.96
Structure x variety						
S_1V_1	6.13	8.55	10.3	11.77	12.96	14.06
S_2V_1	9.14	12.44	13.05	14.98	15.41	16.31
S_3V_1	7.37	10.80	11.95	13.47	14.41	14.95
S_4V_1	9.45	9.93	10.41	11.22	11.71	12.60
S_1V_2	5.61	7.66	10.02	11.34	13.41	14.87
S_2V_2	9.90	12.51	13.03	14.47	13.13	16.20
S_3V_2	10.53	13.97	14.34	16.92	16.71	17.90
S_4V_2	11.25	12.04	12.57	13.66	14.20	15.68

Contd.

Table 1b. continued

Treatment	Plant height in cm. (months after planting)					
	1	2	3	4	5	6
S_1V_3	7.28	8.56	10.17	13.18	14.12	15.78
S_2V_3	12.2	13.15	14.64	15.84	16.65	17.44
S_3V_3	13.23	14.22	16.35	17.2	19.15	19.67
S_4V_3	10.00	10.43	11.17	12.45	13.01	13.92
S_1V_4	6.82	8.64	10.87	12.77	13.30	15.38
S_2V_4	9.52	11.87	13.27	14.04	15.63	16.92
S_3V_4	14.26	15.82	17.3	17.95	18.74	19.71
S_4V_4	11.20	12.04	12.58	13.74	14.85	16.17
CD (0.05)	1.14	1.30	0.54	1.44	1.26	1.05
Planting time x structure						
P_1S_1	5.83	8.45	10.67	13.20	14.90	16.29
P_1S_2	9.95	13.42	14.26	16.04	16.11	19.13
P_1S_3	10.46	13.65	14.17	14.93	16.07	17.01
P_1S_4	12.28	12.85	13.01	13.45	13.90	15.12
P_2S_1	7.17	8.90	9.84	12.15	13.28	15.09
P_2S_2	11.01	12.35	12.71	14.25	14.72	15.53
P_2S_3	12.5	14.21	14.90	16.03	17.45	18.08
P_2S_4	9.60	10.00	10.57	12.05	13.02	13.85
P_3S_1	6.38	7.72	10.51	11.45	12.16	13.70
P_3S_2	9.61	11.7	13.52	14.22	14.76	15.49
P_3S_3	11.08	13.24	15.89	18.20	18.24	19.08
P_4S_4	9.55	10.47	11.47	12.80	13.40	14.81
CD (0.05)	0.98	1.13	1.29	1.25	1.09	0.912

Table 1c. Effects of planting time, variety, growing structure and their interactions on plant height of *Anthurium andreanum* at monthly interval
(3 way interactions)

Treatment	Plant height in cm. (months after planting)					
	1	2	3	4	5	6
Structure x planting time x variety						
$S_1V_1P_1$	5.60	9.80	12.40	14.60	16.20	18.10
$S_2V_1P_1$	9.23	14.00	14.00	15.66	15.83	16.23
$S_3V_1P_1$	8.20	14.66	13.23	14.60	15.30	15.77
$S_4V_1P_1$	9.60	9.83	10.03	10.30	10.93	11.80
$S_1V_2P_1$	6.00	8.56	10.76	12.66	17.33	18.80
$S_2V_2P_1$	9.13	13.73	14.53	17.66	11.90	20.23
$S_3V_2P_1$	11.40	13.66	13.96	14.23	14.60	15.47
$S_4V_2P_1$	14.00	14.60	14.96	15.83	16.23	17.87
$S_1V_3P_1$	6.00	7.36	9.10	14.46	14.63	14.83
$S_2V_3P_1$	10.76	12.46	14.13	16.06	18.00	19.77
$S_3V_3P_1$	11.33	12.80	13.96	15.10	17.97	18.87
$S_4V_3P_1$	10.40	10.80	11.36	11.90	12.27	13.10
$S_1V_4P_1$	5.73	8.06	10.43	11.10	11.43	13.43
$S_2V_4P_1$	10.66	13.50	14.40	14.76	18.73	20.30
$S_3V_4P_1$	10.93	13.50	15.53	15.80	16.43	17.97
$S_4V_4P_1$	15.13	16.20	15.70	15.76	16.17	17.73
$S_1V_1P_2$	5.43	7.86	8.00	9.60	10.17	10.60
$S_2V_1P_2$	9.40	11.50	11.66	14.76	15.67	16.87
$S_3V_1P_2$	6.63	9.00	9.50	11.93	12.27	12.50
$S_4V_1P_2$	10.36	10.60	10.86	12.40	12.53	12.80
$S_1V_2P_2$	6.16	7.16	8.40	9.76	11.00	12.97
$S_2V_2P_2$	11.20	14.16	14.60	15.56	16.07	16.43
$S_3V_2P_2$	11.80	14.70	15.30	16.56	20.17	21.63
$S_4V_2P_2$	10.50	11.10	12.10	12.66	13.40	15.47

Contd.

Table 1c. continued

Treatment	Plant height in cm. (months after planting)					
	1	2	3	4	5	6
$S_1V_3P_2$	9.60	10.50	12.26	14.93	17.00	18.97
$S_2V_3P_2$	14.06	14.26	14.63	15.16	15.27	15.53
$S_3V_3P_2$	13.80	15.00	15.96	16.53	17.03	17.27
$S_4V_3P_2$	8.23	8.80	9.50	11.33	11.93	12.83
$S_1V_4P_2$	7.50	10.06	10.70	14.30	14.97	17.83
$S_2V_4P_2$	9.36	9.50	9.96	11.50	11.90	13.30
$S_3V_4P_2$	17.80	18.16	18.83	19.10	20.33	20.93
$S_4V_4P_2$	9.30	9.53	9.83	11.83	14.23	14.30
$S_1V_1P_3$	7.36	8.00	10.50	11.13	12.53	13.50
$S_2V_1P_3$	8.80	11.83	13.50	14.53	14.73	15.83
$S_3V_1P_3$	7.30	8.73	13.13	13.90	15.67	16.60
$S_4V_1P_3$	8.40	9.36	10.33	10.96	11.67	13.20
$S_1V_2P_3$	4.66	7.26	10.90	11.60	11.90	12.87
$S_2V_2P_3$	9.36	9.63	9.96	10.20	11.43	11.93
$S_3V_2P_3$	8.40	13.56	13.76	19.96	15.37	16.60
$S_4V_2P_3$	9.26	10.43	10.66	12.50	12.97	13.73
$S_1V_3P_3$	6.26	7.83	9.16	10.16	10.73	13.57
$S_2V_3P_3$	11.76	12.73	15.16	16.30	16.70	17.03
$S_3V_3P_3$	14.56	14.86	19.13	19.96	22.47	22.90
$S_4V_3P_3$	11.36	11.70	12.66	14.13	14.83	15.83
$S_1V_4P_3$	7.23	7.80	11.50	12.93	13.50	14.90
$S_2V_4P_3$	8.53	12.63	15.46	15.86	16.27	17.17
$S_3V_4P_3$	14.06	15.80	17.53	18.96	19.47	20.23
$S_4V_4P_3$	9.16	10.40	12.23	13.63	14.17	16.50
CD (0.05)	1.99	2.28	2.62	2.52	2.21	0.46

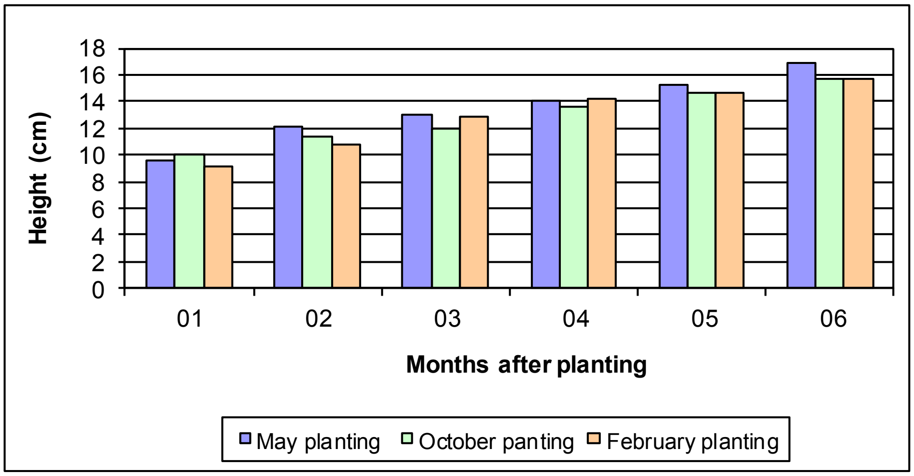


Fig. 1. Effect of planting time on plant height in anthurium

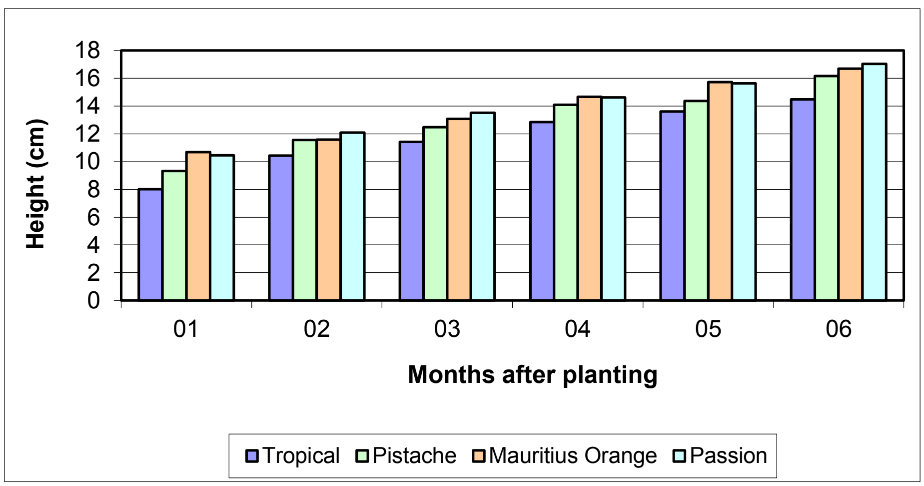


Fig. 2. Effect of variety on plant height in anthurium

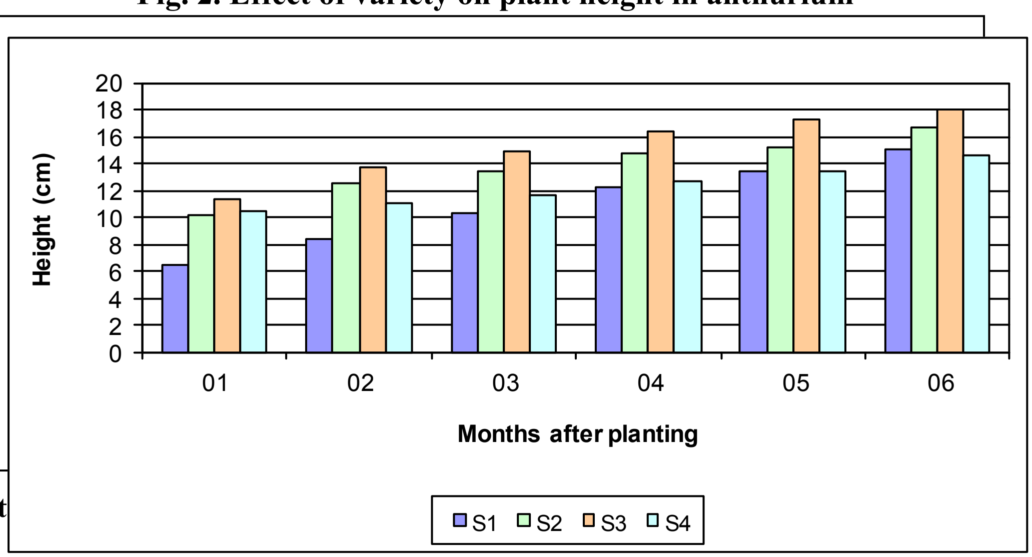


Fig. 3. Effect

4.1.2. Plant Spread (E W)

Table 2 shows the effect of variety, planting time, growing structure and their interactions on plant spread (E W) of anthurium.

Plant spread differed significantly among varieties, months of planting, growing structures and their interactions.

Among the months of planting mean plant spread (EW) was the highest (21.60 cm) in P_1 (May planting) which was significantly superior to all the other months of planting (Fig. 4) and the lowest (20.49 cm) was in P_2 (October planting) which was on par with the spread (20.83 cm) in P_3 (February planting).

Among the varieties, the mean plant spread (EW) was the highest (22.41 cm) in the variety V_2 (Pistache) which was significantly superior to that in all other varieties (Fig. 5) and the lowest (19.41 cm) was in the variety V_1 (Tropical).

Among the growing structures, mean plant spread (EW) was the highest (22.49 cm) in S_3 (low cost structure). This was on par with that in S_2 (22.03 cm). Lower values of 19.81 cm and 19.56 cm were recorded in S_1 and S_4, respectively (Fig. 6).

All the interaction effects were significant with respect to plant spread (EW). The interaction effect of variety x planting time showed that P_1V_2 had the highest value of 25.71 cm which was significantly superior to all other treatment combinations. Lowest plant spread was in P_3V_1 (17.60 cm) which was on par with P_1V_4 (18.79 cm).

The interaction effect of variety x structure showed that S_2V_2, S_3V_3 and S_3V_2 had higher values of 24.73 cm, 24.58 cm and 23.75 cm, respectively which were on par. The lower values were recorded in S_4V_1 (17.52 cm) and S_3V_1 (18.85 cm), respectively.

The interaction effect of planting time x structure showed that P_2S_3 (23.22 cm), P_2S_2 (22.20 cm), P_1S_3 (22.39 cm) and P_1S_1 (22.05 cm) were on par and had significantly higher values than the other treatment combinations. Plant spread was the lowest in P_2S_1 (17.80 cm) which was on par with P_2S_4 (18.73 cm).

The interaction effect of variety x planting time x structure showed that $S_1V_1P_1$ had the highest value of 27.23 cm for plant spread. The lowest was in $S_1V_4P_1$ (13.97 cm).

Table 2a. Effects of planting time, variety, growing structure and their interactions on spread (EW) of *Anthurium andreanum* at monthly interval (Main effects)

Treatment	Spread EW in cm. (months after planting)					
	1	2	3	4	5	6
Planting time						
P_1	15.08	17.72	19.68	19.49	23.29	21.60
P_2	11.03	14.99	13.98	17.14	19.26	20.49
P_3	12.44	13.75	15.63	18.16	18.77	20.83
CD (0.05)	0.64	0.71	1.05	1.05	1.01	0.87
Variety						
V_1	11.84	14.59	14.71	17.51	19.32	19.41
V_2	12.01	14.09	16.43	17.90	20.40	22.41
V_3	13.68	17.10	16.58	19.19	20.96	21.36
V_4	13.83	16.05	18.01	18.45	21.10	20.70
CD (0.05)	0.75	0.82	1.22	1.21	1.17	1.01
Structure						
S_1	11.11	12.70	16.46	16.92	18.63	19.81
S_2	12.58	16.00	16.23	19.13	21.38	22.03
S_3	13.21	16.67	17.10	19.57	22.26	22.49
S_4	14.45	16.56	16.02	17.43	19.50	19.56
CD (0.05)	NS	0.80	0.96	0.82	0.70	0.93

Table 2b. Effects of planting time, variety, growing structure and their interactions on spread (E W) of *Anthurium andreanum at* monthly interval
(2 way interactions)

Treatment	Spread EW in cm. (months after planting)					
	1	2	3	4	5	6
Planting time x variety						
P_1V_1	15.04	20.10	19.27	20.00	24.01	21.12
P_1V_2	14.55	15.86	21.50	18.62	22.30	25.71
P_1V_3	15.96	17.08	17.19	19.42	22.67	20.76
P_1V_4	14.77	17.82	20.78	19.92	24.20	18.79
P_2V_1	8.70	10.98	11.26	17.41	18.22	19.52
P_2V_2	10.40	13.87	13.56	17.97	21.30	21.90
P_2V_3	11.81	20.43	16.11	17.57	18.83	20.15
P_2V_4	13.08	14.66	14.98	15.59	18.70	20.37
P_3V_1	11.78	12.69	13.60	15.13	15.72	17.60
P_3V_2	11.06	12.55	14.23	17.11	17.60	19.61
P_3V_3	13.27	13.79	16.43	20.58	21.38	23.15
P_3V_4	13.63	15.97	18.26	19.83	20.40	22.95
CD(0.05)	1.30	1.42	2.11	2.10	2.02	1.75
Structure x variety						
S_1V_1	11.18	12.47	14.38	16.46	18.06	19.74
S_2V_1	12.63	15.55	16.06	19.94	21.14	21.45
S_3V_1	10.53	13.87	13.95	17.31	19.97	18.85
S_4V_1	13.01	16.46	14.45	16.35	18.10	17.62
S_1V_2	8.94	10.28	16.07	14.81	19.12	20.31
S_2V_2	12.05	16.13	16.10	19.02	20.14	24.73

Table 2b. continued

Treatment	Spread EW in cm. (months after planting)					
	1	2	3	4	5	6
S_3V_2	12.76	15.85	17.26	21.06	23.32	23.75
S_4V_2	14.27	14.11	16.28	16.72	19.02	20.85
S_1V_3	12.22	14.26	14.68	16.77	16.21	19.47
S_2V_3	13.55	17.32	16.37	20.67	23.20	22.04
S_3V_3	14.35	18.24	19.05	21.06	22.95	24.58
S_4V_3	14.61	18.57	16.20	18.25	21.48	19.33
S_1V_4	12.12	13.78	20.70	19.65	21.14	19.73
S_2V_4	12.07	15.00	16.41	16.90	21.05	19.90
S_3V_4	15.20	18.73	17.76	18.84	22.81	22.73
S_4V_4	15.92	17.10	17.16	18.40	19.38	20.45
CD (0.05)	1.33	1.61	1.92	1.64	1.41	1.86
Planting time x structure						
P_1S_1	15.04	13.34	22.88	19.04	22.18	22.05
P_1S_2	14.55	17.54	18.14	20.33	23.30	21.96
P_1S_3	15.96	18.50	18.34	18.70	24.15	22.39
P_1S_4	14.77	21.40	19.38	19.90	23.55	19.98
P_2S_1	8.70	12.16	11.60	14.84	15.88	17.80
P_2S_2	10.40	15.79	14.08	18.69	20.96	22.20
P_2S_3	11.81	16.28	16.34	19.39	22.91	23.22
P_2S_4	13.08	15.71	13.90	15.63	17.29	18.73
P_3S_1	11.78	12.60	14.90	16.90	17.84	19.58
P_3S_2	11.06	14.57	16.49	18.38	19.88	21.93
P_3S_3	13.27	15.25	16.35	20.61	19.73	21.83
P_4S_4	13.63	12.57	14.79	16.76	17.65	19.98
CD (0.05)	1.15	1.40	1.66	1.42	1.22	1.61

Table 2c. Effects of planting time, variety, growing structure and their interactions on of *Anthurium andreanum at* monthly interval (3 way interactions)

Treatment	Spread EW in cm. (months after planting)					
	1	2	3	4	5	6
Structure x planting time x variety						
$S_1V_1P_1$	13.70	16.20	20.43	20.20	24.43	27.23
$S_2V_1P_1$	15.16	19.40	20.10	20.46	23.10	21.17
$S_3V_1P_1$	11.80	19.90	18.53	20.43	24.20	19.83
$S_4V_1P_1$	19.50	24.93	18.03	19.03	24.33	16.27
$S_1V_2P_1$	11.53	12.93	26.36	15.00	25.43	26.63
$S_2V_2P_1$	12.30	17.73	17.90	21.00	15.93	27.10
$S_3V_2P_1$	16.16	17.60	20.63	17.33	24.83	24.13
$S_4V_2P_1$	18.23	15.20	21.10	21.16	23.00	25.00
$S_1V_3P_1$	10.66	11.66	15.26	18.20	16.00	20.40
$S_2V_3P_1$	15.40	17.06	17.06	22.03	26.10	20.13
$S_3V_3P_1$	15.83	16.90	17.06	18.76	23.23	25.03
$S_4V_3P_1$	21.96	22.70	19.36	18.70	25.37	17.50
$S_1V_4P_1$	10.03	12.56	29.46	22.76	22.87	13.97
$S_2V_4P_1$	13.43	16.36	17.50	17.83	28.10	19.47
$S_3V_4P_1$	14.46	19.60	17.13	18.40	24.33	20.57
$S_4V_4P_1$	21.16	22.76	19.03	20.70	21.50	21.17
$S_1V_1P_2$	8.60	8.70	8.80	14.60	14.73	15.77
$S_2V_1P_2$	7.88	12.56	12.60	22.60	22.67	24.10
$S_3V_1P_2$	8.20	8.83	9.66	15.23	18.27	17.10
$S_4V_1P_2$	10.13	13.83	13.96	17.66	17.23	21.13
$S_1V_2P_2$	7.66	7.80	8.53	14.43	16.00	16.63
$S_2V_2P_2$	11.10	17.26	15.53	20.80	25.33	26.13
$S_3V_2P_2$	11.66	16.50	16.60	22.50	26.77	26.87

Contd

Table 2c. continued

Treatment	Spread EW in cm. (months after planting)					
	1	2	3	4	5	6
$S_4V_2P_2$	11.20	13.93	13.60	14.16	17.10	18.00
$S_1V_3P_2$	15.40	19.36	14.83	15.13	14.43	17.57
$S_2V_3P_2$	11.20	20.73	15.13	18.23	20.17	20.57
$S_3V_3P_2$	10.36	20.46	20.70	21.06	22.50	23.97
$S_4V_3P_2$	10.30	21.16	13.80	15.86	18.23	18.53
$S_1V_4P_2$	12.36	12.80	14.23	15.20	18.37	21.27
$S_2V_4P_2$	9.90	12.60	13.03	13.56	15.70	18.00
$S_3V_4P_2$	16.16	19.33	18.40	18.76	24.13	24.97
$S_4V_4P_2$	13.90	13.93	14.26	14.83	16.60	17.27
$S_1V_1P_3$	11.26	12.53	13.93	14.60	15.03	16.23
$S_2V_1P_3$	14.86	14.70	15.46	17.20	17.67	19.10
$S_3V_1P_3$	11.60	12.90	13.66	16.36	17.47	19.63
$S_4V_1P_3$	9.40	10.63	11.36	12.36	12.73	15.47
$S_1V_2P_3$	7.63	10.13	13.33	15.00	15.93	17.67
$S_2V_2P_3$	12.76	13.40	14.86	15.26	19.17	20.97
$S_3V_2P_3$	10.46	13.46	14.56	23.36	18.37	20.27
$S_4V_2P_3$	13.40	13.20	14.16	14.83	16.97	19.57
$S_1V_3P_3$	10.60	11.76	13.96	17.00	18.20	20.47
$S_2V_3P_3$	14.06	14.16	16.93	21.76	23.33	25.43
$S_3V_3P_3$	16.86	17.36	19.40	23.36	23.13	24.77
$S_4V_3P_3$	11.56	11.86	15.43	20.20	20.87	21.97
$S_1V_4P_3$	13.96	16.00	18.40	21.00	22.20	23.97
$S_2V_4P_3$	12.90	16.03	18.70	19.30	19.37	22.23
$S_3V_4P_3$	14.96	17.26	17.76	19.36	19.97	22.67
$S_4V_4P_3$	12.70	14.60	18.20	19.66	20.07	22.93
CD (0.05)	2.34	2.88	3.37	2.88	2.48	0.82

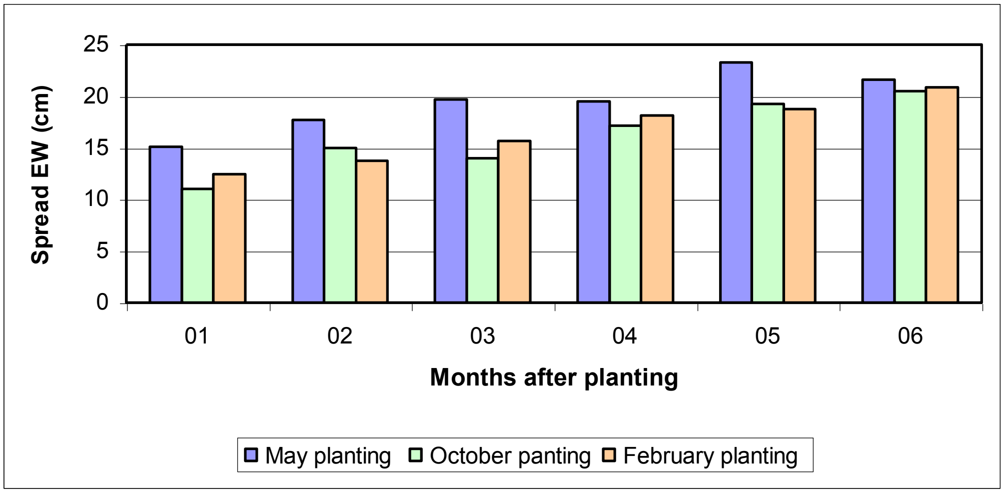


Fig. 4. Effect of planting time on spread EW

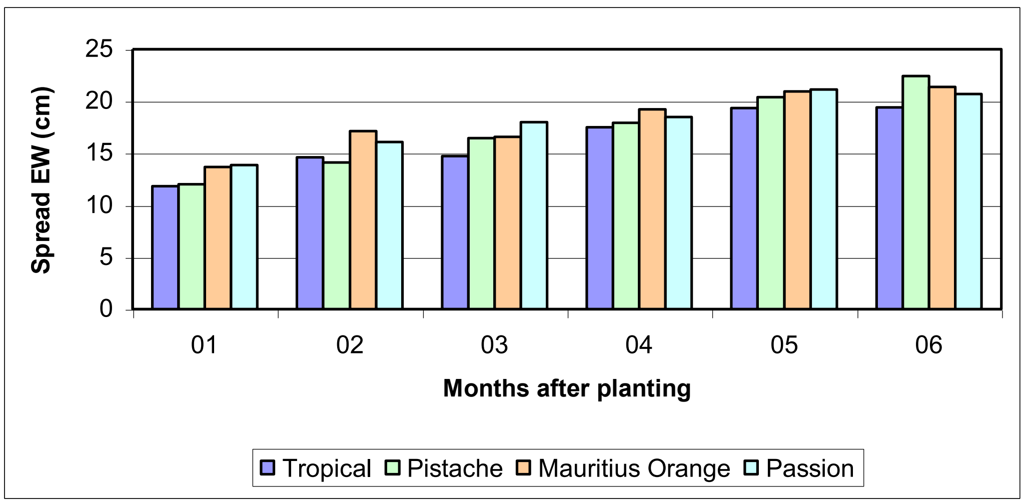


Fig. 5. Effect of variety on spread EW

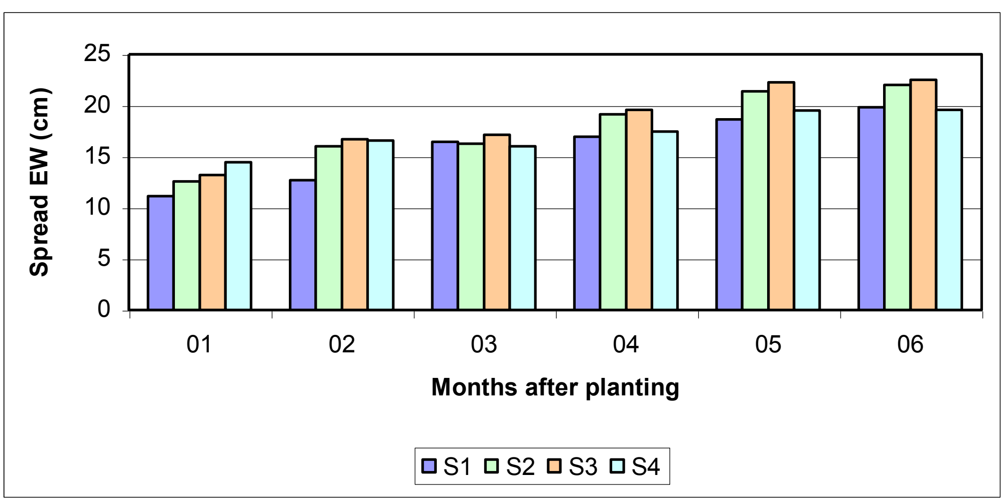


Fig. 6. Effect of structure on spread EW

4.1.3. Plant spread (N S)

Table 3 shows the effects of variety, planting time, growing structure and their interactions on plant spread (NS) of anthurium.

Plant spread differed significantly among varieties, months of planting, growing structures and their interactions.

Among the months of planting mean plant spread (NS) was the highest (21.30 cm) in P_1 (May planting) which was significantly superior to all the other months of planting and the lowest (20.04 cm) was in P_2 (October planting) which was on par with the spread (20.67 cm) in P_3 (February planting).

Among the varieties, the mean plant spread (NS) was the highest (22.26 cm) in the variety V_2 (Pistache) which was significantly superior to that in all other varieties and the lowest (18.93 cm) was in the variety V_1 (Tropical).

Among the growing structures, mean plant spread (NS) was the highest (22.22 cm) in S_2 which was significantly superior to all other structures. The lowest was in S_4 (19.07 cm).

All the interaction effects were significant with respect to plant spread (N S). The interaction effect of variety x planting time showed that P_1V_2 had the highest value of 26.26 cm which was significantly superior to all other treatment combinations. Lowest plant spread was in P_3V_1 (17.55 cm).

The interaction effect of variety x structure showed that S_2V_2, had highest value of 25.13 cm, which was significantly superior to all other treatment combinations. The lower values were recorded in S_4V_1 (16.85 cm) and S_3V_1 (17.66 cm), respectively.

The interaction effect of planting time x structure showed that P2S2 (22.45 cm), P_1S_2 (22.40 cm), P_1S_1 (22.00 cm) and P_3S_3 (21.75 cm) and P_2S_2 (21.82 cm) were on par and had significantly higher values than the other treatment combinations. Plant spread was the lowest in P_3S_4 (10.09 cm).

The interaction effect of variety x planting time x structure showed that $S_2V_2P_1$ had the highest value of 27.67 cm for plant spread. The lowest was in $S_4V_1P_3$ (14.37 cm).

Table 3a. Effects of planting time, variety, growing structure and their interactions on spread N S of *Anthurium andreanum* at monthly interval (Main effects)

Treatment	Spread NS in cm. (months after planting)					
	1	2	3	4	5	6
Planting time						
P1	14.86	17.43	18.86	18.89	24.40	21.30
P2	10.69	15.01	14.10	16.83	18.54	20.04
P_3	13.14	14.15	16.02	18.13	18.66	20.67
CD (0.05)	1.21	0.95	1.08	1.02	0.83	0.66
Variety						
V_1	12.29	14.72	14.17	16.79	19.41	18.93
V_2	12.15	14.25	16.46	18.10	20.13	22.26
V_3	13.33	16.69	16.45	18.09	21.45	20.94
V_4	13.81	16.19	18.23	18.82	21.18	20.65
CD (0.05)	NS	1.09	1.25	1.18	0.96	0.77
Structure						
S_1	10.84	12.56	15.58	16.13	18.90	20.10
S_2	12.87	16.42	16.58	19.10	21.36	22.22
S_3	13.02	16.71	17.04	19.62	22.07	21.38
S_4	14.82	16.43	16.11	16.96	19.85	19.07
CD (0.05)	1.13	0.77	0.85	0.88	0.76	0.62

Table 3b. Effects of planting time, variety, growing structure and their interactions on spread N S of *Anthurium andreanum* at monthly interval (2 way interactions)

Treatment	Spread NS in cm. (months after planting)					
	1	2	3	4	5	6
Planting time x variety						
P_1V_1	14.98	20.7	17.89	19.23	24.69	20.40
P_1V_2	15.59	15.89	20.05	18.40	23.10	26.26
P_1V_3	14.46	16.32	17.53	18.20	25.60	20.01
P_1V_4	14.40	16.80	19.97	19.73	24.35	18.82
P_2V_1	8.53	11.23	11.04	15.94	17.62	18.83
P_2V_2	10.21	14.19	14.73	18.49	20.38	21.72
P_2V_3	11.75	19.77	15.13	16.89	18.45	20.18
P_2V_4	12.25	14.85	15.51	16.02	17.71	19.43
P_3V_1	13.35	12.23	13.58	15.21	15.93	17.55
P_3V_2	10.65	12.69	14.62	17.40	16.92	18.80
P_3V_3	13.78	14.78	16.70	19.19	20.30	22.64
P_3V_4	14.79	16.61	19.20	20.72	21.47	23.69
CD (0.05)	2.42	1.90	2.17	2.05	1.67	1.33
Structure x variety						
S_1V_1	10.72	11.87	12.38	14.47	17.95	18.91
S_2V_1	12.19	15.84	15.55	18.90	20.64	22.28
S_3V_1	9.74	14.45	13.50	17.14	19.82	17.66
S_4V_1	16.50	16.72	15.24	16.67	19.24	16.85
S_1V_2	8.07	9.56	16.32	14.97	18.38	20.40
S_2V_2	12.77	16.82	15.66	19.16	19.88	25.13
S_3V_2	12.36	15.80	17.04	21.60	22.93	23.11
S_4V_2	15.38	14.84	16.84	16.67	19.33	20.41

Contd.

Table 3b. continued

Treatment	Spread NS in cm. (months after planting)					
	1	2	3	4	5	6
S_1V_3	12.25	14.91	13.78	15.67	18.07	20.90
S_2V_3	14.36	17.51	17.25	19.98	23.05	21.22
S_3V_3	14.26	18.42	19.60	20.11	22.76	22.78
S_4V_3	12.45	17.00	15.58	12.61	21.93	18.87
S_1V_4	12.40	13.86	20.24	19.41	21.18	20.18
S_2V_4	12.17	15.52	17.85	18.35	21.85	20.26
S_3V_4	15.71	18.20	18.00	19.64	22.77	21.98
S_4V_4	14.96	17.17	16.78	17.90	18.91	20.15
CD (0.05)	2.28	1.55	1.71	1.77	1.54	1.24
Planting time x structure						
P_1S_1	11.35	13.65	21.33	18.90	22.89	22.00
P_1S_2	14.77	17.49	17.36	19.29	23.46	22.40
P_1S_3	14.90	18.55	17.05	18.96	26.13	21.20
P_1S_4	18.40	20.03	19.67	18.41	25.26	19.89
P_2S_1	10.29	10.94	10.21	12.54	16.16	18.90
P_2S_2	10.30	16.86	15.47	19.65	20.45	21.82
P_2S_3	10.87	16.73	16.76	19.22	20.82	21.20
P_2S_4	11.29	15.51	13.96	15.93	16.74	18.24
P_3S_1	10.94	13.07	15.20	16.95	17.65	19.39
P_3S_2	13.55	14.91	16.90	18.36	20.16	22.45
P_3S_3	13.29	14.87	17.30	20.68	19.26	21.75
P_3S_4	14.78	13.75	14.70	16.53	17.55	10.09
CD (0.05)	1.97	1.34	1.48	1.53	1.33	1.07

Table 3c. Effects of planting time, variety, growing structure and their interactions on spread N S of *Anthurium andreanum* at monthly interval
(3 way interactions)

Treatment	Spread NS in cm. (months after planting)					
	1	2	3	4	5	6
Structure x planting time x variety						
$S_1V_1P_1$	13.10	17.86	18.46	18.43	24.13	25.13
$S_2V_1P_1$	14.16	18.70	17.10	17.56	22.13	22.57
$S_3V_1P_1$	12.00	22.26	17.80	20.93	25.37	18.37
$S_4V_1P_1$	20.66	24.00	18.20	20.00	27.13	15.53
$S_1V_2P_1$	11.10	11.60	26.63	16.66	25.90	26.83
$S_2V_2P_1$	14.43	19.96	16.70	20.10	15.10	27.67
$S_3V_2P_1$	16.73	16.40	15.86	18.76	26.97	24.10
$S_4V_2P_1$	20.10	15.60	21.00	18.10	24.43	26.47
$S_1V_3P_1$	10.06	12.66	12.80	17.90	18.77	20.50
$S_2V_3P_1$	16.43	15.90	17.93	21.76	29.33	20.20
$S_3V_3P_1$	15.93	16.83	17.93	16.90	25.53	22.20
$S_4V_3P_1$	15.43	19.90	21.46	16.26	28.80	17.17
$S_1V_4P_1$	11.16	12.46	27.43	22.63	22.77	15.57
$S_2V_4P_1$	14.06	15.40	17.73	17.73	27.30	19.17
$S_3V_4P_1$	14.93	18.70	16.70	19.26	26.67	20.17
$S_4V_4P_1$	17.43	20.63	18.03	19.30	20.70	20.40
$S_1V_1P_2$	7.43	5.13	5.16	9.86	14.33	14.47
$S_2V_1P_2$	9.15	15.16	17.36	21.36	20.50	24.07
$S_3V_1P_2$	7.16	9.26	8.83	14.80	17.63	16.13
$S_4V_1P_2$	10.40	15.36	15.80	17.73	18.03	20.67
$S_1V_2P_2$	7.20	6.36	9.63	13.33	14.17	17.40
$S_2V_2P_2$	11.33	17.30	16.00	22.10	25.40	26.53
$S_3V_2P_2$	10.33	18.90	9.20	23.03	25.07	25.90
$S_4V_2P_2$	11.96	14.20	14.10	15.50	16.90	17.07

Contd.

Table 3c. continued

Treatment	Spread NS in cm. (months after planting)					
	1	2	3	4	5	6
$S_1V_3P_2$	15.80	20.03	12.36	13.06	18.43	22.73
$S_2V_3P_2$	11.16	20.90	15.86	18.46	18.77	18.63
$S_3V_3P_2$	9.73	20.06	20.83	20.43	19.63	20.47
$S_4V_3P_2$	10.33	18.10	11.46	15.60	17.00	18.90
$S_1V_4P_2$	10.70	12.23	13.70	13.90	17.73	21.00
$S_2V_4P_2$	9.56	14.10	15.66	16.66	17.13	18.07
$S_3V_4P_2$	16.26	8.70	18.20	18.63	20.97	22.33
$S_4V_4P_2$	12.46	14.40	14.50	14.90	15.03	16.33
$S_1V_1P_3$	11.63	12.63	13.53	15.13	15.40	17.13
$S_2V_1P_3$	13.26	13.66	15.20	17.76	19.30	20.23
$S_3V_1P_3$	10.06	11.83	13.86	15.70	16.47	18.50
$S_4V_1P_3$	18.43	10.80	11.73	12.26	12.57	14.37
$S_1V_2P_3$	5.90	10.73	12.70	14.93	15.10	16.97
$S_2V_2P_3$	12.56	13.20	14.30	15.30	19.17	21.20
$S_3V_2P_3$	10.03	12.10	16.06	23.00	16.77	19.33
$S_4V_2P_3$	14.10	14.73	15.43	16.40	16.67	17.70
$S_1V_3P_3$	10.90	12.03	14.96	16.06	17.03	19.47
$S_2V_3P_3$	15.50	15.73	17.96	19.73	21.07	24.83
$S_3V_3P_3$	17.13	18.36	20.03	23.00	23.13	25.70
$S_4V_3P_3$	11.60	13.00	13.83	17.96	20.00	20.57
$S_1V_4P_3$	15.33	16.90	19.60	21.70	23.07	24.00
$S_2V_4P_3$	12.90	17.06	20.16	20.66	21.13	23.57
$S_3V_4P_3$	15.93	17.20	19.23	21.03	20.70	23.47
$S_4V_4P_3$	15.00	16.50	17.83	19.50	21.00	23.73
CD (0.05)	4.00	2.72	3.01	3.113	2.70	0.55

4.1.4. Number of leaves

Table 4 shows the effect of variety, planting time, growing structure and their interactions on number of leaves of anthurium (Fig. 7-9).

Number of leaves differed significantly among varieties, months of planting, growing structures and their interactions.

Among the months of planting mean leaf number was the highest (6.28) in P_3 (February planting) which was significantly superior to all the other months of planting and the lowest (4.55) was in P_2 (October planting) which was on par with the (4.99) in P_1 (May planting).

Among the varieties, the mean leaf number was the highest (5.68) in the variety V_2 (Pistache) which was on par with V_4 (Passion) (5.49) and the lowest (4.81) was in the variety V_3 (Mauritius Orange).

Among the growing structures, mean leaf number S_3 (5.11), S_1 (5.73) and S_4 (5.64) were on par and had significantly higher values. The lowest was in S_2 (4.61).

All the interaction effects were significant with respect to plant spread (N S). The interaction effect of variety x planting time showed that P_3V_2 (6.83), P_3V_1 (6.62) and P_1V_4 (6.29) which were on par and had significantly higher values. Lower values were recorded in P_1V_1 (4.14), P_2V_3 (4.19), P_1V_3 (4.35) and P_2V_4 (4.41) respectively.

The interaction effect of variety x structure showed that S_1V_2 had highest value of 6.64 and this was on par with S_4V_4 (6.36). The lower values were recorded in S_2V_1 (4.24), S_2V_4 (4.47), S_3V_3 (4.64), S_2V_3 (4.77) and S_2V_2 (4.97), respectively.

The interaction effect of planting time x structure showed that P_3S_1 (6.63), P_4S_4 (6.62) and P_3S_3 (6.05) were on par and had significantly higher values than the other treatment combinations. Leaf number had lower values in P_1S_2 (3.93), P_2S_2 (4.11) and P_1S_3 (4.52) which were on par.

The interaction effect of variety x planting time x structure showed that $S_4V_4P_1$ had the highest value of 8.77 for leaf number. The lowest was in $S_4V_3P_1$ (3.00).

Table 4a. Effects of planting time, variety, growing structure and their interactions on [illegible] leaves of *Anthurium andreanum* at monthly interval (Main effects)

Treatment	Number of leaves (months after planting)					
	1	2	3	4	5	6
Planting time						
P_1	6.26	7.89	6.12	5.99	5.93	4.99
P_2	3.80	3.80	3.93	4.22	4.52	4.55
P_3	3.62	4.16	4.83	4.78	4.87	6.28
CD (0.05)	0.24	0.36	0.36	0.34	0.45	0.26
Variety						
V_1	4.40	6.23	4.93	5.40	5.41	5.11
V_2	4.56	5.35	4.90	5.21	5.69	5.68
V_3	4.73	4.75	5.00	4.57	4.85	4.81
V_4	4.53	4.83	5.00	4.81	4.69	5.49
CD (0.05)	NS	0.41	NS	0.39	0.52	0.31
Structure						
S_1	5.12	5.66	5.69	5.65	5.68	5.73
S_2	4.13	5.01	4.33	4.38	4.65	4.61
S_3	4.63	5.13	4.79	4.74	4.87	5.11
S_4	4.35	5.34	5.02	5.21	5.21	5.64
CD (0.05)	0.31	0.36	0.40	0.48	0.41	0.37

Table 4b. Effects of planting time, variety, growing structure and their interactions on number of leaves of *Anthurium andreanum* at monthly interval (2 way interactions)

Treatment	Number of leaves (months after planting)					
	1	2	3	4	5	6
Planting time x variety						
P_1V_1	5.89	10.10	5.47	6.57	5.36	4.14
P_1V_2	6.30	7.89	5.53	5.80	6.49	5.19
P_1V_3	6.49	6.81	6.60	5.54	6.20	4.35
P_1V_4	6.36	6.78	6.89	6.05	5.67	6.29
P_2V_1	3.66	3.83	3.98	4.43	4.94	4.58
P_2V_2	3.75	4.03	4.10	4.43	4.73	5.04
P_2V_3	3.83	3.65	3.75	3.90	4.12	4.19
P_2V_4	3.95	3.70	3.88	4.11	4.28	4.41
P_3V_1	3.65	4.75	5.33	5.19	5.95	6.62
P_3V_2	3.64	4.13	5.08	5.41	5.85	6.83
P_3V_3	3.88	3.79	4.67	4.26	4.23	5.89
P3V4	3.30	3.97	4.23	4.27	3.45	5.77
CD (0.05)	NS	0.72	0.73	NS	0.91	0.54
Structure x variety						
S_1V_1	5.05	6.43	6.02	6.24	6.24	5.38
S_2V_1	3.85	5.44	3.84	4.57	4.08	4.24
S_3V_1	4.80	6.73	5.17	5.34	5.17	5.21
S_4V_1	3.91	6.31	4.67	5.43	6.16	5.62
S_1V_2	5.16	5.18	5.81	6.20	6.24	6.64
S_2V_2	4.05	5.91	4.05	3.83	5.27	4.97
S_3V_2	4.36	4.40	4.71	4.41	5.36	5.24
S_4V_2	4.66	5.91	5.05	6.43	5.88	5.88

Contd.

Table 4b. continued

Treatment	Number of leaves (months after planting)					
	1	2	3	4	5	6
S_1V_3	5.03	5.42	5.43	4.78	5.01	5.13
S_2V_3	4.66	4.40	5.02	4.25	5.34	4.77
S_3V_3	4.78	4.61	5.00	4.75	4.72	4.64
S_4V_3	4.45	4.58	4.57	4.47	4.33	4.70
S_1V_4	5.23	5.63	5.50	5.40	5.24	5.76
S_2V_4	3.96	4.31	4.42	4.86	3.91	4.47
S_3V_4	4.57	4.78	4.30	4.45	4.23	5.36
S_4V_4	4.37	4.55	5.78	4.53	4.48	6.36
CD (0.05)	NS	0.73	0.80	0.97	0.836	0.75
Planting time x structure						
P_1S_1	7.44	8.67	5.47	7.82	7.28	5.92
P_1S_2	5.72	7.48	5.53	4.52	5.40	3.93
P_1S_3	5.97	7.06	6.60	4.97	5.21	4.52
P_1S_4	5.90	8.36	6.89	6.65	5.83	5.60
P_2S_1	4.21	4.05	3.98	4.15	4.69	4.64
P_2S_2	3.29	3.75	4.10	4.20	4.35	4.11
P_2S_3	4.11	3.96	3.75	4.41	4.60	4.76
P_2S_4	3.57	3.45	3.88	4.11	4.42	4.70
P_3S_1	3.70	4.28	5.33	5.00	5.08	6.63
P_3S_2	3.39	3.80	5.08	4.41	4.20	5.80
P_3S_3	3.80	4.36	4.67	4.84	4.80	6.05
P_4S_4	3.57	4.20	4.23	4.89	5.40	6.62
CD (0.05)	0.55	0.63	0.69	0.84	0.72	0.65

Table 4c. Effects of planting time, variety, growing structure and their interactions on number ot leaves of *Anthurium andreanum* at monthly interval (3 way interactions)

Treatment	Number of leaves (months after planting)					
	1	2	3	4	5	6
Structure x planting time x variety						
$S_1V_1P_1$	7.10	10.56	8.56	8.90	6.47	4.37
$S_2V_1P_1$	5.80	9.03	3.10	4.80	3.33	3.10
$S_3V_1P_1$	6.00	10.66	5.00	4.90	5.23	4.23
$S_4V_1P_1$	4.66	10.13	5.23	7.70	6.43	4.87
$S_1V_2P_1$	7.76	7.00	8.20	8.13	8.53	7.67
$S_2V_2P_1$	5.66	10.06	3.13	3.00	5.80	3.67
$S_3V_2P_1$	5.43	4.86	4.03	4.10	4.63	3.67
$S_4V_2P_1$	6.33	9.63	6.76	8.00	7.00	5.77
$S_1V_3P_1$	7.46	8.46	8.03	6.23	6.57	5.00
$S_2V_3P_1$	5.86	5.30	6.00	4.53	8.57	4.77
$S_3V_3P_1$	6.33	6.20	6.00	5.33	5.67	4.67
$S_4V_3P_1$	6.30	7.30	6.36	6.06	4.00	3.00
$S_1V_4P_1$	7.43	8.66	8.56	8.03	7.57	6.67
$S_2V_4P_1$	5.56	5.53	4.90	5.76	3.90	4.20
$S_3V_4P_1$	6.13	6.53	5.56	5.56	5.33	5.53
$S_4V_4P_1$	6.33	6.40	8.53	4.83	5.90	8.77
$S_1V_1P_2$	4.40	4.73	4.73	5.00	5.80	4.97
$S_2V_1P_2$	2.40	3.13	3.20	3.70	4.33	3.80
$S_3V_1P_2$	4.46	3.90	4.23	4.83	4.77	4.90
$S_4V_1P_2$	3.40	3.56	3.76	4.20	4.87	4.67
$S_1V_2P_2$	4.13	4.46	4.40	4.20	4.40	5.10
$S_2V_2P_2$	2.86	3.80	3.86	4.40	4.43	4.53
$S_3V_2P_2$	4.00	4.16	4.60	4.60	5.20	5.30

Contd.

Table 4c. continued

Treatment	Number of leaves (months after planting)					
	1	2	3	4	5	6
$S_4V_2P_2$	4.00	3.70	3.56	4.53	4.90	5.23
$S_1V_3P_2$	3.53	3.86	6.23	3.46	3.97	3.97
$S_2V_3P_2$	4.70	3.93	4.30	4.06	4.00	4.20
$S_3V_3P_2$	3.86	3.73	4.00	4.43	4.60	4.13
$S_4V_3P_2$	3.23	3.10	3.46	3.66	3.93	4.47
$S_1V_4P_2$	4.80	3.13	3.60	3.93	4.60	4.53
$S_2V_4P_2$	3.20	4.16	4.50	4.66	4.67	3.93
$S_3V_4P_2$	4.13	4.06	3.56	3.80	3.87	4.73
$S_4V_4P_2$	3.66	3.46	3.86	4.06	4.00	4.47
$S_1V_1P_3$	3.66	4.00	4.76	4.83	6.47	6.83
$S_2V_1P_3$	3.36	4.16	5.23	5.23	4.60	5.83
$S_3V_1P_3$	3.93	5.63	6.30	6.30	5.53	6.50
$S_4V_1P_3$	3.66	5.23	5.03	4.40	7.20	7.33
$S_1V_2P_3$	3.60	4.10	4.83	6.26	5.80	7.17
$S_2V_2P_3$	3.63	3.86	5.16	4.10	5.60	6.73
$S_3V_2P_3$	3.66	4.16	5.50	4.53	6.27	6.77
$S_4V_2P_3$	3.66	4.40	4.83	6.76	5.77	6.67
$S_1V_3P_3$	4.10	3.93	5.03	4.66	4.50	6.43
$S_2V_3P_3$	3.43	3.96	4.76	4.16	3.47	5.37
$S_3V_3P_3$	4.16	3.90	5.00	4.53	3.90	5.13
$S_4V_3P_3$	3.83	3.36	3.90	3.70	5.07	6.63
$S_1V_4P_3$	3.46	5.10	4.33	4.23	3.57	6.10
$S_2V_4P_3$	3.13	3.23	3.86	4.16	3.17	5.30
$S_3V_4P_3$	3.46	3.76	3.86	4.00	3.50	5.83
$S_4V_4P_3$	3.13	3.80	4.96	4.70	3.57	5.87
CD (0.05)	1.11	1.29	1.41	1.71	1.47	0.33

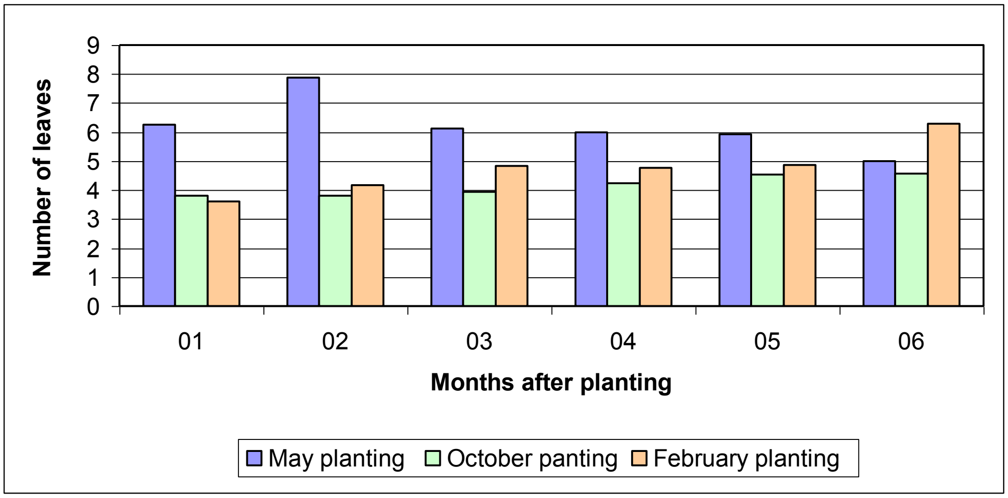


Fig. 7. Effect of planting time on number of leaves in anthurium

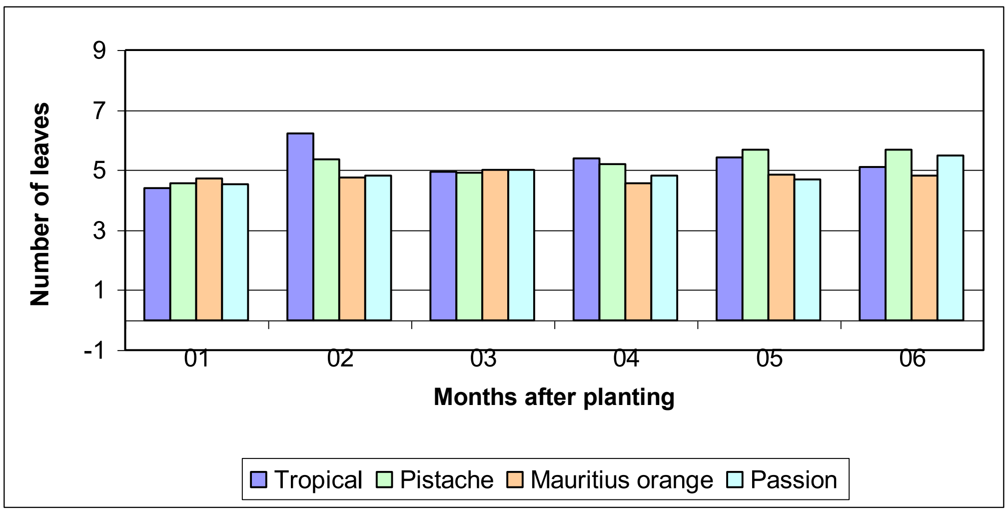


Fig. 8. Effect of variety on number of leaves in anthurium

Fig. 9. Effect of growing structure on number of leaves in anthurium

4.1.5. Leaf length

Table 5 shows the effect of variety, planting time, growing structure and their interactions on leaf length of anthurium.

Leaf length differed significantly among varieties, months of planting, growing structures and their interactions.

Among the months of planting mean leaf length was the highest (13.55 cm) in P_2 (October planting) which was significantly superior to all other months of planting and the lowest (12.31 cm) in P_1 (May planting) which was on par with 12.90 cm in P_3 (October planting).

Among the varieties, the mean leaf length was the highest (13.46 cm) in the variety V_4 (Passion). This was on par with 13.36 cm in V_2 (Pistache) and the lowest (12.08 cm) was in V_1 (Tropical) which was on par with 12.78 cm in V_3 (Mauritius Orange).

Among the growing structures, mean leaf length was the highest (14.48 cm) in S_2 which was significantly superior to all other growing structures and the lowest (11.35 cm) in S_1.

All the interaction effects were significant with respect to leaf length. The interaction effect of variety x planting time showed that P_2V_1 had the highest value of 14.05cm. The lowest was in P_1V_1 (10.97 cm).

The interaction effect of variety x structure showed that S_2V_2 had the highest value of 15.91 cm and this was on par with S_2V_3 (14.61 cm). The lowest was in S_1V_1 (10.5 cm).

The interaction effect of planting time x structure showed that P_1S_2, P_2S_3, P_3S_2, P_2S_2, P_2S_4 and P_3S_3 had the higher values which were on par (14.78 cm, 14.67 cm, 14.44 cm, 14.22 cm, 13.79 cm and 13.65 cm, respectively). The lowest was in P_1S_1 (11.15 cm).

The interaction effect of variety x planting time x structure showed that there was no significant difference among the different treatment combinations with respect to leaf length.

Table 5a. Effects of planting time, variety, growing structure and their interactions on leaf length of *Anthurium andreanum* at monthly interval (Main effects)

Treatment	Leaf length in cm. (months after planting)					
	1	2	3	4	5	6
Planting time						
P_1	8.41	10.05	9.77	10.96	12.08	12.31
P_2	7.50	9.94	10.27	11.20	11.83	13.55
P_3	8.71	9.41	10.38	11.87	12.41	12.90
CD (0.05)	0.32	0.39	0.43	0.59	NS	0.76
Variety						
V_1	7.52	9.317	9.32	10.79	11.15	12.08
V_2	8.21	9.71	10.52	11.50	12.82	13.36
V_3	9.17	10.48	10.47	11.52	12.27	12.78
V_4	7.92	9.70	10.64	11.61	12.19	13.46
CD (0.05)	0.37	0.45	0.50	NS	0.36	0.88
Structure						
S_1	7.00	8.05	8.45	9.62	10.62	11.35
S_2	7.86	10.24	10.82	11.95	12.96	14.48
S_3	8.38	10.49	10.67	12.23	12.88	13.34
S_4	9.58	10.42	11.01	11.62	11.98	12.50
CD (0.05)	0.39	0.49	0.55	0.49	0.37	0.84

Table 5b. Effects of planting time, variety, growing structure and their interactions on leaf length of *Anthurium andreanum* at monthly interval (2 way interactions)

Treatment	Leaf length in cm. (months after planting)					
	1	2	3	4	5	6
			Planting time x variety			
P_1V_1	8.25	10.72	9.75	11.15	11.97	10.97
P_1V_2	8.58	10.60	10.10	9.86	11.93	12.55
P_1V_3	9.46	8.95	8.75	10.58	11.70	12.05
P_1V_4	7.37	9.95	10.49	12.37	12.73	13.69
P_2V_1	6.84	9.34	9.09	11.04	10.79	14.05
P_2V_2	7.47	9.25	11.03	11.42	12.76	13.67
P_2V_3	7.86	11.86	11.37	12.29	12.78	13.38
P_2V_4	7.81	9.30	9.60	10.07	10.98	13.10
P_3V_1	7.48	7.88	9.11	10.19	10.7	11.21
P_3V_2	8.60	9.28	10.42	13.20	13.76	13.85
P_3V_3	10.18	10.64	11.30	11.70	12.33	12.92
P_3V_4	8.57	9.85	11.83	12.39	12.86	13.61
CD (0.05)	0.65	0.78	0.87	1.18	1.08	1.54
				Structure x variety		
S_1V_1	6.34	8.17	9.50	10.30	10.48	10.50
S_2V_1	7.90	9.51	9.92	11.67	12.22	13.11
S_3V_1	6.66	9.21	8.74	10.38	10.98	11.48
S_4V_1	9.17	10.36	9.12	10.82	10.93	13.22
S_1V_2	6.36	7.53	7.45	8.73	11.03	11.62
S_2V_2	7.42	10.81	11.55	12.30	13.36	15.91
S_3V_2	8.87	10.64	10.70	13.13	13.76	12.64
S_4V_2	10.21	9.85	12.37	11.83	13.12	13.26

Contd.

Table 5b. continued

Treatment	Leaf length in cm. (months after planting)					
	1	2	3	4	5	6
S_1V_3	8.82	8.92	8.55	10.37	10.64	10.53
S_2V_3	8.80	10.90	10.87	12.43	13.37	14.61
S_3V_3	9.64	11.22	11.74	13.33	13.94	15.40
S_4V_3	9.42	10.90	10.72	9.96	11.13	10.60
S_1V_4	6.50	7.60	8.30	9.07	10.32	12.77
S_2V_4	7.31	9.75	10.94	11.42	12.87	14.30
S_3V_4	8.36	10.88	11.50	12.08	12.84	13.85
S_4V_4	9.51	10.57	11.83	13.86	12.73	12.94
CD (0.05)	0.78	0.98	1.1	0.98	0.75	1.69
Planting time x structure						
P_1S_1	6.56	7.42	8.11	9.55	10.64	11.15
P_1S_2	7.70	10.91	10.18	11.21	12.49	14.78
P_1S_3	7.94	10.33	9.55	11.10	12.30	11.71
P_1S_4	11.46	11.55	11.25	12.10	12.91	11.61
P_2S_1	6.58	8.35	7.75	9.07	10.33	11.51
P_2S_2	7.69	10.433	11.17	12.13	12.59	14.22
P_2S_3	7.76	11.20	11.37	11.88	12.99	14.67
P_2S_4	7.95	9.77	10.80	11.74	11.40	13.79
P_3S_1	7.87	8.39	9.49	10.23	10.89	11.40
P_3S_2	8.19	9.38	11.11	12.52	13.80	14.44
P_3S_3	9.45	9.94	11.09	13.71	13.36	13.65
P_4S_4	9.31	9.95	10.97	11.02	11.61	12.11
CD (0.05)	0.67	0.85	0.96	0.85	0.65	1.47

Table 5c. Effects of planting time, variety, growing structure and their interactions on leaf length of *Anthurium andreanum* at monthly interval (3 way interactions)

Treatment	Leaf length in cm. (months after planting)					
	1	2	3	4	5	6
Structure x planting time x variety						
$S_1V_1P_1$	6.40	7.80	9.83	10.90	11.00	9.83
$S_2V_1P_1$	7.63	10.36	10.26	10.56	11.10	12.57
$S_3V_1P_1$	7.90	11.23	8.93	12.36	12.73	10.00
$S_4V_1P_1$	11.06	13.50	10.00	10.80	13.07	11.50
$S_1V_2P_1$	5.83	9.13	8.16	7.83	12.17	12.63
$S_2V_2P_1$	7.66	13.43	10.90	10.60	10.10	15.63
$S_3V_2P_1$	10.16	10.7	10.10	10.96	12.93	9.07
$S_4V_2P_1$	10.66	9.10	11.26	10.06	12.53	12.90
$S_1V_3P_1$	8.73	5.96	7.26	10.73	10.07	9.07
$S_2V_3P_1$	8.20	9.76	8.50	12.00	13.80	15.23
$S_3V_3P_1$	8.86	8.66	8.50	9.66	10.40	14.37
$S_4V_3P_1$	12.06	11.40	10.73	9.93	12.57	9.53
$S_1V_4P_1$	5.30	6.80	7.20	8.76	9.33	13.10
$S_2V_4P_1$	7.30	10.10	11.06	11.70	14.97	15.70
$S_3V_4P_1$	4.83	10.73	10.66	11.43	13.13	13.43
$S_4V_4P_1$	12.06	12.16	13.03	17.60	13.50	12.53
$S_1V_1P_2$	5.60	9.40	9.36	9.86	9.67	10.57
$S_2V_1P_2$	7.32	8.50	8.96	12.96	13.67	14.60
$S_3V_1P_2$	5.80	9.96	8.93	9.16	9.90	13.60
$S_4V_1P_2$	8.63	9.50	9.10	12.16	9.93	17.43
$S_1V_2P_2$	5.10	5.26	5.26	8.76	10.83	11.27
$S_2V_2P_2$	8.40	11.67	14.26	13.13	13.47	15.37
$S_3V_2P_2$	8.00	11.83	11.73	12.23	14.93	14.90
$S_4V_2P_2$	8.40	8.13	12.86	11.56	11.83	13.17

Contd.

Table 5c. continued

Treatment	Leaf length in cm. (months after planting)					
	1	2	3	4	5	6
$S_1V_3P_2$	9.13	11.60	8.96	10.20	10.60	10.90
$S_2V_3P_2$	8.26	12.90	12.73	13.40	14.10	15.00
$S_3V_3P_2$	7.26	11.70	13.30	14.13	14.80	15.57
$S_4V_3P_2$	6.80	11.26	10.50	11.43	11.63	12.07
$S_1V_4P_2$	6.50	7.16	7.40	7.46	10.23	13.33
$S_2V_4P_2$	6.76	8.56	8.70	9.03	9.13	11.93
$S_3V_4P_2$	10.00	11.30	11.53	12.00	12.33	14.63
$S_4V_4P_2$	8.00	10.20	10.76	11.80	12.23	12.50
$S_1V_1P_3$	7.03	7.33	9.30	10.13	10.80	11.10
$S_2V_1P_3$	8.76	9.66	10.53	11.50	11.90	12.17
$S_3V_1P_3$	6.30	6.43	8.36	9.63	10.33	10.87
$S_4V_1P_3$	7.83	8.10	8.26	9.50	9.80	10.73
$S_1V_2P_3$	8.16	8.20	8.93	9.60	10.10	10.97
$S_2V_2P_3$	6.20	7.23	9.50	13.16	16.53	16.73
$S_3V_2P_3$	8.46	9.40	10.26	16.20	13.43	13.97
$S_4V_2P_3$	11.56	12.30	13.00	13.86	15.00	13.73
$S_1V_3P_3$	8.60	9.20	9.43	10.20	11.27	11.63
$S_2V_3P_3$	9.93	10.03	11.40	11.90	12.23	13.60
$S_3V_3P_3$	12.80	13.30	13.43	16.20	16.63	16.27
$S_4V_3P_3$	9.40	10.03	10.93	8.53	9.20	10.20
$S_1V_4P_3$	7.70	8.83	10.30	11.00	11.40	11.90
$S_2V_4P_3$	7.86	10.60	13.03	13.53	14.53	15.27
$S_3V_4P_3$	10.26	10.63	12.30	12.83	13.07	13.50
$S_4V_4P_3$	8.46	9.36	11.70	12.20	12.47	13.80
CD (0.05)	1.37	1.72	1.95	1.73	1.33	NS

4.1.6. Leaf breadth

Table 6 shows the effect of variety, planting time, growing structure and their interactions on leaf breadth of anthurium.

Leaf breadth differed significantly among varieties, months of planting, growing structures and their interactions.

Among the months of planting mean leaf breadth was the highest (7.03 cm) in P_2 (October planting) which was significantly superior than all the other months of planting and the lowest (6.64 cm) was in P_3 (February planting) which was on par with the mean leaf breadth (6.68 cm) in P_1 (May planting).

Among the varieties, the mean leaf breadth was the highest (6.94 cm) in the variety V_2 (Pistache) which was on par with 6.87 cm and 6.88 cm, respectively in the varieties V_4 (Passion) and V_3 (Mauritius Orange). The lowest leaf breadth (6.43 cm) was in the variety V_1 (Tropical).

Among the growing structures, mean leaf breadth was the highest (7.62 cm) in S_2 which was significantly superior than that in all other growing structures and the lowest (6.29 cm) in S_1 which was on par with 6.40 cm in S_4.

All the interaction effects were significant with respect to leaf breadth. The interaction effect of variety x planting time showed that P_2V_2, P_2V_1, P_3V_4, P_1V_3 and P_1V_4 had on par higher values of 7.57 cm, 7.22 cm, 7.19 cm, 7.13 cm and 7.11 cm, respectively. The lowest was in P_1V_1 (6.02 cm).

The interaction effect of variety x structure showed that S_2V_3 had the highest value of 8.15 cm and this was on par with S_2V_2 (7.87 cm). The lowest was in S_4V_3 (5.58 cm).

The interaction effect of planting time x structure showed that P_1S_2 had the highest value of 7.93 cm which was on par with P_2S_2 (7.67 cm). The lowest was in P_4S_4 and P_1S_1 (6.17 cm each).

The interaction effect of variety x planting time x structure showed that $S_2V_3P_1$ had the highest value of 9.60 cm with respect to leaf breadth. The lowest was $S_4V_3P_1$ (4.47 cm).

Table 6a. Effects of planting time, variety, growing structure and their interactions on leaf breadth of *Anthurium andreanum* at monthly interval (Main effects)

Treatment	Leaf breadth in cm. (months after planting)					
	1	2	3	4	5	6
Planting time						
P_1	4.89	5.99	5.82	6.45	7.06	6.68
P_2	4.49	5.64	5.65	6.35	6.53	7.03
P_3	4.717	4.89	5.69	6.31	6.65	6.64
CD (0.05)	0.17	0.29	NS	NS	0.37	0.26
Variety						
V_1	4.46	5.03	5.26	6.04	6.44	6.43
V_2	4.71	5.92	5.70	6.51	6.78	6.94
V_3	5.27	5.91	5.90	6.30	6.86	6.87
V_4	4.35	5.71	6.01	6.63	6.90	6.88
CD (0.05)	0.22	0.33	0.42	NS	NS	0.30
Structure						
S_1	4.00	4.58	4.75	5.38	5.94	6.29
S_2	4.82	6.08	6.32	6.97	7.48	7.62
S_3	4.79	5.92	6.19	6.67	7.09	6.82
S_4	5.18	5.45	5.61	6.46	6.47	6.40
CD (0.05)	0.29	0.39	0.38	0.33	0.31	0.30

Table 6b. Effects of planting time, variety, growing structure and their interactions on leaf breadth of *Anthurium andreanum* at monthly interval (2 way interactions)

Treatment	Leaf breadth in cm. (months after planting)					
	1	2	3	4	5	6
Planting time x variety						
P_1V_1	4.80	5.65	6.00	6.60	7.17	6.02
P_1V_2	5.08	7.29	5.93	6.18	6.50	6.46
P_1V_3	5.67	5.30	5.05	6.20	7.16	7.13
P_1V_4	4.00	5.73	6.31	6.84	7.40	7.11
P_2V_1	4.09	5.13	5.12	6.25	6.49	7.22
P_2V_2	4.65	5.47	5.82	6.75	7.16	7.57
P_2V_3	4.85	7.07	6.50	6.61	6.73	6.67
P_2V_4	4.37	4.90	5.15	5.77	5.74	6.35
P_3V_1	4.49	4.31	4.66	5.26	5.67	6.06
P_3V_2	4.41	5.00	5.36	6.60	6.67	6.79
P_3V_3	5.28	5.36	6.15	6.10	6.70	6.51
P_3V_4	4.67	4.88	6.56	7.29	7.56	7.19
CD (0.05)	0.39	0.58	0.73	0.74	0.75	0.52
Structure x variety						
S_1V_1	3.91	4.37	5.15	5.70	5.92	5.92
S_2V_1	4.84	5.12	5.93	7.06	7.52	7.44
S_3V_1	4.05	5.51	5.22	5.68	6.32	6.26
S_4V_1	5.04	5.12	4.75	5.72	6.02	6.12
S_1V_2	3.76	4.30	4.32	5.08	6.16	6.74
S_2V_2	4.58	7.50	6.62	7.15	6.76	7.87
S_3V_2	4.93	6.12	6.32	7.21	7.52	6.50
S_4V_2	5.58	5.77	5.56	6.58	6.66	6.65

Contd.

Table 6b. continued

Treatment	Leaf breadth in cm. (months after planting)					
	1	2	3	4	5	6
S_1V_3	4.88	4.94	4.93	5.68	6.02	6.07
S_2V_3	5.17	6.01	6.27	7.71	7.94	8.15
S_3V_3	5.70	6.63	6.64	6.81	7.17	7.67
S_4V_3	5.32	6.07	5.76	5.61	6.32	5.58
S_1V_4	3.45	4.71	4.62	5.05	5.67	6.42
S_2V_4	4.67	5.70	6.64	6.56	7.68	7.03
S_3V_4	4.50	5.44	6.60	6.97	7.35	6.85
S_4V_4	4.76	4.83	6.35	7.94	6.88	7.23
CD (0.05)	0.59	0.79	0.77	0.67	0.63	0.60
Planting time x structure						
P_1S_1	4.07	4.42	4.77	5.62	6.45	6.17
P_1S_2	4.99	7.59	6.80	7.10	8.03	7.93
P_1S_3	4.68	6.15	5.90	6.46	7.25	6.44
P_1S_4	5.81	5.80	5.82	6.64	6.50	6.19
P_2S_1	3.75	4.85	4.61	5.30	5.56	6.25
P_2S_2	5.00	5.80	6.37	7.09	7.30	7.67
P_2S_3	4.6	6.26	6.33	6.28	6.71	7.36
P_2S_4	4.61	5.65	5.28	6.72	6.54	6.83
P_3S_1	4.18	4.47	4.88	5.22	5.82	6.45
P_3S_2	4.47	4.85	5.80	6.73	7.10	7.27
P_3S_3	5.10	5.35	6.35	7.26	7.31	6.66
P_4S_4	5.10	4.89	5.72	6.03	6.37	6.17
CD (0.05)	0.51	0.68	0.66	0.58	0.55	0.52

Table 6c. Effects of planting time, variety, growing structure and their interactions on leaf breadth of *Anthurium andreanum* at monthly interval (3 way interactions)

Treatment	Leaf breadth in cm. (months after planting)					
	1	2	3	4	5	6
Structure x planting time x variety						
$S_1V_1P_1$	4.03	4.10	5.93	6.46	6.63	5.33
$S_2V_1P_1$	5.06	5.06	7.23	7.60	7.87	7.23
$S_3V_1P_1$	4.70	7.00	5.56	6.83	7.70	5.57
$S_4V_1P_1$	5.43	6.43	5.30	5.53	6.50	5.97
$S_1V_2P_1$	4.13	4.93	4.73	4.76	7.37	7.43
$S_2V_2P_1$	5.00	12.26	7.53	7.00	5.23	7.27
$S_3V_2P_1$	5.80	6.56	6.20	6.43	7.60	4.97
$S_4V_2P_1$	5.40	5.40	5.26	6.53	5.80	6.20
$S_1V_3P_1$	5.30	3.46	4.26	6.20	6.37	6.00
$S_2V_3P_1$	5.20	6.36	5.23	7.50	9.30	9.60
$S_3V_3P_1$	5.26	5.50	5.23	5.46	6.00	8.47
$S_4V_3P_1$	6.93	5.90	5.46	5.63	7.00	4.47
$S_1V_4P_1$	2.83	5.20	4.16	5.06	5.43	5.93
$S_2V_4P_1$	4.70	6.66	7.20	6.30	9.73	7.63
$S_3V_4P_1$	2.96	5.56	6.63	7.13	7.70	6.77
$S_4V_4P_1$	5.50	5.50	7.26	8.86	6.73	8.13
$S_1V_1P_2$	3.26	4.63	4.76	5.50	5.80	6.47
$S_2V_1P_2$	4.54	5.30	5.43	7.63	7.90	8.23
$S_3V_1P_2$	3.70	5.53	5.26	5.30	5.83	7.53
$S_4V_1P_2$	4.86	5.06	5.03	6.60	6.43	6.67
$S_1V_2P_2$	3.03	3.46	3.53	5.46	5.90	6.60
$S_2V_2P_2$	5.46	6.13	7.43	7.83	8.27	8.83
$S_3V_2P_2$	5.06	7.06	7.43	7.23	7.70	7.73
$S_4V_2P_2$	5.06	5.23	4.90	6.46	6.80	7.13

Contd.

Table 6c. continued

Treatment	Leaf breadth in cm. (months after planting)					
	1	2	3	4	5	6
$S_1V_3P_2$	5.10	7.06	5.70	5.60	5.40	5.57
$S_2V_3P_2$	5.46	6.73	7.33	7.20	7.27	7.63
$S_3V_3P_2$	4.56	7.03	7.16	7.00	7.23	7.43
$S_4V_3P_2$	4.30	7.46	5.83	6.66	7.03	7.27
$S_1V_4P_2$	3.63	4.23	4.46	4.63	5.17	6.37
$S_2V_4P_2$	4.53	5.06	5.30	5.70	5.80	6.00
$S_3V_4P_2$	5.10	5.43	5.46	5.60	6.10	6.77
$S_4V_4P_2$	4.23	4.86	5.36	7.10	5.90	6.27
$S_1V_1P_3$	4.43	4.40	4.76	5.10	5.33	5.97
$S_2V_1P_3$	4.93	5.00	5.13	5.96	6.80	6.87
$S_3V_1P_3$	3.76	4.00	4.83	4.93	5.43	5.70
$S_4V_1P_3$	4.83	3.86	3.93	5.03	5.13	5.73
$S_1V_2P_3$	4.13	4.50	4.70	5.03	5.23	6.20
$S_2V_2P_3$	3.30	4.10	4.90	6.63	6.80	7.53
$S_3V_2P_3$	3.93	4.73	5.33	7.96	7.27	6.80
$S_4V_2P_3$	6.30	6.70	6.53	6.76	7.40	6.63
$S_1V_3P_3$	4.26	4.30	4.83	5.26	6.30	6.67
$S_2V_3P_3$	4.86	4.93	6.26	6.63	7.27	7.23
$S_3V_3P_3$	7.26	7.36	7.53	7.96	8.30	7.13
$S_4V_3P_3$	4.73	4.86	6.00	4.53	4.93	5.03
$S_1V_4P_3$	3.90	4.70	5.23	5.46	6.43	6.97
$S_2V_4P_3$	4.80	5.36	6.90	7.70	7.53	7.47
$S_3V_4P_3$	5.43	5.33	7.70	8.20	8.27	7.03
$S_4V_4P_3$	4.56	4.13	6.43	7.80	8.03	7.30
CD (0.05)	1.03	1.38	1.35	1.18	1.12	0.27

4.1.7. Leaf area

Table 7 shows the effects of variety, planting time, growing structure and their interactions on leaf area of anthurium (Fig 10-12).

Leaf area differed significantly among varieties, months of planting, growing structures and their interactions.

Among the months of planting mean leaf area was the highest (67.74 cm^2) in P_2 (October planting) which was significantly superior to all other months of planting and the lowest (61.32 cm^2) in P_1 (May planting) which was on par with (62.70 cm^2) in P_3 (February planting).

Among the varieties, the mean leaf area was the highest (80.22 cm^2) in the variety V_2 (Pistache) which was significantly superior to all other varieties and the lowest (51.91 cm^2) in the variety V_1 (Tropical).

Among the growing structures, mean leaf area was the highest (68.27 cm^2) in S_2. This was on par with 67.20 cm^2 in S_4 and 65.30 cm^2 in S_3 and the lowest (54.91 cm^2), in S_1.

All the interaction effects were significant with respect to leaf area. The interaction effect of variety x planting time showed that P_1V_2, P_2V_2 and P_2V_3 had the highest values of 85.05 cm^2, 79.58 cm^2 and 78.07 cm^2 respectively. The lowest was in P_1V_1 (50.35 cm^2).

The interaction effect of variety x structure showed that S_2V_2 and S_3V_3 had significantly higher values of 90.15 cm^2 and 84.84 cm^2 respectively. Significantly the lower values for leaf area were in S_3V_4, S_1V_1, S_3V_1, S_1V_4 and S_1V_3 (43.64 cm^2, 44.97 cm^2, 46.30 cm^2, 50.59 cm^2 and 52.94 cm^2, respectively).

The interaction effect of planting time x structure showed that P_2S_2, P_3S_4, P_1S_4, P_3S_2 and P_2S_3 had higher values of 75.49 cm^2, 70.86 cm^2, 70.42 cm^2, 68.65 cm^2 and 68.21 cm^2, respectively. The lowest was in P_1S_1 (49.34 cm^2) which was on par with (48.43 cm^2) in P_3S_1.

The interaction effect of variety x planting time x structure showed that $S_3V_2P_1$ had the highest value of 105.65 cm^2. The lowest was in $S_3V_4P_1$ (30.71 cm^2).

Table 7a. Effects of planting time, variety, growing structure and their interactions on leaf area of *Anthurium andreanum* at monthly interval (Main effects)

Treatment	Leaf area in cm^2 (months after planting)					
	1	2	3	4	5	6
Planting time						
P_1	31.11	44.06	42.21	52.77	62.74	61.32
P_2	25.13	42.28	43.81	52.53	56.87	67.74
P_3	30.33	34.28	45.13	55.77	60.90	62.70
CD (0.05)	2.65	3.48	4.07	4.19	4.18	3.90
Variety						
V_1	21.54	27.47	29.54	37.74	45.96	51.90
V_2	26.51	45.34	50.64	60.72	71.20	80.22
V_3	30.68	46.21	49.27	60.14	67.02	67.20
V_4	36.69	41.80	45.14	56.16	56.50	56.35
CD (0.05)	3.06	4.01	4.70	4.84	4.83	4.50
Structure						
S_1	24.06	35.47	36.22	47.73	52.62	54.91
S_2	29.20	42.62	44.93	55.37	63.55	68.27
S_3	36.22	46.15	45.96	53.96	62.35	65.30
S_4	25.94	36.58	47.49	57.70	62.16	67.20
CD (0.05)	3.06	4.01	4.70	4.80	4.83	4.50

Table 7b. Effects of planting time, variety, growing structure and their interactions on leaf area of *Anthurium andreanum* at monthly interval (2 way interactions)

Treatment	Leaf area in cm^2 (months after planting)					
	1	2	3	4	5	6
Planting time x variety						
P_1V_1	20.92	24.03	28.59	39.46	50.52	50.35
P_1V_2	26.70	56.77	50.96	57.74	74.83	85.05
P_1V_3	28.37	46.60	41.51	52.10	64.95	57.16
P_1V_4	48.45	48.83	47.76	61.79	60.66	52.71
P_2V_1	19.11	31.32	26.58	35.13	41.60	52.12
P_2V_2	27.99	45.88	53.36	63.30	68.15	79.58
P_2V_3	26.64	51.53	53.42	54.70	63.98	78.07
P_2V_4	26.81	40.39	41.08	56.99	53.75	61.21
P_3V_1	24.60	27.06	33.46	38.64	45.76	53.26
P_3V_2	24.86	33.38	47.59	61.14	70.61	76.04
P_3V_3	37.05	40.50	52.89	73.62	72.12	66.36
P_3V_4	34.82	36.19	46.57	49.69	55.09	55.13
CD (0.05)	5.30	6.95	8.15	8.38	8.36	7.80
Structure x variety						
S_1V_1	18.18	25.91	35.54	42.49	44.99	44.97
S_2V_1	17.79	24.12	23.89	32.34	49.51	56.98
S_3V_1	33.58	34.07	30.71	42.68	46.67	46.30
S_4V_1	16.62	25.77	28.04	33.46	42.67	59.38
S_1V_2	24.50	36.54	43.36	59.72	66.85	71.13
S_2V_2	25.35	56.42	56.69	64.09	67.04	90.15
S_3V_2	31.60	47.89	50.15	64.00	76.82	36.42
S_4V_2	24.62	40.53	52.34	55.09	74.07	73.18

Contd.

Table 7b. continued

Treatment	Leaf area in cm^2 (months after planting)					
	1	2	3	4	5	6
S_1V_3	19.80	39.38	34.26	43.49	50.76	52.94
S_2V_3	32.03	48.17	49.55	67.92	74.66	62.28
S_3V_3	41.85	54.64	58.31	67.59	73.99	84.84
S_4V_3	29.07	42.65	54.97	61.55	68.05	68.73
S_1V_4	33.78	40.06	31.71	45.21	47.87	50.59
S_2V_4	41.66	41.78	49.58	57.11	63.00	63.66
S_3V_4	37.88	48.01	44.66	41.58	51.91	43.64
S_4V_4	33.47	37.36	54.61	80.71	63.23	67.5
CD (0.05)	6.12	8.03	9.40	9.68	9.66	9.00
Planting time x structure						
P_1S_1	28.83	45.24	42.75	53.30	62.05	48.83
P_1S_2	32.42	53.87	44.01	45.35	56.38	60.66
P_1S_3	39.72	35.73	32.30	48.35	62.30	65.75
P_1S_4	23.48	41.39	49.77	64.06	70.24	70.42
P_2S_1	20.96	36.41	34.22	50.84	51.75	66.96
P_2S_2	26.34	39.18	49.65	57.03	67.92	75.49
P_2S_3	28.08	60.31	54.52	59.35	62.92	68.21
P_2S_4	25.19	33.22	36.06	42.88	45.63	60.31
P_3S_1	22.41	24.77	31.69	39.04	44.06	49.34
P_3S_2	28.86	34.82	41.12	63.70	67.11	68.65
P_3S_3	40.90	42.42	51.06	54.18	61.82	61.94
P_3S_4	29.17	35.13	56.64	66.16	70.60	70.86
CD (0.05)	5.30	6.95	8.15	8.38	8.36	7.80

Table 7c. Effects of planting time, variety, growing structure and their interactions on leaf area of *Anthurium andreanum* at monthly interval (3 way interactions)

Treatment	Leaf area in cm^2 (months after planting)					
	1	2	3	4	5	6
Structure x planting time x variety						
$S_1V_1P_1$	18.82	23.16	42.41	50.90	53.01	37.88
$S_2V_1P_1$	17.38	32.48	27.94	27.07	64.68	67.98
$S_3V_1P_1$	36.50	14.89	22.43	47.88	47.54	39.30
$S_4V_1P_1$	10.99	25.56	21.58	31.95	36.85	56.23
$S_1V_2P_1$	26.32	38.06	53.89	58.26	63.58	66.44
$S_2V_2P_1$	27.58	95.22	59.13	53.92	38.01	81.81
$S_3V_2P_1$	28.11	45.03	32.24	65.67	92.72	105.65
$S_4V_2P_1$	24.78	48.77	58.58	53.07	104.99	86.28
$S_1V_3P_1$	26.73	56.94	36.45	60.54	70.38	40.08
$S_2V_3P_1$	42.79	52.08	46.09	50.84	70.74	35.32
$S_3V_3P_1$	33.57	34.34	32.24	38.18	44.94	87.32
$S_4V_3P_1$	10.38	43.02	51.24	58.81	73.74	65.90
$S_1V_4P_1$	43.44	62.8	38.23	43.49	61.20	49.31
$S_2V_4P_1$	41.91	35.68	42.86	49.62	52.05	57.53
$S_3V_4P_1$	60.70	48.63	42.27	41.66	64.00	30.71
$S_4V_4P_1$	47.76	48.18	67.67	112.40	65.38	73.25
$S_1V_1P_2$	13.23	31.29	32.28	39.11	40.47	49.15
$S_2V_1P_2$	11.54	13.22	13.33	35.04	46.10	53.64
$S_3V_1P_2$	34.58	58.86	37.03	41.46	41.46	43.59
$S_4V_1P_2$	17.07	21.90	23.66	24.89	38.36	62.08
$S_1V_2P_2$	24.30	36.78	35.71	71.42	78.48	86.70
$S_2V_2P_2$	33.69	52.73	77.38	74.93	82.19	97.94
$S_3V_2P_2$	31.80	62.91	66.79	69.47	73.79	82.35
$S_4V_2P_2$	22.15	31.07	33.53	37.35	38.13	51.32

Contd.

Table 7c. Continued

Treatment	Leaf area in cm^2 (months after planting)					
	1	2	3	4	5	6
$S_1V_3P_2$	15.57	42.83	35.48	35.12	41.66	74.04
$S_2V_3P_2$	29.42	60.34	63.12	63.97	82.91	82.93
$S_3V_3P_2$	24.79	59.05	69.82	71.43	77.40	83.71
$S_4V_3P_2$	36.77	43.91	45.26	48.26	53.92	71.58
$S_1V_4P_2$	30.71	34.71	33.38	57.70	46.38	57.94
$S_2V_4P_2$	30.71	30.44	44.76	54.18	57.50	67.44
$S_3V_4P_2$	21.05	60.40	44.41	55.05	59.02	63.17
$S_4V_4P_2$	24.76	35.99	41.77	61.01	52.08	56.26
$S_1V_1P_3$	22.49	23.27	31.92	37.44	41.48	47.89
$S_2V_1P_3$	24.44	26.67	30.39	34.88	37.74	49.31
$S_3V_1P_3$	29.63	28.46	32.67	38.69	51.00	56.00
$S_4V_1P_3$	21.81	29.83	38.86	43.52	52.80	59.81
$S_1V_2P_3$	22.87	34.75	40.47	49.46	58.49	60.25
$S_2V_2P_3$	14.77	21.30	33.56	63.41	80.91	90.70
$S_3V_2P_3$	34.88	35.71	51.41	56.85	63.54	71.25
$S_4V_2P_3$	26.93	41.74	64.91	74.82	79.07	81.94
$S_1V_3P_3$	17.10	18.37	30.83	34.81	40.22	44.67
$S_2V_3P_3$	23.87	32.07	39.43	88.95	70.33	68.58
$S_3V_3P_3$	67.17	70.52	72.87	93.14	99.62	83.48
$S_4V_3P_3$	40.05	41.02	68.41	77.56	78.28	68.70
$S_1V_4P_3$	27.18	22.66	23.51	34.44	36.02	44.52
$S_2V_4P_3$	52.35	59.20	61.10	67.54	79.44	65.98
$S_3V_4P_3$	31.89	34.99	47.27	28.04	32.69	37.01
$S_4V_4P_3$	27.87	27.90	54.37	68.72	72.22	72.97
CD (0.05)	10.61	13.91	16.29	16.77	16.73	15.59

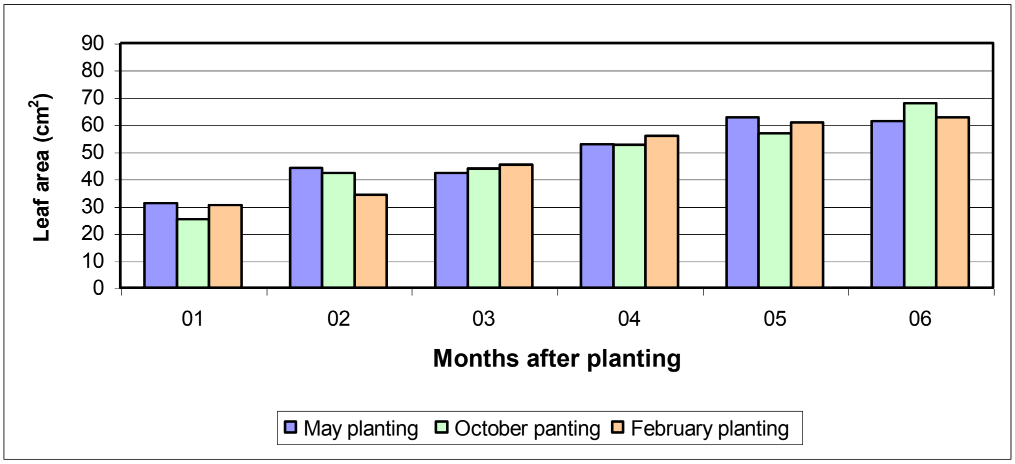


Fig. 10. Effect of planting time on leaf area in anthurium

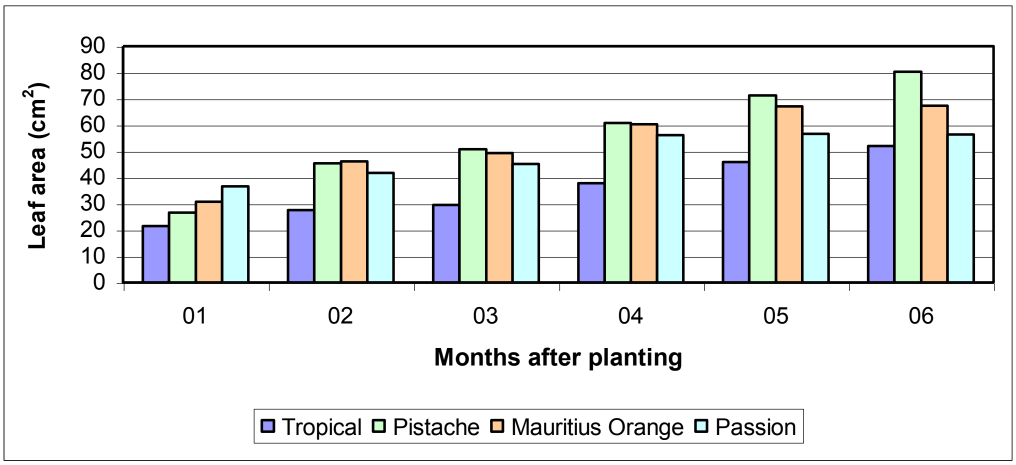


Fig. 11. Effect of variety on leaf area in anthurium

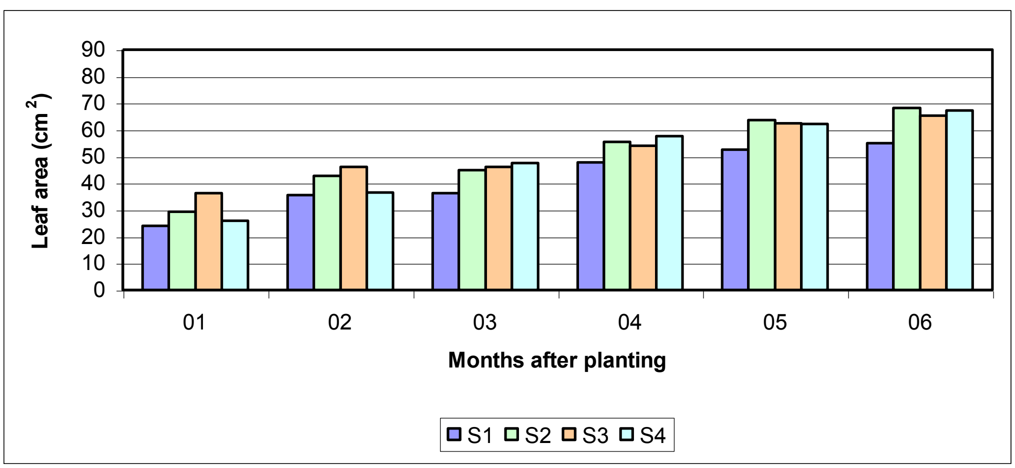


Fig. 12. Effect of growing structure on leaf area in anthurium

4.1.8. Petiole length

Table 8 shows the effects of variety, planting time, growing structure and their interactions on petiole length of anthurium (Fig. 13-15).

Length of the petiole differed significantly among varieties, months of planting, growing structures and their interactions.

Among the months of planting mean length of petiole was the highest (16.79 cm) in P_3 (February planting) which was significantly superior to all other months of planting and the lowest was (13.75 cm) in P_2 (October planting).

Among the varieties, the mean length of petiole was the highest (15.73 cm) in the variety V_4 (Passion) which was significantly superior to all the other varieties. The lowest (13.58 cm) was in the variety V_1 (Tropical).

Among the growing structures, mean petiole length was the highest (16.67 cm) in S_3 (Low cost growing structure) which was significantly superior to that in all other growing structures and the lowest (13.47 cm) in S_4 which was on par with 13.98 cm S_1.

All the interaction effects were significant with respect to petiole length. The interaction effect of variety x planting time showed that P_3V_3 had the highest value of 18.37 cm but this was on par with P_3V_4 (17.77 cm). The lowest value was in P_2V_1 (10.78 cm).

The interaction effect of variety x structure showed that S_3V_3 and S_3V_4 had significantly higher values of 18.62 cm and 18.48 cm, respectively. The lowest was in S_4V_1 (11.64 cm).

The interaction effect of planting time x structure showed that P_3S_3 had the highest value of 19.98 cm which was significantly superior to all other treatment combinations. The lowest were in P_2S_4, P_1S_4 and P_2S_1 of 12.26, 12.39 and 12.82 cm respectively.

The interaction effect of variety x planting time x structure showed that $S_3V_3P_3$ had the highest value of 24.00 cm with respect to petiole length. The lowest was in $S_1V_1P_2$ (8.27 cm).

Table 8a. Effects of planting time, variety, growing structure and their interactions on petiole length of *Anthurium andreanum* at monthly interval (Main effects)

Treatment	Petiole length in cm. (months after planting)					
	1	2	3	4	5	6
Planting time						
P_1	8.27	10.37	11.65	13.45	15.51	14.41
P_2	8.16	9.61	10.38	11.80	12.74	13.75
P_3	7.64	9.76	11.038	11.85	12.71	16.79
CD (0.05)	0.36	0.48	0.83	0.65	0.71	0.52
Variety						
V_1	6.35	8.52	10.42	11.70	12.87	13.58
V_2	7.80	8.76	11.16	12.11	12.61	14.95
V_3	9.12	9.77	11.02	13.06	14.61	15.65
V_4	8.83	10.28	11.48	12.6	14.52	15.73
CD (0.05)	0.42	0.55	NS	0.76	0.82	0.61
Structure						
S_1	5.43	6.74	9.13	11.33	12.15	13.98
S_2	8.55	10.44	11.48	12.81	13.86	15.79
S_3	9.60	11.76	12.83	14.64	16.06	16.67
S_4	8.51	9.40	10.64	10.69	12.54	13.47
CD (0.05)	0.52	0.67	0.75	0.79	0.64	0.49

Table 8b. Effects of planting time, variety, growing structure and their interactions on petiole length of *Anthurium andreanum* at monthly interval (2 way interactions)

Treatment	Petiole length in cm. (months after planting)					
	1	2	3	4	5	6
Planting time x variety						
P_1V_1	7.07	10.47	12.15	13.50	16.16	14.22
P_1V_2	8.95	10.69	12.45	14.02	14.26	15.03
P_1V_3	8.24	9.05	10.05	13.92	15.89	14.15
P_1V_4	8.83	11.27	11.95	12.38	15.72	14.23
P_2V_1	5.62	6.91	8.08	10.41	10.36	10.78
P_2V_2	7.90	9.85	10.08	11.27	12.77	14.61
P_2V_3	9.74	10.33	11.51	12.79	13.75	14.43
P_2V_4	7.40	10.39	11.06	12.71	14.07	15.19
P_3V_1	6.36	8.19	11.03	11.18	12.09	15.75
P_3V_2	6.54	8.76	10.19	11.05	10.80	15.20
P_3V_3	9.40	9.92	11.49	12.49	14.18	18.37
P_3V_4	8.25	9.20	11.43	12.70	13.77	17.77
CD (0.05)	0.73	0.96	1.68	1.32	1.43	1.06
Structure x variety						
S_1V_1	4.96	6.78	8.47	11.60	11.95	13.38
S_2V_1	7.25	10.46	11.47	13.02	14.25	16.03
S_3V_1	5.70	8.78	10.20	11.74	14.12	13.28
S_4V_1	7.50	8.06	11.53	10.43	11.14	11.64
S_1V_2	4.67	6.23	10.87	9.61	11.65	14.06
S_2V_2	7.98	10.12	11.11	12.87	11.21	15.02
S_3V_2	8.88	12.40	12.02	14.74	15.45	16.28
S_4V_2	9.64	10.32	10.66	11.24	12.14	14.43

Contd.

Table 8b. continued

Treatment	Petiole length in cm. (months after planting)					
	1	2	3	4	5	6
S_1V_3	5.93	6.97	8.32	11.44	13.27	14.36
S_2V_3	11.13	11.04	11.98	13.96	15.42	16.46
S_3V_3	11.46	12.24	14.24	15.07	17.04	18.62
S_4V_3	7.97	8.82	9.53	11.78	12.70	13.15
S_1V_4	6.16	6.97	8.85	12.68	11.73	14.13
S_2V_4	7.84	10.13	11.37	11.38	14.54	15.64
S_3V_4	12.36	13.62	14.86	17.00	17.62	18.48
S_4V_4	8.95	10.42	10.83	9.32	14.20	14.66
CD (0.05)	1.04	1.36	1.50	1.58	1.29	0.98
Planting time x structure						
P_1S_1	4.85	7.10	9.52	13.40	14.87	14.43
P_1S_2	8.74	11.15	12.08	14.57	15.41	17.17
P_1S_3	9.20	11.82	12.28	14.83	16.84	13.64
P_1S_4	10.3	11.42	12.72	11.01	14.91	12.39
P_2S_1	5.69	7.20	8.58	10.86	11.40	12.82
P_2S_2	9.01	10.15	10.92	12.29	13.10	13.54
P_2S_3	10.33	12.05	12.82	13.75	15.35	16.39
P_2S_4	7.64	8.08	9.19	10.28	11.10	12.26
P_3S_1	5.76	5.93	9.29	9.73	10.18	14.78
P_3S_2	7.91	10.01	11.45	11.57	13.06	16.65
P_3S_3	9.27	11.41	13.39	15.33	15.99	19.98
P_4S_4	7.60	8.71	10.00	10.79	11.61	15.76
CD (0.05)	0.90	1.18	1.30	0.72	1.11	0.84

Table 8c. Effects of planting time, variety, growing structure and their interactions on petiole length of *Anthurium andreanum* at monthly interval (3 way interactions)

Treatment	Petiole length in cm. (months after planting)					
	1	2	3	4	5	6
Structure x planting time x variety						
$S_1V_1P_1$	4.56	8.33	10.56	15.56	17.37	17.57
$S_2V_1P_1$	8.46	12.26	12.26	13.83	16.60	17.77
$S_3V_1P_1$	7.00	12.80	12.70	13.13	17.90	11.50
$S_4V_1P_1$	8.26	8.50	13.06	11.46	12.80	10.07
$S_1V_2P_1$	5.56	7.46	11.96	11.56	16.23	17.13
$S_2V_2P_1$	7.76	10.36	12.90	16.53	10.00	16.57
$S_3V_2P_1$	10.30	12.50	12.06	13.96	15.63	11.90
$S_4V_2P_1$	12.20	12.43	12.90	14.03	15.20	14.53
$S_1V_3P_1$	5.00	5.93	7.53	13.00	15.43	12.00
$S_2V_3P_1$	9.63	10.10	11.00	15.50	16.90	17.30
$S_3V_3P_1$	10.10	10.33	11.00	14.40	16.17	16.23
$S_4V_3P_1$	8.23	9.86	10.70	12.80	15.07	11.07
$S_1V_4P_1$	4.26	6.66	8.03	13.50	10.47	11.03
$S_2V_4P_1$	9.10	11.86	12.16	12.43	18.17	17.07
$S_3V_4P_1$	9.43	11.66	13.36	17.83	17.67	14.93
$S_4V_4P_1$	12.53	14.90	14.23	5.76	16.60	13.90
$S_1V_1P_2$	3.86	5.36	5.56	9.23	7.37	8.27
$S_2V_1P_2$	6.34	8.46	9.90	12.63	13.30	13.57
$S_3V_1P_2$	4.40	5.63	6.46	9.76	10.47	10.67
$S_4V_1P_2$	7.90	8.20	10.40	10.03	10.33	10.63
$S_1V_2P_2$	4.86	5.53	8.56	7.50	8.73	10.80
$S_2V_2P_2$	8.90	12.03	12.30	13.90	14.30	14.70
$S_3V_2P_2$	9.20	12.50	12.46	13.56	17.53	19.63
$S_4V_2P_2$	8.63	9.33	10.10	10.13	10.53	13.33

Contd.

Table 8c. Continued

Treatment	Petiole length in cm. (months after planting)					
	1	2	3	4	5	6
$S_1V_3P_2$	7.76	9.13	10.80	13.36	15.57	16.27
$S_2V_3P_2$	12.80	11.86	12.66	13.43	13.67	13.90
$S_3V_3P_2$	11.93	13.50	15.10	14.13	15.43	15.63
$S_4V_3P_2$	6.46	6.83	7.50	10.23	10.37	11.93
$S_1V_4P_2$	6.26	8.76	9.40	13.36	13.97	15.97
$S_2V_4P_2$	8.00	8.26	8.83	9.20	11.17	12.00
$S_3V_4P_2$	15.80	16.56	17.26	17.56	17.97	19.63
$S_4V_4P_2$	7.56	7.96	8.76	10.73	13.20	13.17
$S_1V_1P_3$	6.46	6.66	9.30	10.00	11.13	14.33
$S_2V_1P_3$	6.96	10.66	12.26	12.60	12.93	16.77
$S_3V_1P_3$	5.70	7.93	11.43	12.33	14.00	17.70
$S_4V_1P_3$	6.33	7.50	11.13	9.80	10.30	14.23
$S_1V_2P_3$	3.60	5.70	12.1	9.76	10.00	14.27
$S_2V_2P_3$	7.30	7.96	8.13	8.20	9.33	13.80
$S_3V_2P_3$	7.16	12.2	11.53	16.70	13.20	17.33
$S_4V_2P_3$	8.10	9.20	9.00	9.56	10.70	15.43
$S_1V_3P_3$	5.03	5.86	6.63	7.96	8.83	14.83
$S_2V_3P_3$	10.96	11.16	12.30	12.96	15.70	18.20
$S_3V_3P_3$	12.36	12.90	16.63	16.70	19.53	24.00
$S_4V_3P_3$	9.23	9.76	10.40	12.33	12.67	16.47
$S_1V_4P_3$	7.96	5.50	9.13	11.20	10.77	15.40
$S_2V_4P_3$	6.43	10.26	13.13	12.53	14.30	17.87
$S_3V_4P_3$	11.86	12.63	13.96	15.60	17.23	20.90
$S_4V_4P_3$	6.76	8.40	9.50	11.46	12.80	16.93
CD (0.05)	1.82	2.38	2.64	2.78	2.27	0.43

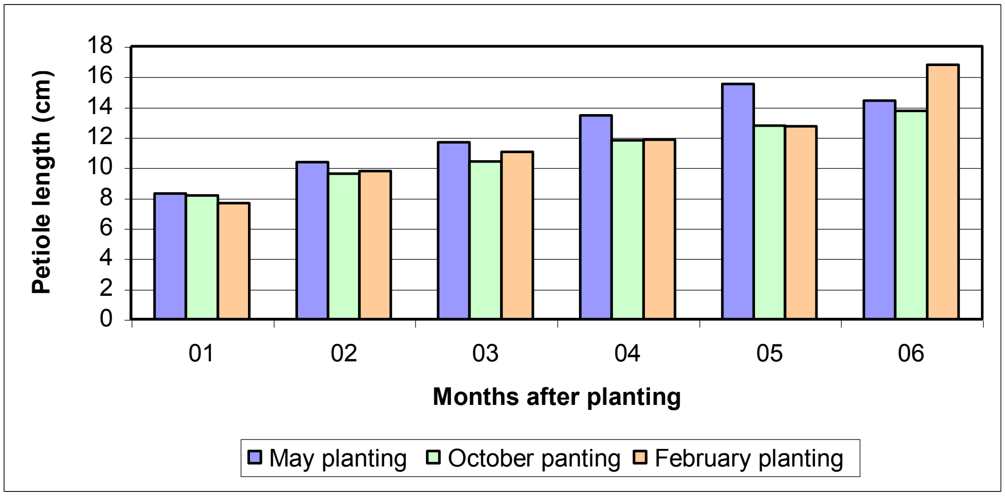


Fig. 13. Effect of planting time on petiole length in anthurium

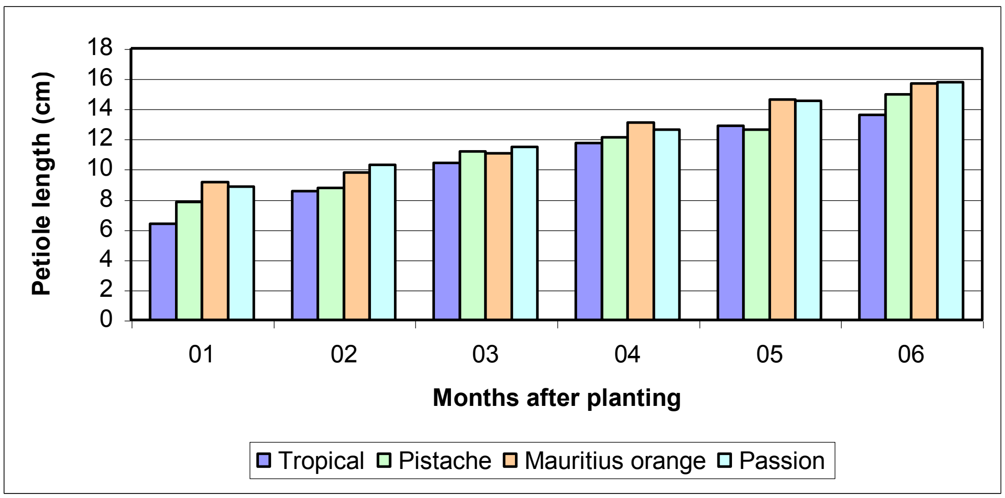


Fig. 14. Effect of variety on petiole length in anthurium

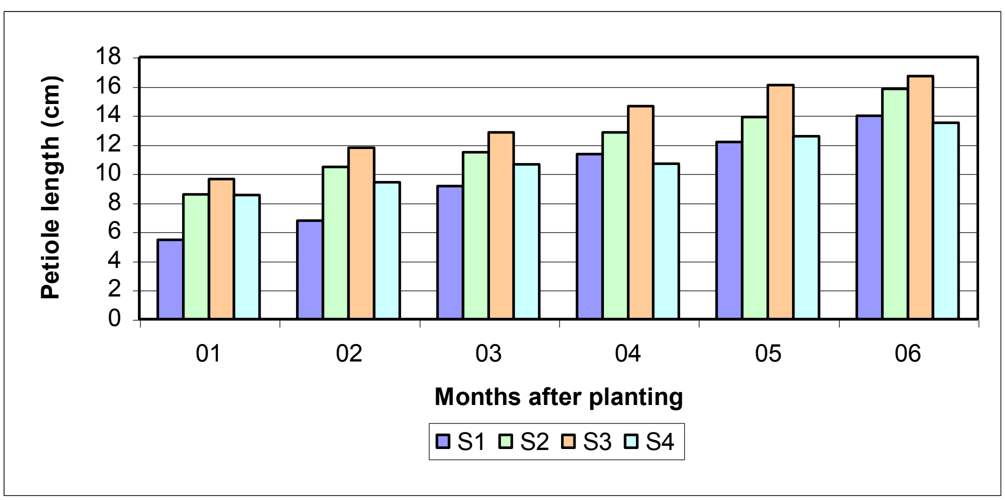


Fig. 15. Effect of structure on petiole length in anthurium

4.2. EFFECTS OF VARIETY, GROWING STRUCTURE AND THEIR INTERACTIONS ON LEAF LONGEVITY AND LEAF PRODUCTION INTERVAL IN *Anthurium andreanum*.

Leaf longevity and leaf production interval were observed for one year in four varieties of anthurium grown in four growing structures. The effects of variety, growing structure and their interactions on leaf longevity and leaf production interval are presented in Table 9 and Fig. 16-19.

4.2.1. Leaf longevity

Leaf longevity differed significantly among varieties, growing structures and their interactions (Table 9).

Among the varieties, the highest longevity was recorded for the variety V_3 (Mauritius Orange) (177.36 days) which was on par with V_2 (Pistache) (165.32days). The lowest (94.92 days) was in the variety V_4 (Passion).

Among the growing structures, the highest longevity was recorded in S_3 (190.89days) which was significantly superior to that in all other growing structures and the lowest (118.08 days) in S_2.

The interaction effect of variety x structure showed that S_3V_4, S_1V_3, S_2V_3, S_3V_3 and S_2V_4 had significantly higher values of 220.46 days, 195.33 days, 191.96 days, 200.46 days and 209.90 days respectively. The lowest was in S_4V_4 (65.10 days) but this was on par with S_4V_2 (65.30 days), S_4V_1 (73.50 days), S_1V_2 (85.53 days) and S_4V_1 (73.50 days).

Table 9a. Effects of variety, growing structure and their interactions on leaf longevity and leaf production interval on *Anthurium andreanum* (Main effects)

Treatment	Plant characters	
	Leaf longevity (days)	Leaf production interval (days)
Variety		
V_1	152.43	31.96
V_2	165.32	33.45
V_3	177.36	37.40
V_4	94.92	33.44
CD (0.05%)	16.86	0.99
Structure		
S_1	120.28	33.09
S_2	118.08	34.67
S_3	190.89	33.80
S_4	160.79	34.71
CD (0.05%)	16.86	0.99

Table 9b. Effects of variety, growing structure and their interactions on leaf longevity and leaf production interval on *Anthurium andreanum*
(2 way interactions)

Treatment	Plant characters	
	Leaf longevity (days)	Leaf production interval (days)
Structure x variety		
S_1V_1	181.16	33.28
S_2V_1	119.50	33.99
S_3V_1	106.96	34.81
S_4V_1	73.50	30.26
S_1V_2	85.53	31.24
S_2V_2	139.93	33.49
S_3V_2	181.56	41.56
S_4V_2	65.30	32.37
S_1V_3	195.33	30.76
S_2V_3	191.96	35.87
S_3V_3	200.46	33.61
S_4V_3	175.80	34.96
S_1V_4	147.70	32.58
S_2V_4	209.90	30.46
S_3V_4	220.46	39.64
S_4V_4	65.10	36.15
CD (0.05%)	33.72	1.97

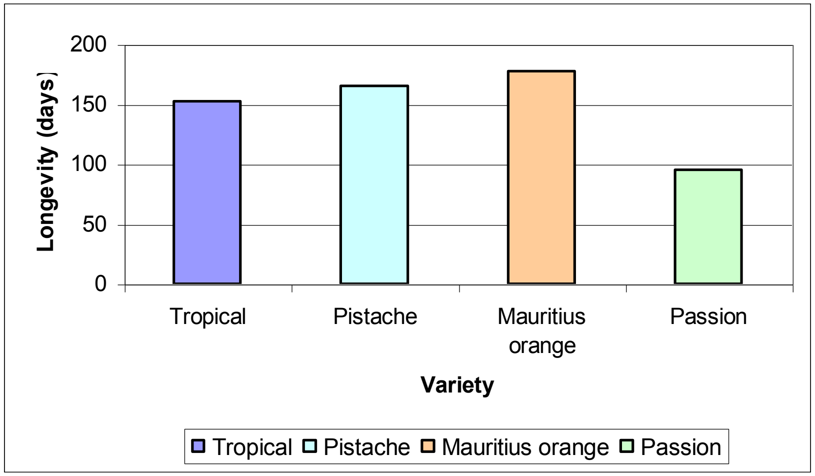


Fig. 16. Effect of variety on leaf longevity (days) in anthurium

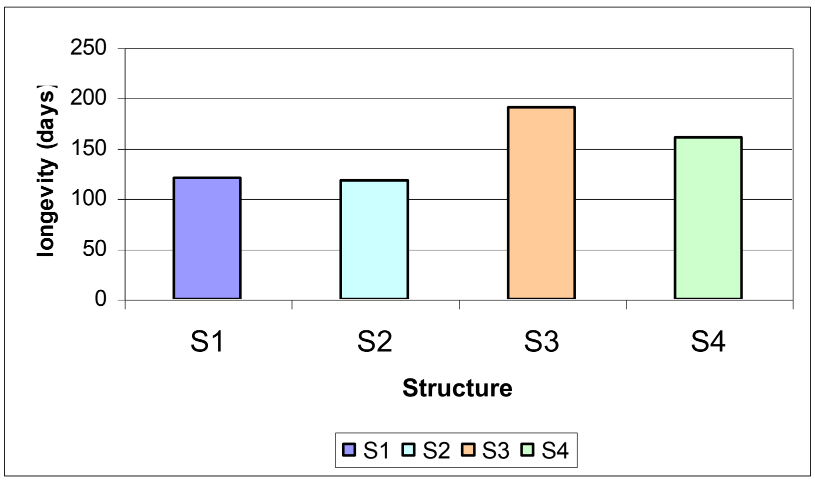


Fig. 17. Effect of structure on leaf longevity (days) in anthurium

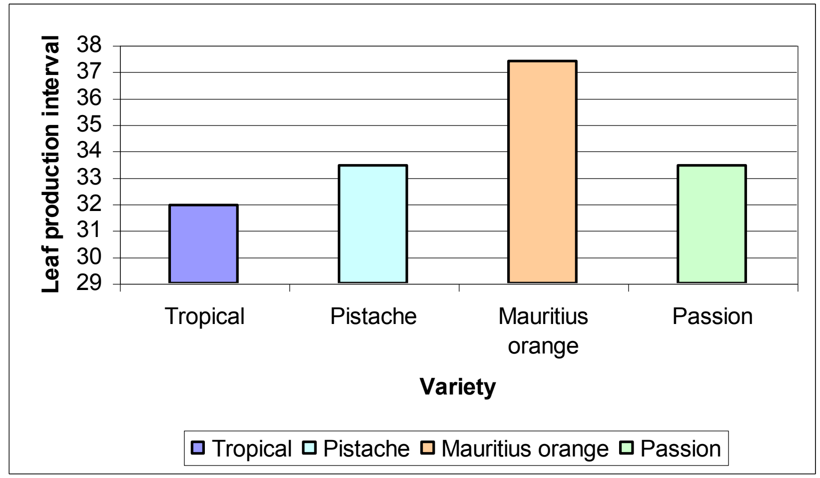


Fig. 18. Effect of variety on leaf production interval in anthurium

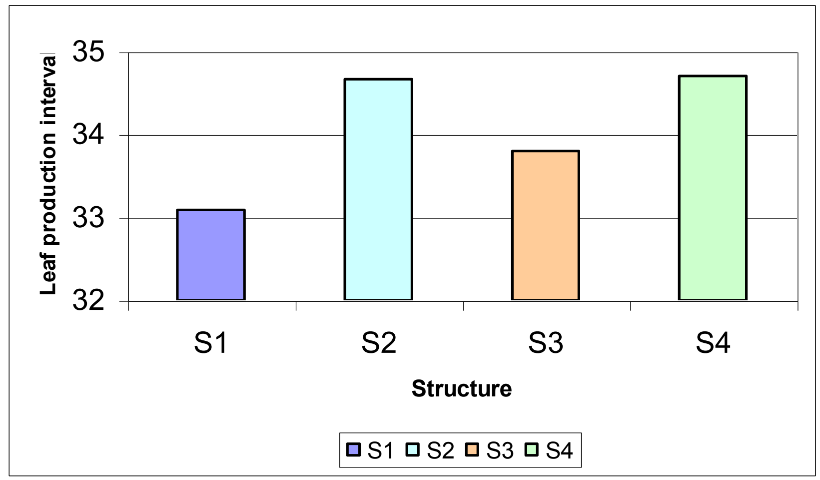


Fig. 19. Leaf production interval in anthurium

4.2.2. Leaf production interval

Leaf production interval differed significantly among varieties, growing structures and their interactions (Table 9).

Among the varieties, the mean leaf production interval was lowest for the variety V_1 (Tropical, 31.96 days) which was significantly superior to all other varieties. The longest leaf production interval was recorded for the variety V_3 (Mauritius Orange, 37.407days).

Among the growing structures, the lowest leaf production interval was recorded in S_1 (33.09days) which was on par with S_3 (33.80days) and highest leaf production interval was recorded in S_4 (34.71days) which was on par with S_2 (34.67days).

The interaction effect of variety x structure showed that S_4V_1, (30.26days), S_1V_2 (31.24 days), S_1V_3 (30.76 days) and S_2V_4 (30.46 days) had lower values which were on par. The highest value was recorded for S_3V_2 (41.56 days) which was on par with S_3V_4 (39.64 days).

4.3. EFFECTS OF PLANTING TIME, VARIETY AND GROWING STRUCTURE ON DAYS TO FLOWERING AND FLOWER CHARACTERS OF *Anthurium andreanum*

Data pertaining to the effects of planting time, variety and growing structure on days to flowering and flower characters of anthurium are presented in Tables 10 to 14. Days to fist flowering were observed in four varieties planted in May and October and grown in four growing structures and the floral characters were recorded in four varieties planted in May and grown in four growing structures.

4.3.1. Effects of planting time, variety and growing structure on days to flowering in *Anthurium andreanum*

The data pertaining to the effects of planting time, variety, growing structure and their interactions on days to flowering in anthurium are presented in Table 10.

Days taken to first flowering differed significantly among varieties, months of planting, growing structures and their interactions.

Among the two months of planting the number of days for first flowering was the lowest (52.56 days) in P_2 (October) and the highest (74.56 days) in P_1 (May).

Among the varieties, the number of days for first flowering was lowest (35.08 days) in V_4 (Passion) which was significantly lower to all other varieties and the highest (82.75 days) in V_1 (Tropical).

Among the growing structures, the number of days for first flowering was lowest (43.71 days) in S_2 which was significantly lower than all other structures and the highest (78.96 days) in S_1.

All the interaction effects were significant with respect to flowering. The interaction effect of variety x planting time showed that P_1V_2 had the lowest value (62.75 days) and the highest was P_1V_1 (97.17 days).

The interaction effect of variety x structure showed that S_3V_4, S_2V_4 and S_4V_4 had lower values (31.00, 31.33 and 35.00 days, respectively). The highest was in S_1V_1 (102.17 days).

The interaction effect of planting time x structure showed that P_2S_2 and P_1S_2 had the lower values (43.17 and 44.25 days respectively) and the highest was in P_1S_1 (89.83 days)

Table 10a. Effects of variety, growing structure and their interactions on days to first flowering in *Anthurium andreanum* (Main effects)

Treatment	Days to flowering
Planting time	
P_1	74.56
P_2	52.56
CD (0.05%)	2.30
Variety	
V_1	82.75
V_2	65.67
V_3	70.75
V_4	35.08
CD (0.05%)	3.25
Structure	
S_1	78.96
S_2	43.71
S_3	62.96
S_4	68.63
CD (0.05%)	3.25

Table 10b. Effects of variety, growing structure and their interactions on days to first flowering in *Anthurium andreanum* (2 way interactions)

Treatment	Days to flowering
Planting time x variety	
P_1V_1	97.17
P_1V_2	62.75
P_1V_3	68.17
P_1V_4	70.17
P_2V_1	68.33
P_2V_2	68.58
P_2V_3	73.33
P_2V_4	0.00
CD (0.05%)	4.60

Contd.

Table 10b. continued

Treatment	Days to flowering
Structure x variety	
S_1V_1	102.17
S_2V_1	50.67
S_3V_1	84.00
S_4V_1	94.17
S_1V_2	78.33
S_2V_2	50.83
S_3V_2	55.67
S_4V_2	77.83
S_1V_3	92.33
S_2V_3	42.00
S_3V_3	81.17
S_4V_3	67.50
S_1V_4	43.00
S_2V_4	31.33
S_3V_4	31.00
S_4V_4	35.00
CD (0.05%)	6.50
Planting time x structure	
P_1S_1	89.83
P_1S_2	44.25
P_1S_3	79.67
P_1S_4	84.50
P_2S_1	68.08
P_2S_2	43.17
P_2S_3	46.25
P_2S_4	52.75
CD (0.05%)	4.60

4.3.2. Peduncle length

Data pertaining to the effect of variety, growing structure and their interactions on peduncle length in anthurium are presented in Table 11.

Length of the peduncle differed significantly among varieties, growing structures and their interactions.

Among the varieties, the mean peduncle length was the highest (20.22 cm) in the variety V_2 (Pistache) but this was on par with V_3 (Mauritius Orange, 19.96 cm) and the lowest (14.32 cm), in the variety V_4 (Passion).

Among the growing strictures, mean length of peduncle was the highest (21.34 cm) in S_4 which was significantly superior to all other growing structure and the lowest (16.25 cm) in S_1.

All the interaction effects were significant with respect to peduncle length. The interaction effect of variety x structure showed that S_2V_4 and S_3V_4 (25.4 cm and 25.2 cm) had higher values. The lowest was in S_4V_1 (12.50 cm).

4.3.3. Girth of peduncle

Data pertaining to the effect of variety, growing structure and their interactions on girth of peduncle in anthurium are presented in Table 11.

Girth of peduncle differed significantly among varieties and growing structures.

Among the varieties, the mean girth of peduncle was the highest (1.82 cm) in the variety V_2 (Pistache) which was significantly superior to all other varieties and the lowest (0.87 cm), in the variety V_4 (Passion).

The growing structure S_1, S_2, S_3 showed no significant difference in girth of peduncle except in S_4 which recorded the lowest girth of 1.15 cm.

The interaction effect of variety x structure showed that S_2V_3 (2.00cm), S_2V_2(1.86cm) and S_2V_4 (1.76cm) had higher values and the lower values were recorded for S_4V_1 (0.80cm), S_4V_2 (0.80cm) and S_1V_4 (0.86cm) respectively.

4.3.4. Spathe length

Data pertaining to the effect of variety, growing structure and their interactions on spathe length in anthurium are presented in Table 11.

Spathe length differed significantly among varieties. The mean spathe length was the highest (7.57 cm) in the variety V_2 (Pistache) but this was on par with (6.98 cm) that of V_3 (Mauritius Orange) and the lowest (5.45 cm) was in the variety V_4 (Passion) which was on par with V_1 (Tropical) (6.03 cm).

Analysis of data showed that there was no significant difference among the growing structures with respect to spathe length.

Interaction was significant with respect to spathe width. The interaction effect of variety x structure showed that S_2V_2, S_2V_3, S_3V_1, S_2V_4, S_3V_4 and S_3V_1 had higher value of 8.36cm, 7.86cm, 7.70cm, 7.46cm, 7.23cm and 7.70 cm respectively. The lower values were recorded in the treatment combination S_4V_2, S_1V_1, S_4V_1, S_3V_2, S_4V_2, S_1V_4 and S_4V_4 (5.00 cm, 5.47 cm, 5.20 cm 5.30 cm, 5.00 cm, 5.97 cm and 5.60 cm respectively).

4.3.5. Spathe width

Data pertaining to the effects of variety, growing structure and their interactions on Spathe width in anthurium are presented in Table 11.

Spathe width differed significantly among varieties. The mean spathe width was the highest (5.41 cm) in the variety V_2 (Pistache) which was significantly superior to all other varieties and the lowest (4.38 cm), in the variety V_1 (Tropical) but this was on par with variety V_4 (Passion) (4.70).

Growing structures showed no significant difference with respect to spathe width.

Interaction effect was significant with respect to spathe width. The interaction effect of variety x structure showed that S_3V_1, S_2V_2, S_2V_3, $S_3V_3$and S_2V_4 had higher values (5.90 cm, 5.56 cm, 5.80 cm, 5.40 cm and 5.60 cm, respectively) which were on par with S_1V_1 (4.23 cm).

Table 11a. Effects of variety, growing structure and their interactions on floral characters of *Anthurium andreanum* (Main effects)

Treatment	Floral characters			
	Peduncle length (cm)	Peduncle girth (cm)	Spathe length (cm)	Spathe width (cm)
Variety				
V_1	17.74	1.21	6.03	4.38
V_2	20.22	1.82	7.57	5.41
V_3	19.96	1.25	6.98	4.99
V_4	14.32	0.87	5.45	4.70
CD (0.05%)	1.76	0.19	0.67	0.44
Structure				
S_1	16.25	1.30	6.24	4.83
S_2	16.62	1.27	6.35	4.73
S_3	18.03	1.44	6.87	4.94
S_4	21.34	1.15	6.56	4.98
CD (0.05%)	1.76	0.19	0.67	0.44

Table 11b. Effects of variety, growing structure and their interactions on floral characters of *Anthurium andreanum* (2 way interactions)

Treatment	Floral characters			
	Peduncle length (cm)	Peduncle girth (cm)	Spathe length (cm)	Spathe width (cm)
Structure x variety				
S_1V_1	18.53	1.26	5.47	4.23
S_2V_1	16.67	1.66	6.60	4.70
S_3V_1	17.33	1.46	7.70	5.90
S_4V_1	12.50	0.80	5.20	4.50
S_1V_2	17.43	1.23	6.76	4.70
S_2V_2	18.63	1.86	8.36	5.56
S_3V_2	15.23	1.20	5.30	3.96
S_4V_2	15.20	0.80	5.00	4.70
S_1V_3	15.63	1.50	4.93	3.76
S_2V_3	20.20	2.00	7.86	5.80
S_3V_3	22.10	1.26	7.70	5.40
S_4V_3	14.20	1.00	6.00	4.80
S_1V_4	19.36	0.86	5.96	4.83
S_2V_4	25.40	1.76	7.46	5.60
S_3V_4	25.20	1.06	7.23	4.70
S_4V_4	15.40	0.90	5.60	4.80
CD (0.05%)	3.53	0.39	1.34	0.89

4.3.6. Spadix length

Data pertaining to the effects of variety, growing structure and their interactions on spadix length in anthurium are presented in Table 12 and Fig. 20-21.

Spadix length differed significantly among varieties, growing structures and their interactions.

Table 12a.Effects of variety, growing structure and their interactions on floral characters of *Anthurium andreanum* (Main effects)

Treatment	Floral characters		
	Spadix Length (cm)	Angle of Orientation spadix (^{0})	Longevity of spike (days)
Variety			
V_1	3.30	32.91	102.91
V_2	4.73	38.33	153.00
V_3	4.09	37.08	122.75
V_4	3.10	27.50	57.50
CD (0.05%)	0.30	4.02	9.70
Structure			
S_1	3.03	29.16	124.25
S_2	3.56	32.08	94.58
S_3	4.06	35.41	116.66
S_4	4.56	39.16	100.66
CD (0.05%)	0.30	4.02	9.70

Table 12b.Effects of variety, growing structure and their interactions on floral characters of *Anthurium andreanum* (2 way interactions)

Treatment	Floral characters		
	Spadix Length (cm)	Angle of Orientation spadix (^{0})	Longevity of spike (days)
Structure x variety			
S_1V_1	2.36	21.66	103.33
S_2V_1	3.66	33.33	191.00
S_3V_1	3.96	36.66	142.66
S_4V_1	2.10	25.00	60.00
S_1V_2	3.66	36.66	100.00
S_2V_2	5.26	36.66	105.00
S_3V_2	2.83	30.00	103.33
S_4V_2	2.50	25.00	70.00
S_1V_3	2.90	31.66	105.00
S_2V_3	5.13	43.33	185.00
S_3V_3	5.03	41.66	131.66
S_4V_3	3.20	25.00	45.00
S_1V_4	4.26	41.66	103.33
S_2V_4	4.86	40.00	131.00
S_3V_4	4.53	40.00	133.33
S_4V_4	4.60	35.00	55.00
CD (0.05%)	0.60	8.04	19.39

Among the varieties, the mean spadix length was the highest (4.73 cm) in the variety V_2 (Pistache) which was significantly superior to all other varieties and the lowest (3.10 cm), in the variety V_4 (Passion). This was on par with V_1 (Tropical, 3.30 cm).

Among the growing structures, mean spadix length was the highest (4.56 cm) in S_4 which was significantly superior to all other growing structures and the lowest (3.03 cm) in S_1.

The Interaction effect was significant with respect to spadix length. The interaction effect of variety x structure showed that S_2V_2 (5.26 cm) had the highest value and this was on par with S_2V_3 (5.13 cm), S_3V_3 (5.03 cm) and S_2V_4 (4.86cm). The lowest were in S_4V_1 (2.10 cm), which was on par with S_1V_1 (2.36 cm) and S_4V_2 (2.50 cm).

4.3.7. Angle of orientation of spadix

The data pertaining to the effects of variety, growing structure and their interactions on angle of orientation of spadix in anthurium are presented in Table 12.

Angle of orientation differed significantly among varieties, growing structures and their interactions.

Among the varieties, the mean angle of orientation was the highest (38.33^o) in the variety V_2 (Pistache) and this was on par with the variety V_3 (Mauritius Orange, 37.08^o) and the lowest (32.91^o) in the variety V_1 (Tropical).

Among the growing structures, mean angle of orientation was the highest (39.16^o) in S_4 but this was on par with S_3 (low cost structure, 35.41^o) and the lowest (29.16^o) in S_1.

The interaction effect of variety x structure showed that S_2V_3 (43.33^o), S_3V_1 (36.66^o), S_1V_2 (36.66^o), S_2V_2 (36.66^o), S_3V_3 (41.66^o), S_1V_4 (41.66^o), S_2V_4 (40.00^o) and S_3V_4 (40.00^o) were on par and had significantly higher values than the other treatment combinations. The lower values were recorded for S_1V_1 (21.66^o), S_4V_1 (25.00^o) and S_4V_3 (25.00^o).

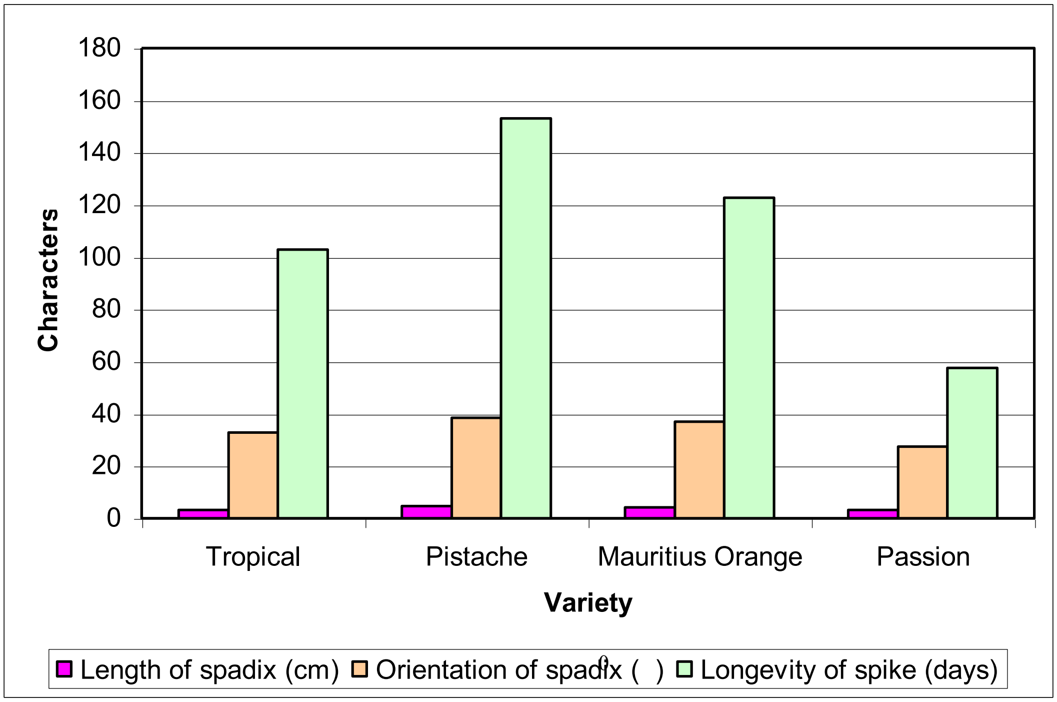


Fig. 20. Effect of variety on flower characters in anthurium

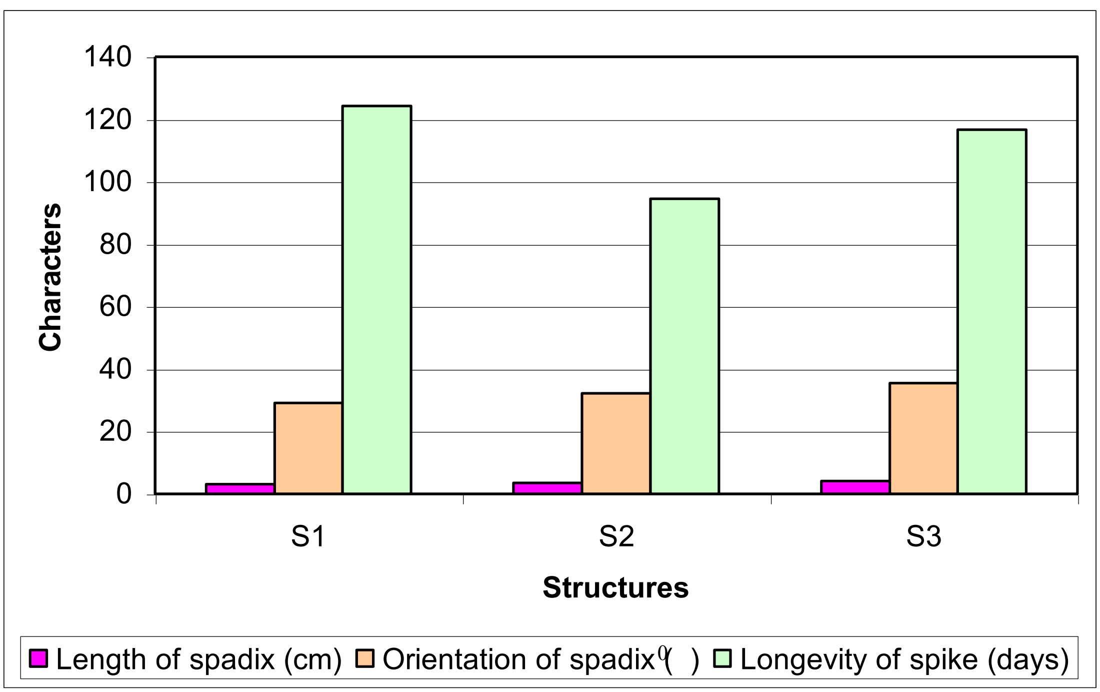


Fig. 21. Effect of growing structure on flower characters in anthurium

4.3.8. Longevity of spike

Data pertaining to the effects of variety, growing structure and their interactions on longevity of spike in anthurium are presented in Table 12.

Longevity of spike differed significantly among varieties, growing structures and their interactions.

Among the varieties, the highest longevity was recorded for variety V2 (Pistache, 153 days) which was significantly superior to all other varieties and the lowest (57.50 days), in the variety V4 (Passion).

Among the growing structures, the highest longevity was recorded for S1 (124.25) days but this was on par (116.60 days) with S3 (low cost) and the lowest (94.58 days) in S2 which was on par with S4 (100.67 days).

The interaction effect of variety x structure showed that S_2V_1 (191.00 days) had the highest value but this was on par with S_2V_3 (185.00 days). The lowest were in S_4V_3 (45.00 days), S_4V_1 (60.00 days) and S_4V_4 (55.00 days) which were on par.

4.3.9. Interval of flower production

There was no significant difference among varieties, growing structure and interactions with respect to interval of flower production. In variety V_4 (Passion) only one flower was produced during the period of study.

4.3.10. Nature of peduncle

Nature of peduncle of all the varieties (Tropical, Pistache and Passion) was straight except that of Mauritius Orange which was bending towards the ground in all planting times and growing structures.

4.3.11. Colour of spathe and spadix

Spathe colour of Tropical (V_1) was red with cream coloured spadix in all planting times and growing structures. The tip of the spadix showed yellow colour and along with maturity the yellow colour spread to the entire spadix.

Pistache (V_2) showed green coloured spathe with light purplish colour at the bottom and the spadix was light brown with dark brown tip which changes to entirely dark brown along with maturity. In the period October to December the spathe and spadix were green in all the growing structure.

Variety Mauritius Orange (V_3) showed orange coloured spathe with yellow coloured spadix in all the planting times and growing structures.

Since the variety Passion (V_4) flowered in P_1 (May planting) only, changes in colour formation were not recorded.

4.4. POST HARVEST LONGEVITY

Analysis of data on post harvest longevity of flowers was done for two varieties V_1 (Tropical) and V_2 (Pistache) grown under four growing systems S_1, S_2, S_3 and S_4. The results reveled that there was significant difference in water uptake and total vase life of flowers. The data are presented in Table 13

4.4. 1. Water uptake (ml)

Water uptake differed significantly among varieties, growing structures and their interactions (Table 13).

Among the varieties, the mean water uptake was the highest (16.25 ml) in the variety V_2 (Pistache) which was significantly superior to variety V_1 (Tropical, 10.16 ml).

Mean water uptake was the highest (21.16 ml) in flowers produced in S_3 which was significantly superior to that in all other growing structures and the lowest (10.00 ml) in S_2, which was on par with that in S_1 (10.50 ml).

The interaction effect of variety x structure showed that S_3V_2 (25.00 ml) had the highest value and this was significantly superior to all other treatment combinations and the lowest was in S_4V_1 (4.66 ml).

Table 13a. Effect of variety, growing structure and their interactions on post harvest longevity of *Anthurium andreanum* (Main effects)

Treatment	Post harvest characters	
	Water uptake (ml)	Vase life (days)
Variety		
V_1	10.16	13.00
V_2	16.25	19.58
CD (0.05%)	2.41	1.44
Structure		
S_1	10.50	14.33
S_2	10.00	14.50
S_3	21.16	19.50
S_4	11.16	16.83
CD (0.05%)	3.41	2.04

Table 13b. Effect of variety, growing structure and their interactions on post harvest longevity of *Anthurium andreanum* (2 way interactions)

Treatment	Post harvest characters	
	Water uptake (ml)	Vase life (days)
Structure x variety		
S_1V_1	7.00	12.66
S_2V_2	14.00	16.00
S_2V_1	11.66	15.00
S_2V_2	8.33	14.00
S_3V_1	17.33	17.00
S_3V_2	25.00	22.00
S_4V_1	4.66	7.33
S_4V_2	17.66	26.33
CD (0.05%)	4.82	2.89

4.4. 2. Vase life

Vase life differed significantly among varieties, growing structures and their interactions (Table 13).

Among the varieties, the mean vase life was longest (19.58 days) in the variety V_2 (Pistache) and lowest (13.00 days) in the variety V_1 (Tropical).

Among the growing structures, mean total vase life was the highest (19.50 days) in flowers from S_3 which was significantly superior to all other growing structures and the lowest (14.33 days), in S_1 which was on par with that in S_2 (14.50 days).

The interaction effect of variety x structure showed that S_4V_2 (26.33 days) had the highest value and this was significantly superior to all other treatment combinations and the lowest was in S_4V_1 (7.33 days).

4.5. CORRELATION STUDIES

To understand the effect of microclimate on plant growth, temperature, humidity and light intensity under each growing structures were correlated with the growth parameters of anthurium varieties.

4.5.1. Microclimate in growing structures

The temperature, relative humidity and light intensity recorded inside and outside the four growing structures for a period of one year are presented in tables 14 to 17 and Fig 22-.

4.5.1.1. Growing structure (S_1)

The monthly average of temperature, relative humidity and light intensity inside and outside growing structure (S_1) are presented in Table 14 and Fig. 22.

4.5.1.1.1. Temperature

In growing structure (S_1) the lowest temperature was recorded in July (30.6^0C) and the highest temperature in the month of March (40.4^0C).

4.5.1.1.2. Relative humidity

There was variation in relative humidity and the recorded lowest was in the month of February (42 %) and the highest in the month of July (76 %).

4.5.1.1.3. Light intensity

Variation in light intensity was measured and the lowest light intensity was recorded in the month of August (4490.11 lux). The highest light intensity was recorded in the month of December (11461.54 lux).

Table 14. Mean monthly weather data in growing structure (S_1)

Month	Temperature (^0C)		Relative humidity (%)		Light intensity (lux)		% light intensity
	Outside	Inside	Outside	Inside	Outside	Inside	
May	34.1	33.5	51	66	35860.25	7342.50	20.40
June	31.3	31.4	74	74	40962.35	7389.41	18.04
July	30.6	30.6	77	76	25833.53	5702.35	22.07
August	31.2	31.1	73	74	33457.22	4490.11	13.42
September	33.9	33.7	62	64	43303.58	6731.05	15.54
October	34.9	34.8	60	62	38623.75	5735.00	14.85
November	36.1	35.7	55	57	68840.77	10083.85	14.65
December	36.7	36.4	50	52	84861.54	11461.54	13.51
January	37.6	36.9	49	55	61337.50	8717.50	14.21
February	41.0	39.9	40	42	69543.75	10955.63	15.75
March	41.6	40.4	47	49	59020.00	9994.00	16.93
April	38.2	37.9	62	62	35705.83	7336.67	20.55
May	37.4	37.6	60	61	49810.63	9221.88	18.51

4.5.1.2. Growing structure (S_2)

The monthly average of temperature, relative humidity and light intensity inside and outside growing structure (S_2) are presented in Table 15.

4.5.1.2.1. Temperature

The lowest air temperature was recorded in the month of July (30.4^{0}C) and the highest in the month of March (40.9^{0}C).

4.5.1.2.2. Relative humidity

Lowest relative humidity was recorded in the month of February (48 %) and the highest was recorded in the month of July (79 %).

4.5.1.2.3. Light intensity

The highest light intensity was observed in the month of December (16062.35 lux) and the lowest in the month of July (3825.12 lux).

Table 15. Mean monthly weather data in growing structure (S_2)

Month	Temperature (^{0}C)		Relative humidity (%)		Light intensity (lux)		% light intensity
	Outside	Inside	Outside	Inside	Outside	Inside	
May	33.8	34.1	66	66	38075.00	8585.00	22.55
June	31.7	31.6	79	78	45125.00	9486.00	21.02
July	30.1	30.4	80	79	25297.65	3825.12	15.12
August	29.6	31.3	77	75	37707.78	6159.00	16.33
September	33.8	34.0	66	67	41752.11	5517.36	13.21
October	34.2	35.3	59	61	42792.50	5555.00	12.98
November	35.3	35.8	53	58	61250.63	8279.38	13.62
December	36.7	37.2	49	55	85811.76	16062.35	18.72
January	37.4	37.6	48	57	66753.33	8308.00	12.45
February	40.1	40.2	42	48	69464.29	11132.14	16.03
March	40.9	40.9	48	51	51118.18	7530.91	14.73
April	38.0	37.7	62	63	39814.62	6008.46	15.09
May	37.1	37.1	61	64	46167.33	7909.33	17.13

4.5.1.3. Growing structure (S_3)

The monthly average of temperature, relative humidity and light intensity inside and outside growing structure (S_3) are presented in Table 16.

4.5.1.3.1. Temperature

Highest temperature in this structure was seen in the month of March (40.0^{0}C) and lowest in the month of July (30.

4.5.1.3.2. Relative humidity

Highest relative humidity was seen in the month of August (81%) and lowest in February (46 %).

4.5.1.3.3. Light intensity

Variation in light intensity showed that the highest light intensity was seen in the month of December (11280.48lux) and lowest in July (3156.59lux)

Table 16. Mean monthly weather data in growing structure (S_3)

Month	Temperature (^{0}C)		Relative humidity (%)		Light intensity (lux)		% light intensity
	Outside	Inside	Outside	Inside	Outside	Inside	
May	33.4	33.9	69	67	30440.00	4440.00	14.59
June	31.9	31.5	77	75	42357.54	7240.40	17.09
July	30.4	30.5	80	77	32776.47	3156.59	9.63
August	30.0	30.5	80	81	41800.00	10690.00	25.57
September	33.3	33.0	70	69	39380.00	8613.68	21.87
October	33.6	34.6	62	63	38362.50	6947.50	18.11
November	34.7	34.6	59	61	67941.81	9370.00	13.79
December	35.5	35.3	53	56	85447.62	11280.48	13.20
January	36.7	36.5	50	56	62688.89	8745.56	13.95
February	39.4	38.9	42	46	69582.35	9904.12	14.23
March	40.3	40.0	48	50	62716.67	9686.67	15.45
April	37.5	37.4	66	66	44945.00	7140.63	15.89
May	36.8	36.7	64	65	38228.33	4986.67	13.04

4.5.1.4. Growing structure (S_4)

The monthly average of temperature, relative humidity and light intensity inside and outside growing structure (S_4) are presented in Table 17.

4.5.1.4.1. Temperature

Highest air temperature in this structure was recorded in the month of March (41.1^0C) and the lowest in the month of August (29.4^0C).

4.5.1.4. 2. Relative humidity

Variation in relative humidity measured showed that the highest relative humidity was recorded in the month of July (77 %) and the lowest (45%) in the month of February.

4.5.1.4. 3. Light Intensity

Light intensity ranged from 3129.76lux in July to 10470.63lux in December.

Table 17. Mean monthly weather data in growing structure (S_4)

Month	Temperature (^0C)		Relative humidity (%)		Light intensity (lux)		% light intensity
	Outside	Inside	Outside	Inside	Outside	Inside	
May	33.2	33.1	67	67	46905.00	6015.25	12.82
June	31.9	31.7	75	74	43168.82	4711.29	10.91
July	30.5	30.4	77	77	20986.47	3129.76	14.91
August	30.8	29.4	74	77	30116.11	5169.55	17.17
September	33.7	33.6	67	67	36198.95	5262.63	14.54
October	34.7	34.6	63	65	41200.00	5888.75	14.29
November	34.7	35.0	58	62	68849.93	9022.67	13.10
December	35.5	35.4	53	57	88587.50	10470.63	11.82
January	36.8	37.0	52	55	57172.73	7495.45	13.11
February	39.3	39.3	43	45	69157.33	7645.33	11.05
March	41.2	41.1	46	48	59660.77	7112.31	11.92
April	38.6	37.9	61	61	42263.85	6268.46	14.83
May	35.9	36.1	64	65	33394.17	5396.67	16.16

Fig. 22- Mean monthly weather data

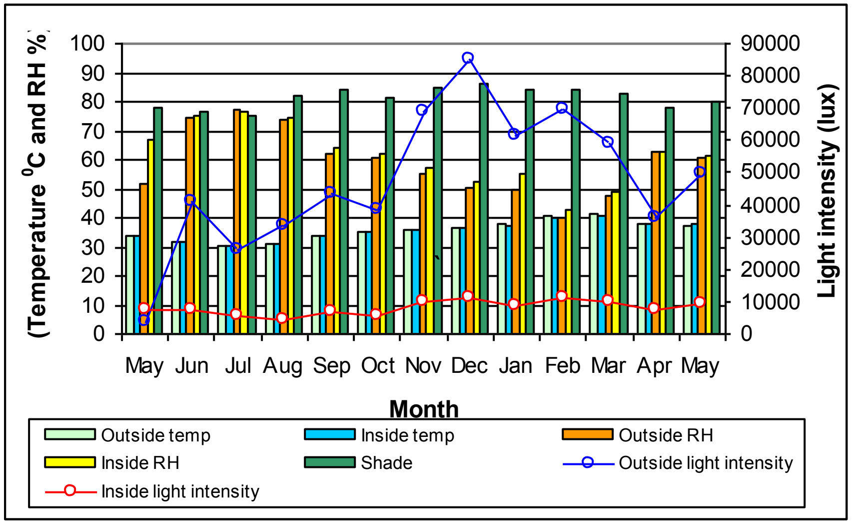


Fig. 22-1. Mean monthly weather data in growing structure (S1)

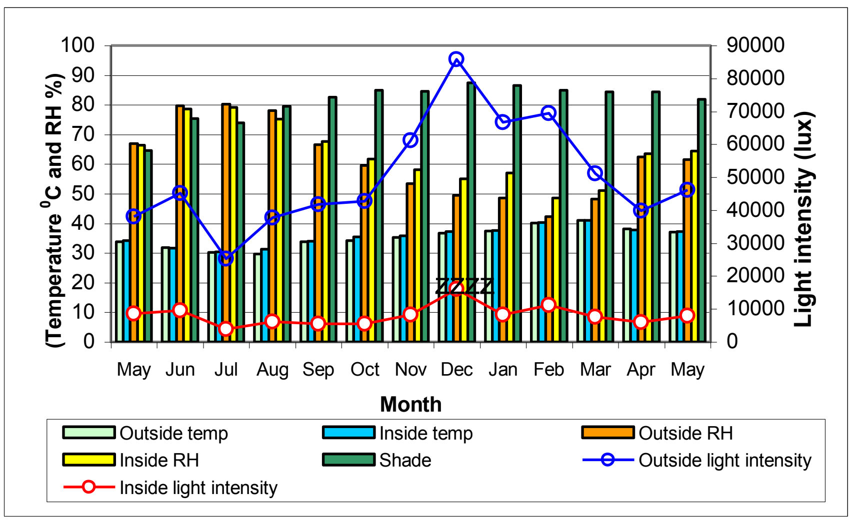


Fig. 22-2. Mean monthly weather data in growing structure (S2)

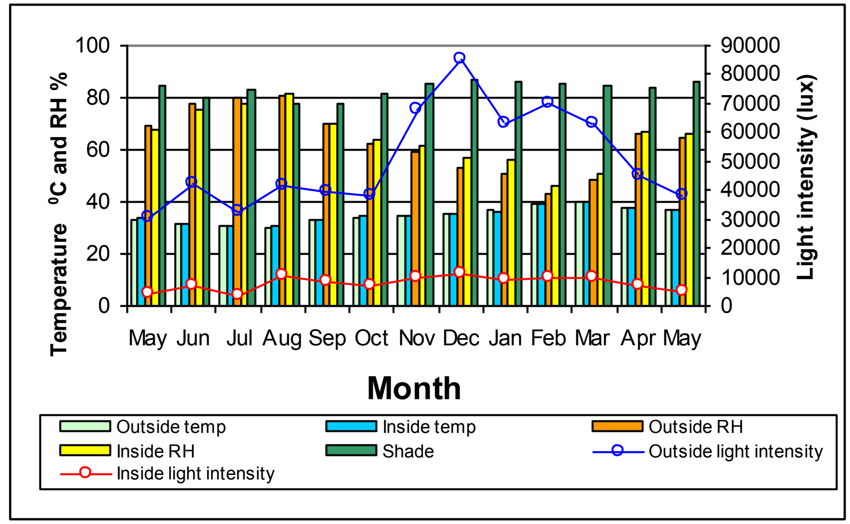


Fig. 22-3. Mean monthly weather data in growing structure (S3)

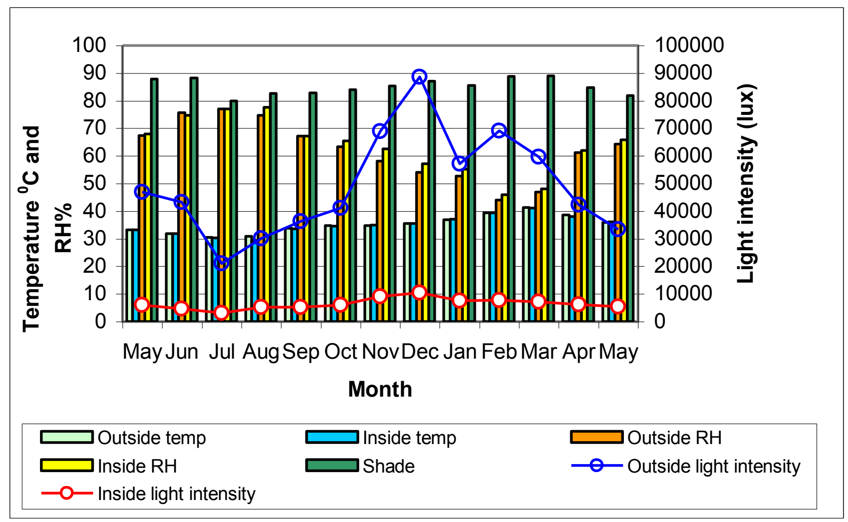


Fig. 22-4. Mean monthly weather data in growing structure (S4)

4.5.2. Effect of correlation studies on growth parameters of *Anthurium andreanum*

Data pertaining to the correlation effects of temperature, relative humidity and light intensity on growth parameters of four varieties of anthurium grown under four growing structures for one year are presented in Tables 18 to 29.

4.5.2.1. Effects of temperature on growth parameters

The results of the correlation studies of temperature on growth parameters of anthurium varieties grown under four growing structures are presented in Tables 18 to 21 and Fig 23.

4.5.2.1.1. Growing structure (S_1)

Data pertaining to the effect of temperature on growth parameters of anthurium Varieties grown in growing structure (S_1) are presented in Table 18.

In variety V_1 all the characters were positively and significantly correlated with temperature except number of leaves. Number of leaves showed negative correlation with inside temperature.

In the variety V_2 all the characters except number of leaves showed significant and positive correlation with temperature.

In the variety V_3 plant height, petiole length, leaf length and leaf area were positively and significantly correlated with temperature. Number of leaves showed negative correlation with inside temperature.

In the variety V_4 plant height and leaf breadth were significantly and positively corre3lated with inside temperature. There was negative correlation of inside temperature with number of leaves.

Table 18. Correlations between temperature with growth parameters of four *Anthurium andreanum* varieties in growing structure S_1

Vegetative characters	Correlation coefficient							
	V_1		V_2		V_3		V_4	
	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2
Plant height (cm)	0.76**	0.80**	0.80**	0.83**	0.67*	0.71**	0.79**	0.83**
Plant spread EW (cm)	0.74**	0.78**	0.75**	0.75**	0.55	0.57	0.10	0.11
Plant spread NS (cm)	0.84**	0.88**	0.87**	0.88**	0.45	0.44	0.07	0.07
Leaf number	-0.81**	-0.83**	-0.32	-0.34	-0.64*	-0.64*	-0.58*	-0.56*
Leaf length (cm)	0.83**	0.85**	0.83**	0.87**	0.62*	0.65*	0.04	0.08
Leaf breadth (cm)	0.84**	0.85**	0.60*	0.63*	0.46	0.50	0.59*	0.64*
Leaf area (cm^2)	0.86**	0.88**	0.78**	0.82**	0.58	0.62*	0.37	0.41
Petiole length (cm)	0.71**	0.75**	0.75**	0.79**	0.59*	0.62*	0.35	0.39

** Correlation is significant at 0.01 level (2-tailed).
* Correlation is significant at 0.05 level (2-tailed).
T_1 - Outside temperature ^0C, T_2 - Inside temperature ^0C

4.5.2.1.2. Growing structure (S_2)

Data pertaining to the effects of temperature on growth parameters of *Anthurium andreanum* varieties grown in growing structure (S_2) are presented in Table 19.

In the case of variety V_1 there was positive and significant correlation of height, petiole length, leaf length, leaf breadth and leaf area with inside temperature. Variety V_2 (Pistache) showed positive and significant correlation of temperature with height, spread EW, spread NS, petiole length, leaf length and leaf area.

In the case of variety (V_3) there was positive and significant correlation of inside temperature with height, spread EW, leaf length and leaf area. There was significant and positive correlation of inside temperature with height in the case of variety (V_4).

Table 19. Correlations between temperature with growth parameters of four *Anthurium andreanum* varieties in growing structure S_2

Vegetative characters	Correlation coefficient							
	V_1		V_2		V_3		V_4	
	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2
Plant height (cm)	0.78**	0.81**	0.75**	0.77**	0.75**	0.76**	0.82**	0.84**
Plant spread EW (cm)	0.37	0.40	0.70**	0.72**	0.59*	0.60*	-0.18	-0.11
Plant spread NS (cm)	0.45	0.48	0.72**	0.74**	0.39	0.44	-0.13	-0.09
Leaf number	-0.38	-0.34	0.18	0.11	-0.06	-0.04	-0.31	-0.32
Leaf length (cm)	0.76**	0.78**	0.77**	0.77**	0.77**	0.74**	0.04	0.10
Leaf breadth (cm)	0.78**	0.80**	0.22	0.16	0.58*	0.53	0.18	0.25
Leaf area (cm^2)	0.77**	0.79**	0.67*	0.65*	0.73**	0.69**	0.15	0.21
Petiole length (cm)	0.75**	0.78**	0.75**	0.78**	0.53	0.53	0.69**	0.70

** Correlation is significant at 0.01 level (2-tailed).
* Correlation is significant at 0.05 level (2-tailed).
T_1 - Outside temperature ^0C, T_2 - Inside temperature ^0C

4.5.2.1.3. Growing structure (S_3)

Table 20 shows the effects of temperature on growth parameters of anthurium varieties grown in growing structure (S_3)

In the variety V_1 (Tropical) inside temperature was significantly and positive correlated with height spread EW, spread NS, petiole length, leaf length leaf breadth and leaf area.

In the case of the variety V_2 (Pistache) the inside temperature was significantly and positively correlated with height, spread (EW and NS), petiole length, leaf length and leaf breadth.

Variety V_3 (Mauritius Orange) showed significant and positive correlation of inside temperature with height, spread EW, spread NS and petiole length.

In the case of the variety V_4 (Passion) there was significant and positive correlation of inside temperature with height and leaf length.

Table 20. Correlations between temperature with growth parameters of four *Anthurium andreanum* varieties in growing structure S_3

Vegetative characters	Correlation coefficient							
	V_1		V_2		V_3		V_4	
	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2
Plant height (cm)	0.74**	0.74**	0.83**	0.82**	0.82**	0.82**	0.86**	0.85**
Plant spread EW (cm)	0.73**	0.73**	0.79**	0.77**	0.83**	0.82**	-0.046	-0.11
Plant spread NS (cm)	0.70**	0.70**	0.77**	0.74**	0.78**	0.77**	0.002	-0.05
Leaf number	-0.47	-0.52	-0.11	-0.15	0.17	0.15	-0.28	-0.32
Leaf length (cm)	0.76**	0.76**	0.80**	0.81**	0.48	0.49	0.64*	0.57*
Leaf breadth (cm)	0.76**	0.77**	0.56*	0.58*	0.36	0.39	0.51	0.45
Leaf area (cm^2)	0.78**	0.78**	0.72**	0.74**	0.45	0.46	0.58*	0.51
Petiole length (cm)	0.67*	0.67*	0.83**	0.83**	0.77**	0.76**	0.52	0.49

** Correlation is significant at 0.01 level (2-tailed).
* Correlation is significant at 0.05 level (2-tailed).
T_1 - Outside temperature ^0C, T_2 - Inside temperature ^0C

4.5.2.1.4. Growing structure (S_4)

Data pertaining to the effects of temperature on growth parameters of *Anthurium andreanum* varieties grown in growing structure (S_4) are presented in Table 21.

In the variety V_1 (Tropical) there was significant and positive correlation of temperature with height, petiole length, leaf length, leaf breadth and leaf area.

In the varieties V_2 (Pistache) and V_3 (Mauritius Orange) all the characters were significantly and positively correlated with inside temperature.

In the variety V_4 (Passion) plant height, spread EW, spread NS and petiole length were significantly and positively correlated with temperature.

Table. 21. Correlations between temperature with growth parameters of four *Anthurium andreanum* varieties in growing structure S_4

Vegetative characters	Correlation coefficient							
	V_1		V_2		V_3		V_4	
	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2
Plant height (cm)	0.84**	0.82**	0.84**	0.84**	0.77**	0.76**	.81**	.81**
Plant spread EW (cm)	0.53	0.50	0.79**	0.79**	0.80**	0.80**	.77**	.76**
Plant spread NS (cm)	0.56*	0.53	0.83**	0.83**	0.84**	0.83**	.78**	.77**
Leaf number	-0.26	-0.25	0.65**	0.62**	0.78**	0.78**	.20	.25
Leaf length (cm)	0.84**	0.84**	0.85**	0.84**	0.75**	0.74**	.46	.38
Leaf breadth (cm)	0.76**	0.77**	0.84**	0.83**	0.59*	0.57*	.20	.15
Leaf area (cm^2)	0.82**	0.83**	0.89**	0.87**	0.73**	0.72**	.31	.28
Petiole length (cm)	0.77**	0.74**	0.84**	0.84**	0.63*	0.60*	.70**	.75**

** Correlation is significant at 0.01 level (2-tailed).
* Correlation is significant at 0.05 level (2-tailed).
T_1 - Outside temperature ^0C, T_2 - Inside temperature ^0C

4.5.2.2. Effects of relative humidity on growth parameters

The results of the correlation studies of relative humidity on growth parameters of anthurium varieties grown under four growing structures are presented in Tables 22 to 25

4.5.2.2.1. Growing structure (S_1)

Data pertaining to the effects of relative humidity on growth parameters of *Anthurium andreanum* varieties grown in growing structure (S_1) are presented in Table 22.

In the variety V_1 (Tropical) plant height, plant spread EW, spread NS, petiole length, leaf length and leaf area were significantly and negatively correlated with inside humidity. Number of leaves showed positive and significant correlation with humidity.

Variety V_2 (Pistache) showed significant negative correlation of plant height, spread EW, spread NS, petiole length, leaf length and leaf area with inside humidity.

Table 22. Correlations between relative humidity with growth parameters of four *Anthurium andreanum* varieties in growing structure S1

Vegetative characters	Correlation coefficient							
	V_1		V_2		V_3		V_4	
	H_1	H_2	H_1	H_2	H_1	H_2	H_1	H_2
Plant height (cm)	-0.43	-0.65*	-0.45	-0.66*	-0.35	-0.61*	-0.41	-0.56
Plant spread EW (cm)	-0.45	-0.66*	-0.41	-0.57*	-0.14	-0.38	0.12	0.10
Plant spread NS (cm)	-0.55	-0.76**	-0.53	-0.71**	-0.17	-0.37	-0.01	0.004
Leaf number	0.73**	0.78**	0.28	0.37	0.56*	0.64*	0.73**	0.69*
Leaf length (cm)	-0.52	-0.70**	-0.53	-0.73**	-0.34	-0.56*	-0.02	-0.07
Leaf breadth (cm)	-0.56	-0.74	-0.33	-0.51	-0.13	-0.36	-0.34	-0.47
Leaf area (cm^2)	-0.57	-0.73**	-0.48	-0.66*	-0.27	-0.48	-0.20	-0.31
Petiole length (cm)	-0.37	-0.59*	-0.39	-0.61*	-0.25	-0.49	0.04	-0.14

** Correlation is significant at 0.01 level (2-tailed).
* Correlation is significant at 0.05 level (2-tailed).
H_1 - Outside humidity %, H_2 - Inside humidity %

In the case of variety V_3 (Mauritius Orange) plant height and leaf length were negatively and significantly correlated with inside humidity. There was positive correlation of humidity with number of leaves. Variety V_4 (Passion) showed significant and positive correlation of humidity with number of leaves.

4.5.2.2.2. Growing structure (S_2)

Data pertaining to the effects of relative humidity on growth parameters of *Anthurium andreanum* varieties grown in growing structure (S_2) are presented in Table 23.

Table. 23. Correlations between relative humidity with growth parameters of four *Anthurium andreanum* varieties in growing structure S_2

Vegetative characters	Correlation coefficient							
	V_1		V_2		V_3		V_4	
	H_1	H_2	H_1	H_2	H_1	H_2	H_1	H_2
Plant height (cm)	-0.79**	-0.77**	-0.68*	-0.66*	-0.68*	-0.66*	-0.77**	0.75**
Plant spread EW (cm)	-0.61*	-0.55	-0.65*	-0.62*	-0.66*	-0.61*	-0.10	-0.13
Plant spread NS (cm)	-0.62*	-0.59*	-0.64*	-0.63*	-0.64*	-0.59*	-0.11	-0.14
Leaf number	-0.02	0.03	-0.14	-0.10	-0.26	-0.21	0.15	0.18
Leaf length (cm)	-0.79**	-0.79**	-0.67*	-0.64*	-0.64*	-0.62*	-0.44	-0.40
Leaf breadth (cm)	-0.79**	-0.81**	0.03	0.06	-0.41	-0.39	-0.51	-0.48
Leaf area (cm^2)	-0.77**	-0.80**	-0.50	-0.46	-0.58*	-0.55*	-0.53	-0.49
Petiole length (cm)	-0.75**	-0.73**	-0.68**	-0.68*	-0.41	-0.41	-0.60*	-0.58*

** Correlation is significant at 0.01 level (2-tailed).
* Correlation is significant at 0.05 level (2-tailed).
H_1 - Outside humidity %, H_2 - Inside humidity %

In the variety V_1 (Tropical) inside humidity was significantly and negatively correlated with height spread EW, spread NS, petiole length and leaf length.

In the variety V_3 (Mauritius Orange) there was significant and negative correlation of inside humidity with plant height, spread EW, spread NS leaf length and leaf area.

Variety V_4 (Passion) showed that there was significant and negative correlation of inside humidity with plant height and petiole length.

4.5.2.2.3. Growing structure (S3)

Data pertaining to the effects of relative humidity on growth parameters of *Anthurium andreanum* varieties grown in growing structure (S_3) are presented in Table 24.

Table 24. Correlations between relative humidity with growth parameters of four *Anthurium andreanum* varieties in growing structure S_3

Vegetative characters	Correlation coefficient							
	V_1		V_2		V_3		V_4	
	H_1	H_2	H_1	H_2	H_1	H_2	H_1	H_2
Plant height (cm)	-0.64**	-0.59**	-0.66*	-0.63*	-0.72**	-0.69**	-0.73**	-0.69**
Plant spread EW (cm)	-0.68*	-0.62*	-0.71**	-0.67*	-0.67*	-0.63*	0.21	0.17
Plant spread NS (cm)	-0.66*	-0.60*	-0.68*	-0.64*	-0.63*	-0.59*	-0.001	-0.02
Leaf number	0.39	0.33	0.27	0.23	0.20	0.17	0.51	0.49
Leaf length (cm)	-0.75**	-0.69**	-0.72**	-0.67*	-0.49	-0.44	-0.53	-0.55*
Leaf breadth (cm)	-0.75**	-0.69**	-0.51	-0.45	-0.35	-0.30	-0.49	-0.51
Leaf area (cm^2)	-0.76**	-0.71**	-0.64*	-0.59*	-0.41	-0.37	-0.53	-0.55
Petiole length (cm)	-0.54	-0.49	-0.66*	-0.62*	-0.73**	-0.68*	-0.38	-0.33

** Correlation is significant at 0.01 level (2-tailed).
* Correlation is significant at 0.05 level (2-tailed).
H_1 - Outside humidity %, H_2 - Inside humidity %

In the variety V_1 (Tropical) the characters plant height, spread EW, spread NS, leaf length and leaf area were significantly and negatively correlated with inside humidity.

In the variety V_2 (Pistache) there was significant and negative correlation of inside humidity with plant height, spread EW, spread NS, petiole length, leaf lengthy and leaf area.

Variety V_3 (Mauritius Orange) showed that plant height, spread EW, spread NS and petiole length were significantly and negatively correlated with humidity inside.

In variety V_4 (Passion) plant height and leaf length were significantly and negatively correlated with inside humidity.

4.5.2.2.4. Growing structure (S_4)

Data pertaining to the effects of relative humidity on growth parameters of *Anthurium andreanum* varieties grown in growing structure (S_4) are presented in Table 25.

In variety V_1 (Tropical) there was significant and negative correlation of inside humidity with plant height, petiole length, leaf length, leaf breadth and leaf area.

In variety V_2 (Pistache) all the characters except number of leaves showed significant and negative correlation with inside humidity.

In the case of variety V_3 (Mauritius Orange) there was significant and negative correlation of inside humidity with plant height, spread EW, spread NS, leaf length, number of leaves and leaf area.

Variety V_4 (Passion) showed that plant height, spread EW, spread NS and petiole length were significantly and negatively correlated with inside humidity.

Table. 25. Correlations between relative humidity with growth parameters of four *Anthurium andreanum* varieties in growing structure S_4

Vegetative characters	Correlation coefficient							
	V_1		V_2		V_3		V_4	
	H_1	H_2	H_1	H_2	H_1	H_2	H_1	H_2
Plant height (cm)	-0.69**	-0.69**	-0.77**	-0.76**	-0.64*	-0.63*	-.62*	-.63*
Plant spread EW (cm)	-0.41	-0.43	-0.65*	-0.66*	-0.70**	-0.70**	-.52	-.56*
Plant spread NS (cm)	-0.50	-0.51	-0.72**	-0.73**	-0.71**	-0.72**	-.60**	-.62**
Leaf number	-0.007	-0.01	-0.43	-0.46	-0.80**	-0.80**	-.37	-.34
Leaf length (cm)	-0.80**	-0.77**	-0.76**	-0.75**	-0.67**	-0.65**	-.29	-.28
Leaf breadth (cm)	-0.70**	-0.68*	-0.69**	-0.72**	-0.42	-0.41	-.23	-.14
Leaf area (cm^2)	-0.75**	-0.74**	-0.74**	-0.76**	-0.57*	-0.56*	-.26	-.21
Petiole length (cm)	-0.60*	-0.59*	-0.76**	-0.75**	-0.51	-0.50	-.50	-.57*

** Correlation is significant at 0.01 level (2-tailed).
* Correlation is significant at 0.05 level (2-tailed).
H_1 - Outside humidity %, H_2 - Inside humidity %

4.5.2.3. Effects of light intensity on growth parameters

The results of the correlation studies of light intensity on growth parameters of anthurium varieties grown under four growing structures are presented in Tables 26 to 29.

4.5.2.3.1. Growing structure (S_1)

Data pertaining to the effects of light intensity on growth parameters of anthurium varieties grown in growing structure (S_1) are presented in Table 26.

In the variety V_1 (Tropical) there was significant and positive correlation of light intensity inside the growing structure with spread (NS), petiole length, leaf breadth and leaf area. There was negative correlation of number of leaves with inside light intensity.

Table 26. Correlations between light intensity and growth parameters of four *Anthurium andreanum* varieties in growing structure S_1

Vegetative characters	Correlation coefficient							
	V_1		V_2		V_3		V_4	
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2
Plant height (cm)	0.65*	0.50	0.63*	0.55	0.78**	0.59*	0.40	0.48
Plant spread EW (cm)	0.65*	0.51	0.33	0.31	0.42	0.19	-0.09	-0.02
Plant spread NS (cm)	0.73**	0.67*	0.51	0.50	0.36	0.16	0.08	0.11
Leaf number	-0.52	-0.57*	-0.36	-0.19	-0.37	-0.34	-0.41	-0.53
Leaf length (cm)	0.64*	0.62*	0.71**	0.68*	0.71**	0.51	0.40	0.32
Leaf breadth (cm)	0.64*	0.63*	0.54	0.33	0.61**	0.48	0.58*	0.58*
Leaf area (cm^2)	0.61*	0.65*	0.64*	0.57*	0.66*	0.54	0.55*	0.51
Petiole length (cm)	0.59*	0.40	0.55*	0.40	0.61*	0.43	0.15	0.05

** Correlation is significant at 0.01 level (2-tailed).
* Correlation is significant at 0.05 level (2-tailed).
L_1 - Outside light intensity Lux, L_2 - Inside light intensity Lux

Variety V_2 (Pistache) showed positive significant correlation of leaf length and leaf area with light intensity inside the growing structure. Variety V_3 (Mauritius Orange) recorded positive and significant correlation of light intensity inside the structure with height. In variety V_4 (Passion) there was significant and positive correlation of leaf breadth with light intensity.

4.5.2.3.2. Growing structure (S_2)

Data pertaining to the effect of light intensity on growth parameters of *Anthurium andreanum* varieties grown in growing structure (S_2) are presented in Table 27.

Variety V_1, V_2 and V_3 showed no correlation of vegetative characters with light intensity. Variety V_4 (Passion) recorded positive and significant correlation of light intensity with leaf breadth and leaf area.

Table 27. Correlations between light intensity and growth parameters of four *Anthurium andreanum* varieties in growing structure S_2

Vegetative characters	Correlation coefficient							
	V_1		V_2		V_3		V_4	
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2
Plant height (cm)	0.59*	0.25	0.50	0.26	0.55*	0.29	0.58*	0.31
Plant spread EW (cm)	0.53	0.15	0.51	0.29	0.49	0.17	0.11	-0.02
Plant spread NS (cm)	0.42	0.01	0.51	0.33	0.64*	0.30	0.10	-0.01
Leaf number	0.34	0.24	0.40	0.49	0.55*	0.52	0.18	0.22
Leaf length (cm)	0.67*	0.42	0.52	0.30	0.57*	0.38	0.61*	0.47
Leaf breadth (cm)	0.53	0.23	0.08	0.15	0.40	0.26	0.71**	0.56*
Leaf area (cm^2)	0.56*	0.32	0.39	0.21	0.52	0.349	0.73**	0.60*
Petiole length (cm)	0.51	0.16	0.50	0.26	0.41	0.27	0.42	0.15

** Correlation is significant at 0.01 level (2-tailed).
* Correlation is significant at 0.05 level (2-tailed).
L_1 - Outside light intensity Lux, L_2 - Inside light intensity Lux

4.5.2.3.3. Growing structure (S_3)

Data pertaining to the effects of light intensity on growth parameters of *Anthurium andreanum* varieties grown in growing structure (S_3) are presented in Table 28.In this structure all the four varieties showed no correlation of light intensity with vegetative characters.

Table 28. Correlations between light intensity and growth parameters of four *Anthurium andreanum* varieties in growing structure S_3

Vegetative characters	Correlation coefficient							
	V_1		V_2		V_3		V_4	
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2
Plant height (cm)	0.49	0.49	0.46	0.30	0.48	0.32	0.54	0.32
Plant spread EW (cm)	0.63*	0.44	0.62*	0.52	0.42	0.21	-0.22	-0.14
Plant spread NS (cm)	0.63*	0.49	0.52	0.44	0.45	0.20	-0.04	0.07
Leaf number	-0.27	-0.28	-0.38	-0.27	-0.39	-0.53	-0.39	-0.47
Leaf length (cm)	0.73**	0.52	0.52	0.47	0.44	0.19	0.49	0.18
Leaf breadth (cm)	0.64*	0.53	0.30	0.43	0.25	0.03	0.53	0.33
Leaf area (cm^2)	0.73**	0.52	0.40	0.41	0.33	0.08	0.54	0.30
Petiole length (cm)	0.38	0.46	0.45	0.34	0.51	0.41	0.29	0.43

** Correlation is significant at 0.01 level (2-tailed).
* Correlation is significant at 0.05 level (2-tailed).
L_1 - Outside light intensity Lux, L_2 - Inside light intensity Lux

4.5.2.3.4. Growing structure (S_4)

Data pertaining to the effects of light intensity on growth parameters of *Anthurium andreanum* varieties grown in growing structure (S_4) are presented in Table 29.

In the variety V_1 (Tropical) leaf length was significantly and positively correlated with light intensity inside the growing structure.

Variety V_2 (Pistache) and V_4 (Passsion) showed no correlation of light intensity with vegetative characters. In variety V_3 (Mauritius Orange) leaf number was positively and significantly correlated with light intensity.

Fig. 23. Effect of microclimate on plant growth of anthurium (correlations)

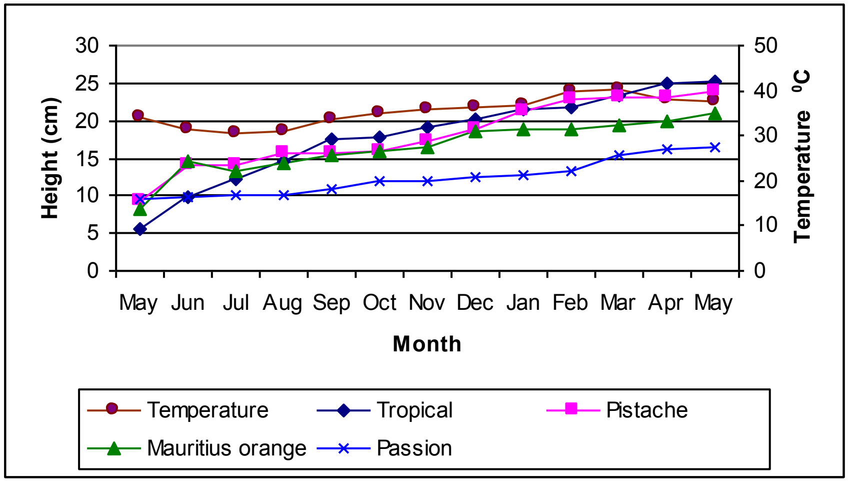


Fig. 23-1. Effect of temperature on plant height in growing structure 1

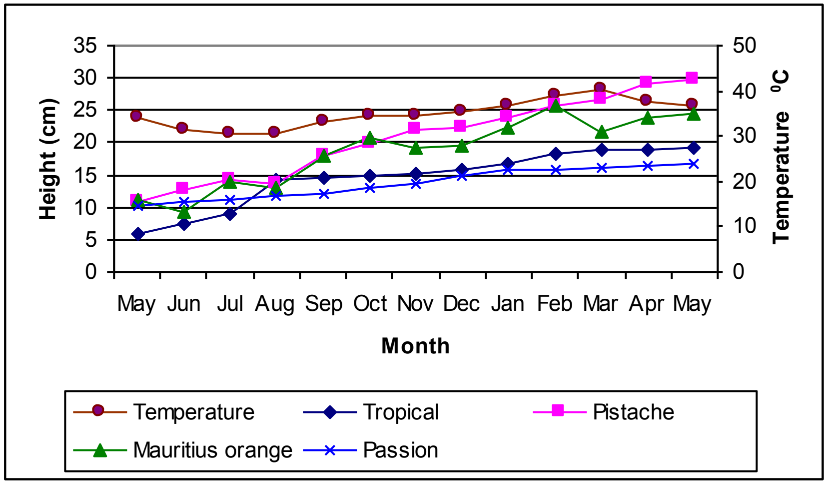


Fig. 23-3. Effect of temperature on plant height in growing structure 3

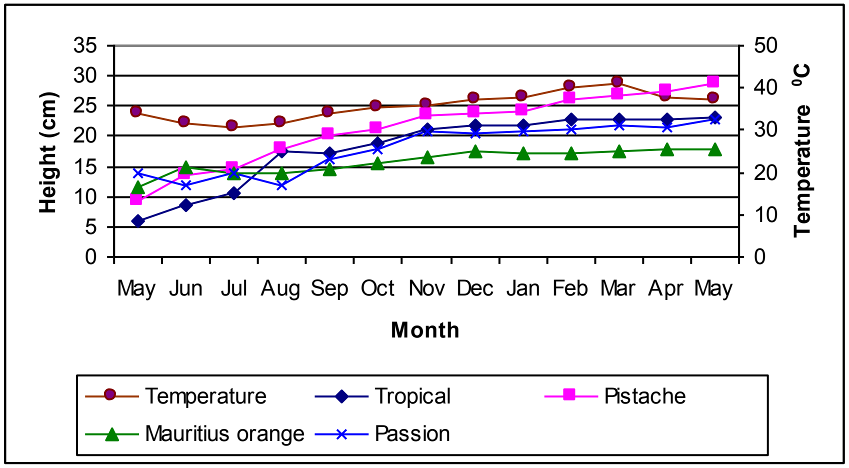


Fig. 23-2. Effect of temperature on plant height in growing structure 2

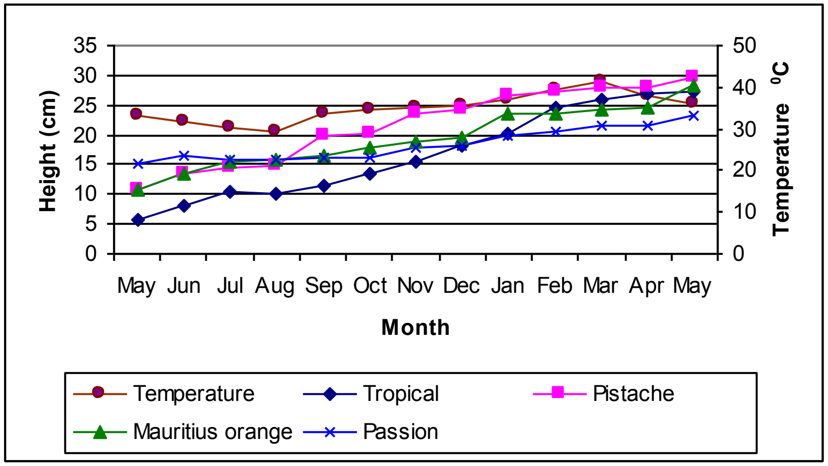


Fig. 23-4. Effect of temperature on plant height in growing structure 4

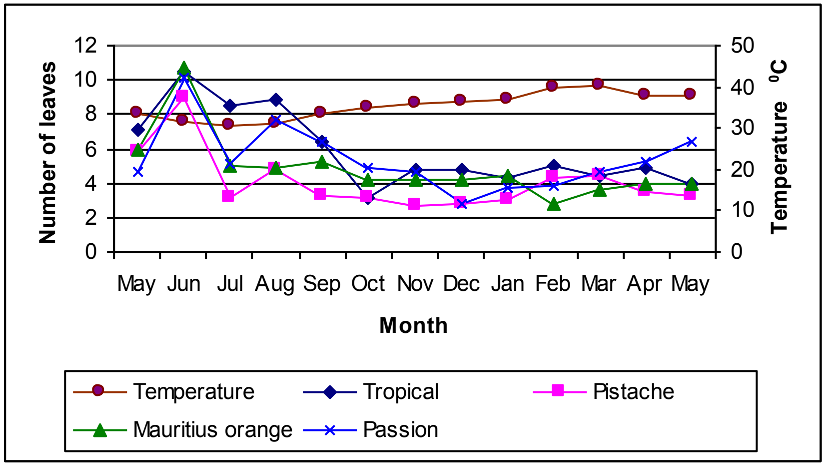


Fig. 23-5. Effect of temperature on number of leaves in growing structure 1

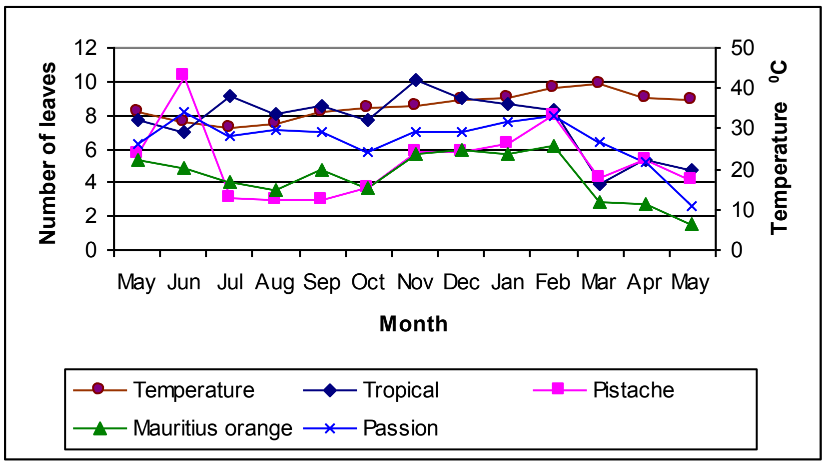


Fig. 23-6. Effect of temperature on number of leaves in growing structure 2

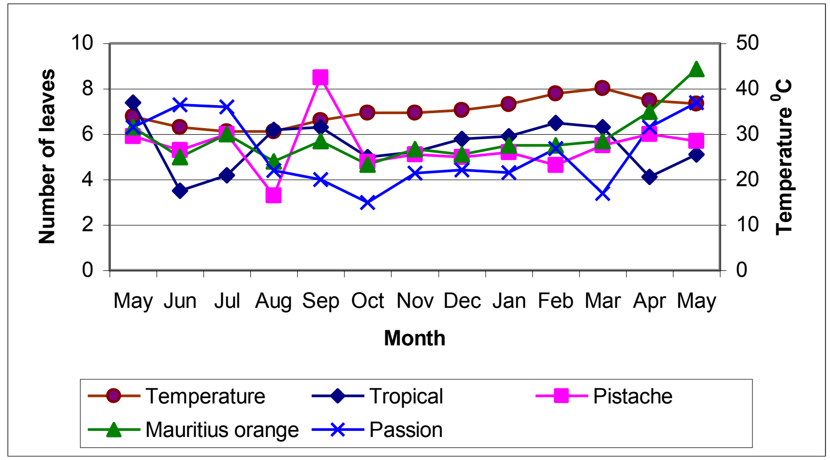


Fig. 23-7. Effect of temperature on number of leaves in growing structure 3

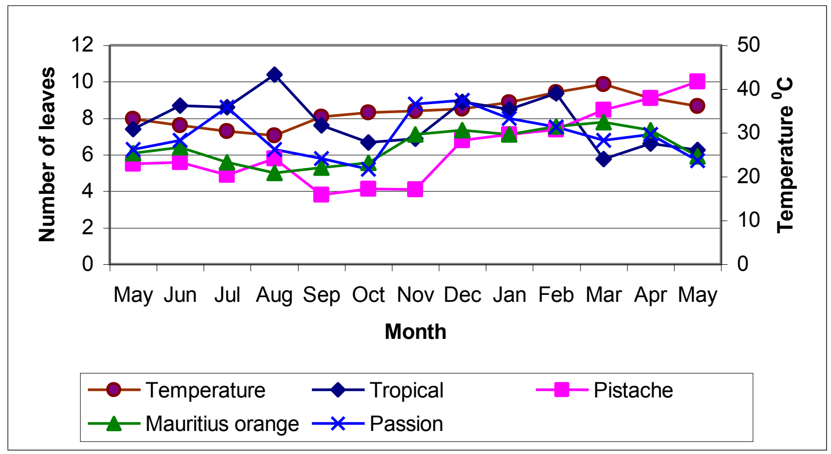


Fig. 23-8. Effect of temperature on number of leaves in growing structure 4

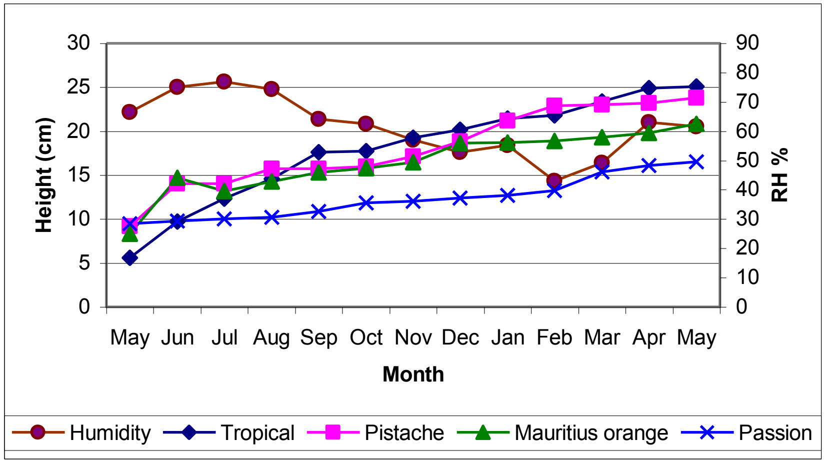


Fig. 23-9. Effect of RH on plant height in growing structure 1

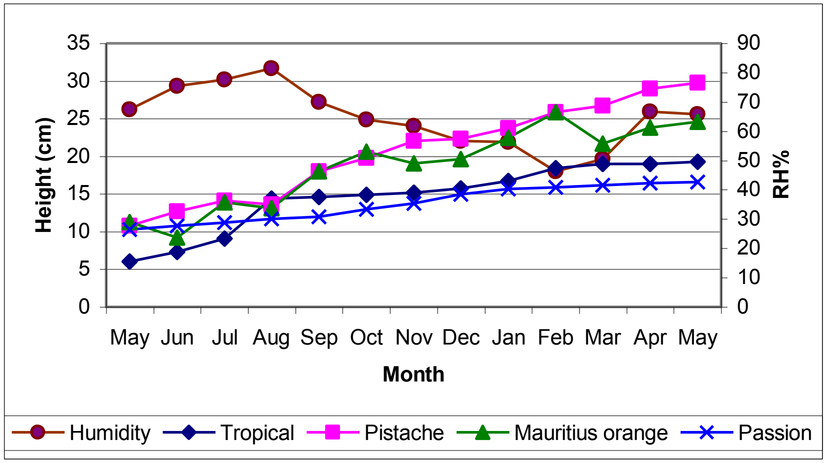


Fig. 23-11. Effect of RH on plant height in growing structure 3

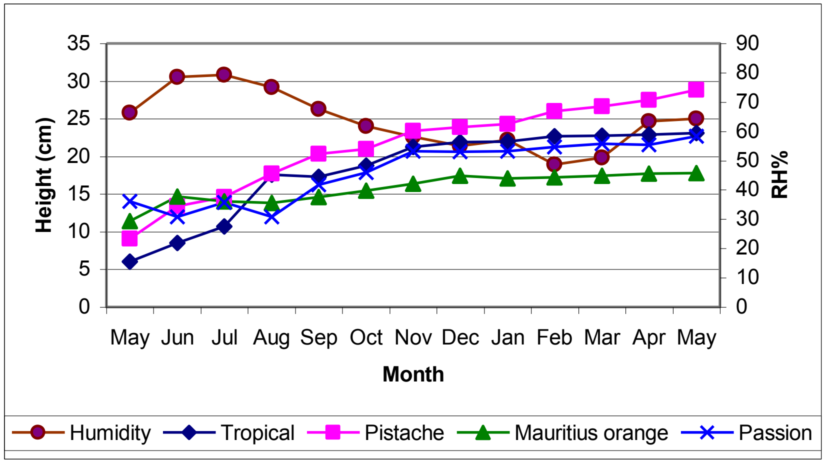


Fig. 23-10. Effect of RH on plant height in growing structure 2

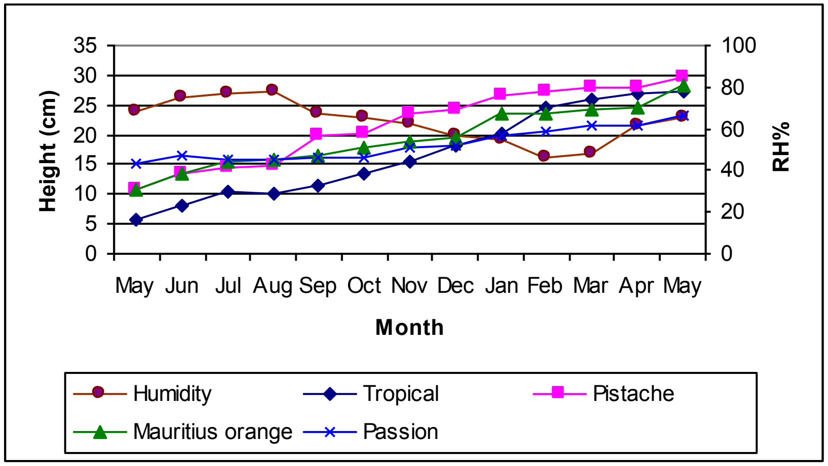


Fig. 23-12. Effect of RH on plant height in growing structure 4

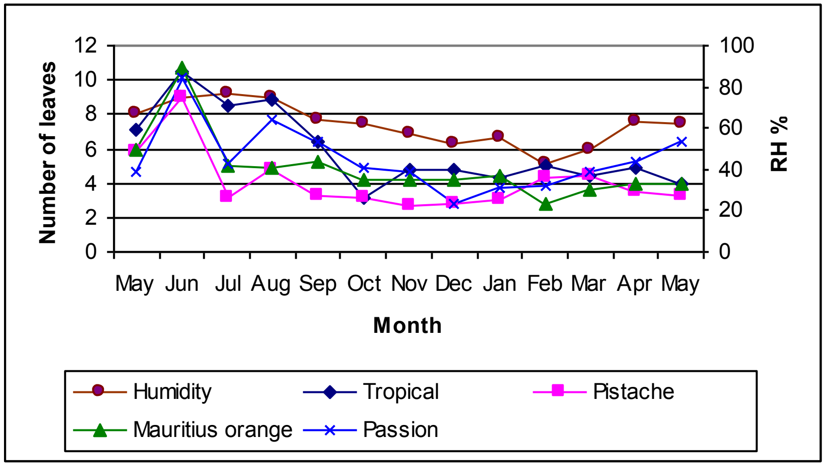


Fig. 23-13. Effect of RH on number of leaves in growing structure 1

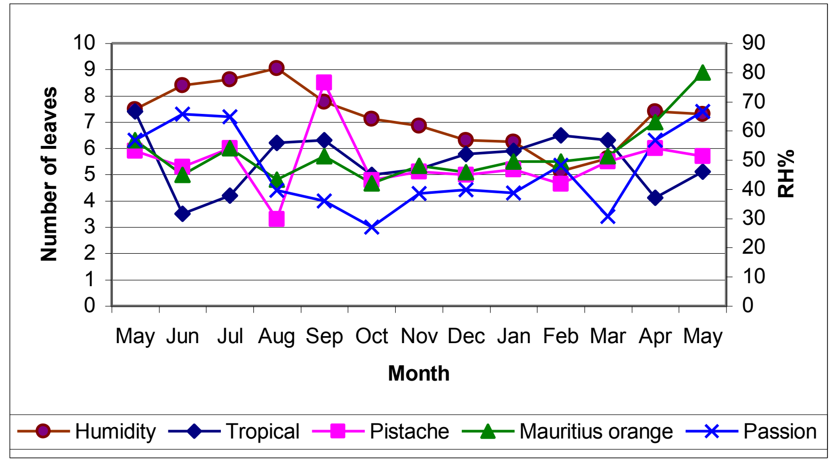


Fig. 23-15. Effect of RH on number of leaves in growing structure 3

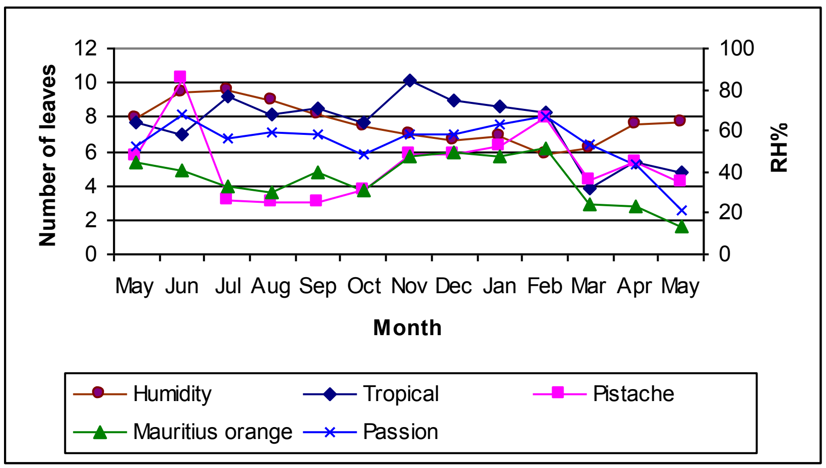


Fig. 23-14. Effect of RH on number of leaves in growing structure 2

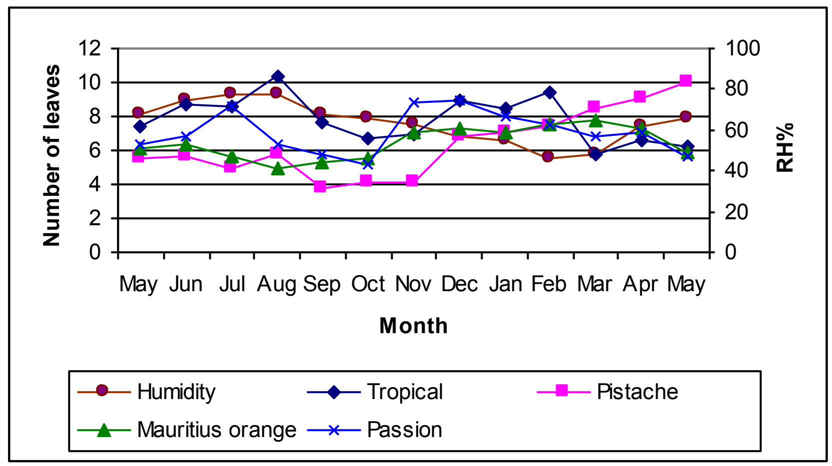


Fig. 23-16. Effect of RH on number of leaves in growing structure 4

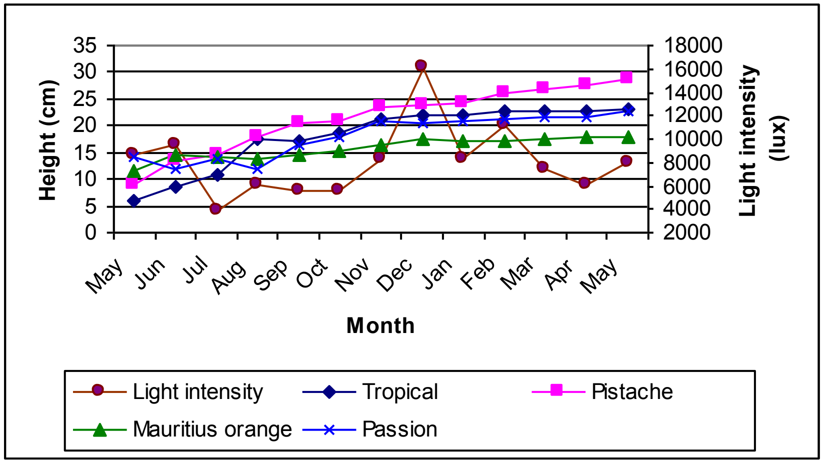


Fig. 23-17. Effect of light intensity on plant height in growing structure 1

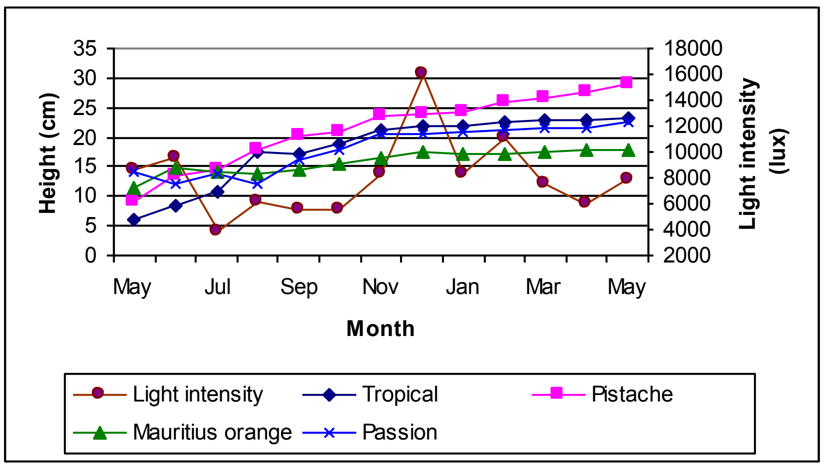


Fig. 23-18. Effect of light intensity on plant height in growing structure 2

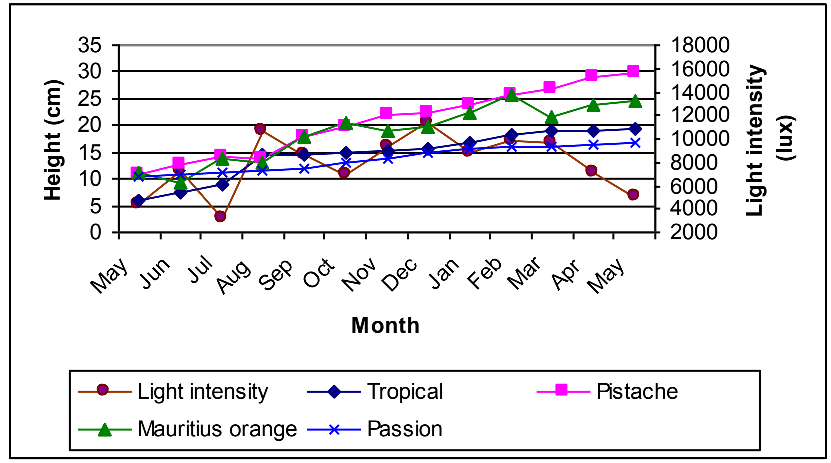


Fig. 23-19. Effect of light intensity on plant height in growing structure 3

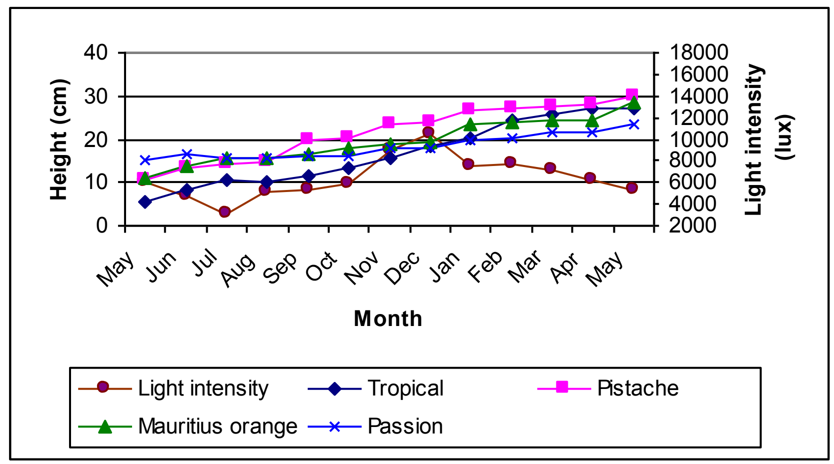


Fig. 23-20. Effect of light intensity on plant height in growing structure 4

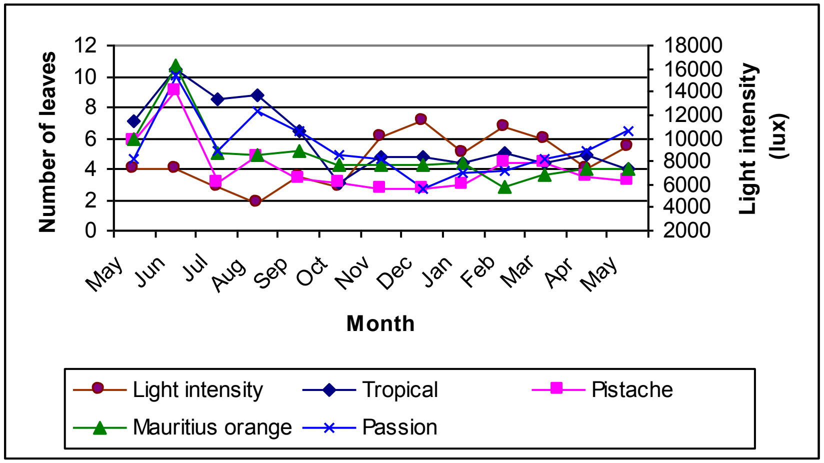


Fig. 23-21. Effect of light intensity on number of leaves in growing structure 1

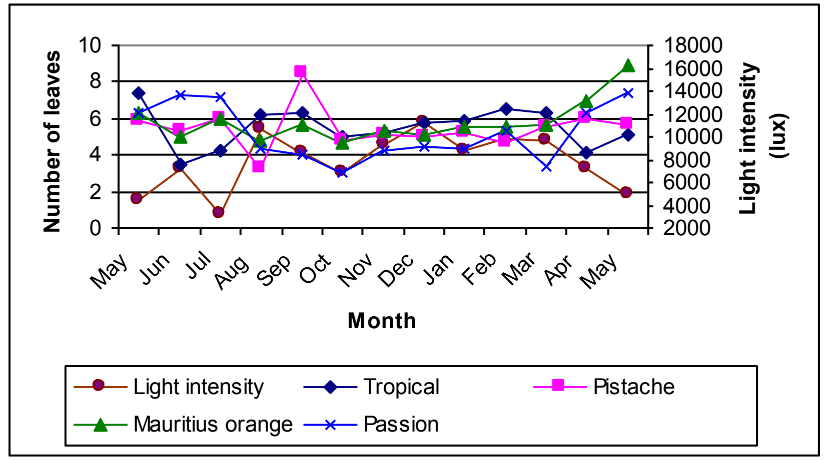


Fig. 23-23. Effect of light intensity on number of leaves in growing structure 3

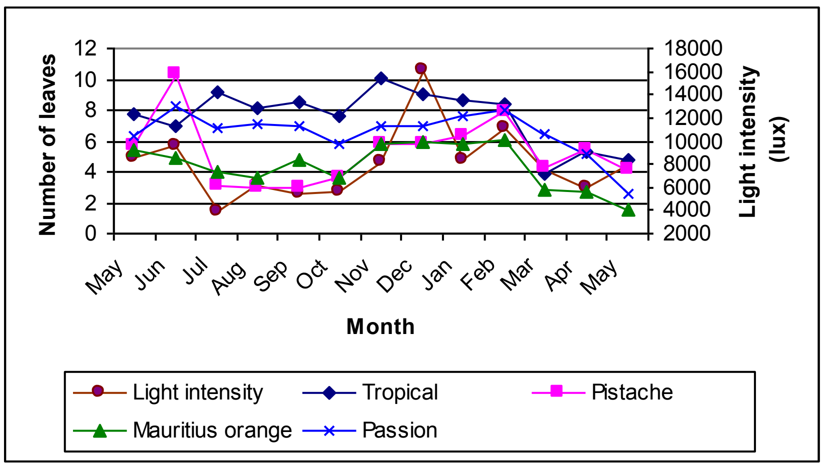


Fig. 23-22. Effect of light intensity on number of leaves in growing structure 2

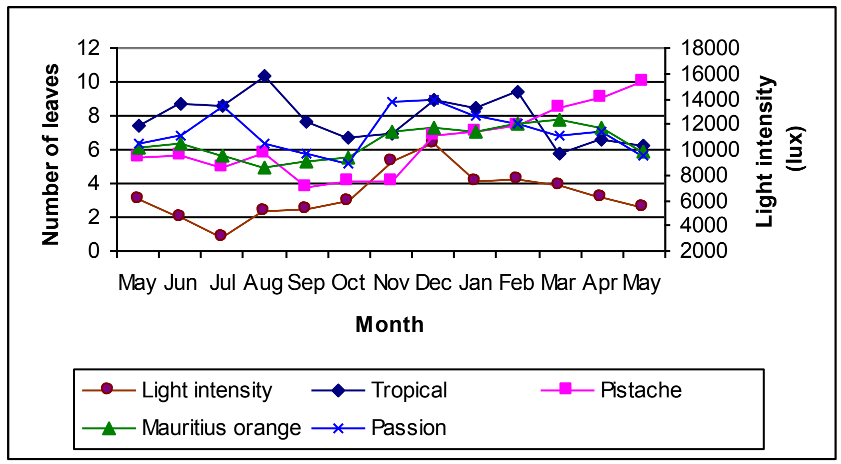


Fig. 23-24. Effect of light intensity on number of leaves in growing structure 4

Table 29. Correlations between light intensity and growth parameters of four *Anthurium andreanum* varieties in growing structure S_4

Vegetative characters	Correlation coefficient							
	V_1		V_2		V_3		V_4	
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2
Plant height (cm)	0.30	0.36	0.43	0.50	0.22	0.30	.22	.28
Plant spread EW (cm)	0.02	0.06	0.19	0.26	0.40	0.46	.14	.17
Plant spread NS (cm)	0.14	0.19	0.31	0.37	0.36	0.41	.17	.21
Leaf number	0.24	0.09	0.11	0.13	0.77**	0.70**	.50	.48
Leaf length (cm)	0.48	0.56*	0.40	0.48	0.40	0.48	-.03	.08
Leaf breadth (cm)	0.38	0.45	0.24	0.25	0.07	0.18	-.04	.13
Leaf area (cm^2)	0.40	0.47	0.31	0.34	0.23	0.33	-.06	.10
Petiole length (cm)	0.23	0.33	0.42	0.50	0.06	0.17	.15	.11

** Correlation is significant at 0.01 level (2-tailed).
* Correlation is significant at 0.05 level (2-tailed).
L_1 - Outside light intensity Lux, L_2 - Inside light intensity Lux

4.6 REGRESSION ANALYSIS

Results of the multiple regression analysis between meteorological factors and vegetative characters of four varieties grown in four growing structures are presented in tables 30 to 38. Prediction lines of vegetative characters in relation to meteorological factors are presented in Fig. 24. R^2 values reveled that the effect of meteorological factors varied with variety and growing structure. In plant height (Table 30) and leaf breadth (Table 35) the variations controlled by meteorological factors were the highest (76.20% and 66.60%, respectively) in S_1V_1. In plant spread (EW) the variation controlled by meteorological factors was the highest (66.60%) in S_4V_4 (Table 31). In plant spread (NS) the variation controlled by meteorological factors was the highest (79.50%) in S_1V_2 (Table 32). In number of leaves (Table 33) the variation controlled by meteorological factors was the highest (77.00%) in S_2V_1. In leaf length (Table 34) the variation controlled by meteorological factors was the highest (79.60%) in S_2V_4. In leaf area (Table 36) the variation controlled by meteorological factors was the highest (78.10%) in S_2V_4. In petiole length (Table 37) the variation controlled by meteorological factors was the highest (76.80%) in S_3V_2. In leaf production interval (Table 38) the variation controlled by meteorological factors was the highest (56.40%) in S_4V_1.

Table 30. Linear regression and coefficient of determination between meteorological factors data and plant height

Treatment	Regression Equation	(R^2 %)
S_1V_1	$Y = -72.404 + 2.233X_1 + 0.215\ X_2 - 0.0002X_3$	76.20
S_1V_2	$Y = -64.432 + 1.868X_1 + 0.256\ X_2 + 0.00008X_3$	62.10
S_1V_3	$Y = -36.819 + 1.072X_1 + 0.186\ X_2 + 0.0005X_3$	32.30
S_1V_4	$Y = -54.83 + 1.370X_{1+}\ 0.286X_2 + 0.0001X_3$	24.30
S_2V_1	$Y = -16.889 + 1.249X_1 – 0.127\ X_2 - 0.0002X_3$	56.10
S_2V_2	$Y = -94.658 + .554X_1 + 0.371\ X_2 - 0.00007X_3$	51.50
S_2V_3	$Y = -19.499 + 0.770X_1 + 0.115X_2 - 0.00005X_3$	49.00
S_2V_4	$Y = -25.852 + 1.061X_1 + 0.101X_2 - 0.00002X_3$	62.60
S_3V_1	$Y = -77.575 + 1.881X_1 + 0.314X_2 + 0.008X_3$	64.00
S_3V_2	$Y = -109.562 + 2.856X_1 + 0.414\ X_2 - 0.0005X_3$	69.50
S_3V_3	$Y = -50.837 + 1.653X_1 + 0.151\ X_2 - 0.0003X_3$	60.30
S_3V_4	$Y = -26.727 + 0.929X_1 + 0.105X_2 - 0.0002X_3$	70.50
S_4V_1	$Y = -138.462 + 3.319X_1 + 0.578\ X_2 - 0.0004X_3$	65.40
S_4V_2	$Y = -94.584 + 2.465X_1 + 0.390\ X_2 - 0.0008X_3$	66.40
S_4V_3	$Y = -73.933 + 2.040X_1 + 0.336X_2 + 0.00009X_3$	50.70
S_4V_4	$Y = -50.119 + 1.408\ X_1 + 0.291X_2 + 0.0001X_3$	70.40

Y = Plant height; X_1 = Temperature; X_2 = Humidity; X_3 = Light intensity

Table 31. Linear regression and coefficient of determination between meteorological factors and plant spread (EW)

Treatment	**Regression Equation**	**(R^2 %)**
S_1V_1	$Y = -53.041 +2.033X_1 +0.140\ X_2 - 0.0003X_3$	52.20
S_1V_2	$Y = -54.08 +2.254X_1 +0.120\ X_2 - 0.001X_3$	62.10
S_1V_3	$Y = -43.451 + 1.638X_1 +0.197\ X_2 - 0.0007X_3$	31.40
S_1V_4	$Y = -54.843 +1.234X_1\ 0.460\ X_2 + 0.0004X_3$	4.30
S_2V_1	$Y = 177.997 – 2.213X_1 – 1.135\ X_2 - 0.0005X_3$	30.20
S_2V_2	$Y = -136.644 + 3.529X_1 + 0.559\ X_2 + 0.0003X_3$	41.40
S_2V_3	$Y = 30.254 + 0.1416X_1 -0.185\ X_2 - 0.0002X_3$	21.00
S_2V_4	$Y = 190.055 – 2.849\ X_1 – 1.025\ \ X_2 - 0.0004X_3$	45.50
S_3V_1	$Y = -74.044 + 2.062X_1 + 0.254\ X_2 + 0.0008X_3$	52.10
S_3V_2	$Y = -88.242 + 2.454X_1 + 0.298\ X_2 + 0.001X_3$	64.10
S_3V_3	$Y = -138.010 +3.793X_1 +0.475\ X_2 + 0.0003X_3$	65.30
S_3V_4	$Y = 14.666 +0.091X_1 + 0.051\ X_2 - 0.00006X_3$	-28.20
S_4V_1	$Y = -2.916+1.205\ X_1 – 0.116\ X_2 -0.001X_3$	8.70
S_4V_2	$Y = -110.829 +3.194X_1 +0.423\ X_2 - 0.00004X_3$	58.70
S_4V_3	$Y= -106.523 +2.730X_1 +0.489\ X_2 +0.0008X_3$	58.60
S_4V_4	$Y = -53.908 +1.613\ X_1 +0.333\ \ X_2 -0.00006X_3$	66.60

Y = Plant spread (EW); X_1 = Temperature; X_2 = Humidity; X_3 = Light intensity

Table 32. Linear regression and coefficient of determination between meteorological factors and plant spread (NS)

Treatment	Regression Equation	(R^2 %)
S_1V_1	$Y = -75.240 +2.327X_1 +0.237\ X_2 + 0.0005X_3$	71.90
S_1V_2	$Y = -58.722 +2.217X_1 +0.136\ X_2 - 0.0006X_3$	79.50
S_1V_3	$Y = 8.160 + 0.785X_1 -0.119\ X_2 - 0.0010X_3$	2.70
S_1V_4	$Y = -16.310 +0.492X_{1+}\ 0.249\ X_2 + 0.0006X_3$	-22.20
S_2V_1	$Y = 161.080 – 1.744X_1 – 1.075\ X_2 - 0.0009X_3$	39.70
S_2V_2	$Y = -160.019 + 3.898X_1 + 0.700\ X_2 + 0.0005X_3$	47.10
S_2V_3	$Y = 105.304 -1.206X_1 -0.630\ X_2 - 0.0001X_3$	28.40
S_2V_4	$Y = 222.189 – 3.381\ X_1 – 1.222\ \ X_2 - 0.0005X_3$	36.70
S_3V_1	$Y = -75.296 + 2.039X_1 + 0.268X_2 + 0.001X_3$	49.70
S_3V_2	$Y = -96.719 + 2.707X_1 + 0.319\ X_2 + 0.001X_3$	53.30
S_3V_3	$Y = -127.671 +3.570X_1 +0.437\ X_2 + 0.0003X_3$	51.90
S_3V_4	$Y = 41.463 -0.437X_1 - 0.114\ X_2 - 0.00007X_3$	-30.10
S_4V_1	$Y = 32.155+0.493\ X_1 – 0.315\ X_2 -0.0009X_3$	8.80
S_4V_2	$Y = -92.321 +2.839X_1 +0.297\ X_2 - 0.00001X_3$	61.20
S_4V_3	$Y= -97.848 +2.739X_1 +0.397\ X_2 +0.0004X_3$	61.90
S_4V_4	$Y = -58.274 +1.908\ X_1 +0.265\ \ X_2 -0.0003X_3$	58.10

Y = Plant spread (NS); X_1 = Temperature; X_2 = Humidity; X_3 = Light intensity

Table 33. Linear regression and coefficient of determination between meteorological factors and number of leaves

Treatment	Regression Equation	(R^2 %)
S_1V_1	$Y = 14.071 + 0.426X_1 + 0.083\ X_2 + 0.0002X_3$	61.90
S_1V_2	$Y = -6.86 + 0.01X_1 + 0.127\ X_2 - 0.0003X_3$	-7.50
S_1V_3	$Y = -3.77 - 0.180X_1 + 0.170\ X_2 + 0.0006X_3$	41.50
S_1V_4	$Y = -17.693 + 0.235X_{1+}\ 0.222X_2 + 0.0001X_3$	35.70
S_2V_1	$Y = 86.340 – 1.443X_1 – 0.437\ X_2 - 0.0006X_3$	77.00
S_2V_2	$Y = -18.122 + 0.315X_1 + 0.143\ X_2 - 0.0004X_3$	7.70
S_2V_3	$Y = 49.307 -0.826X_1 -0.264\ X_2 - 0.0002X_3$	58.90
S_2V_4	$Y = 33.001 – 0.560\ X_1 – 0.120\ X_2 - 0.0002X_3$	6.50
S_3V_1	$Y = 32.414 – 0.512X_1 + 0.034X_2 - 0.00007X_3$	25.10
S_3V_2	$Y = -17.527 + 0.481X_1 + 0.125\ X_2 - 0.0002X_3$	20.10
S_3V_3	$Y = -127.671 + 3.570X_1 + 0.437\ X_2 + 0.0003X_3$	52.30
S_3V_4	$Y = -6.971 + 0.199X_1 + 0.102\ X_2 - 0.0002X_3$	15.40
S_4V_1	$Y = 58.170-0.857X_1 – 0.301\ X_2 -0.0002X_3$	48.80
S_4V_2	$Y = -34.963 + 0.865X_1 -0.178\ X_2 - 0.000004X_3$	34.40
S_4V_3	$Y= 0.409 + 0.145X_1 -0.002X_2 + 0.0002X_3$	63.20
S_4V_4	$Y = 9.235-0.063\ X_1 -0.027\ X_2 -0.0003X_3$	-2.20

Y = Number of leaves; X_1 = Temperature; X_2 = Humidity; X_3 = Light intensity

Table 34. Linear regression and coefficient of determination between meteorological factors and leaf length

Treatment	Regression Equation	(R^2 %)
S_1V_1	$Y = -57.478 + 1.562X_1 + 0.213\ X_2 + 0.0003X_3$	68.10
S_1V_2	$Y = -47.314 + 1.276X_1 + 0.199\ X_2 + 0.0004X_3$	73.90
S_1V_3	$Y = -11.402 + 0.502X_1 + 0.069\ X_2 + 0.0002X_3$	25.80
S_1V_4	$Y = -0.393 + 0.064X_1 + 0.098\ X_2 + 0.0005X_3$	-2.50
S_2V_1	$Y = 9.399 + 0.367X_1 – 0.172\ X_2 + 0.00008X_3$	53.20
S_2V_2	$Y = -68.927 + 1.749X_1 + 0.318\ X_2 + 0.0002X_3$	54.10
S_2V_3	$Y = -25.960 + 0.768X_1 + 0.152\ X_2 + 0.0001X_3$	51.80
S_2V_4	$Y = 105.252 – 1.612\ X_1 - 0.586\ X_2 + 0.0001X_3$	79.60
S_3V_1	$Y = -34.675 + 1.070X_1 + 0.080\ X_2 + 0.0006X_3$	58.70
S_3V_2	$Y = -51.189 + 1.401X_1 + 0.190\ X_2 + 0.0005X_3$	70.50
S_3V_3	$Y = -13.441 + 0.695X_1 + 0.020\ X_2 + 0.0001X_3$	-0.30
S_3V_4	$Y = 9.070 + 0.132X_1 – 0.028\ X_2 - 0.00001X_3$	12.10
S_4V_1	$Y = -60.004 + 1.517X_1 – 0.235\ X_2 + 0.0007X_3$	66.70
S_4V_2	$Y = -67.017 + 1.782X_1 + 0.276\ X_2 + 0.0005X_3$	64.90
S_4V_3	$Y = -67.935 + 1.624X_1 + 0.331\ X_2 + 0.0007X_3$	48.30
S_4V_4	$Y = -14.985 + 0.613\ X_1 + 0.131\ X_2 + 0.00001X_3$	-6.80

Y = Leaf length; X_1 = Temperature; X_2 = Humidity; X_3 = Light intensity

Table 35. Linear regression and coefficient of determination between meteorological factors and leaf breadth

Treatment	Regression Equation	(R^2 %)
S_1V_1	$Y = -24.760 + 0.766X_1 + 0.072\ X_2 + 0.00010X_3$	66.60
S_1V_2	$Y = -6.294 + 0.408X_1 + 0.016\ X_2 - 0.0002X_3$	25.10
S_1V_3	$Y = -15.885 + 0.359X_1 + 0.121\ X_2 + 0.0003X_3$	23.20
S_1V_4	$Y = -13.204 + 0.326X_{1+}\ 0.100X_2 + 0.0003X_3$	49.50
S_2V_1	$Y = 12.726 + 0.164X_1 – 0.161\ X_2 - 0.0001X_3$	61.30
S_2V_2	$Y = -71.893 + 1.326X_1 + 0.477\ X_2 - 0.0003X_3$	43.50
S_2V_3	$Y = -14.321 + 0.396X_1 + 0.102X_2 - 0.00006X_3$	25.30
S_2V_4	$Y = 33.716 – 0.471\ X_1 – 0.183X_2 - 0.00009X_3$	54.50
S_3V_1	$Y = -16.633 + 0.512X_1 + 0.005X_2 - 0.0003X_3$	63.90
S_3V_2	$Y = -19.270 + 0.540X_1 + 0.099\ X_2 - 0.0003X_3$	32.80
S_3V_3	$Y = -4.780 + 0.301X_1 + 0.024\ X_2 - 0.00004X_3$	-11.70
S_3V_4	$Y = 7.388 + 0.017X_1 - 0.031X_2 - 0.00005X_3$	3.70
S_4V_1	$Y = -34.974 + 0.871X_1 + 0.152\ X_2 - 0.0003X_3$	51.40
S_4V_2	$Y = -16.469 + 0.758X_1 + 0.016\ X_2 - 0.0003X_3$	65.30
S_4V_3	$Y = -41.959 + 0.957X_1 + 0.238X_2 + 0.0001X_3$	27.00
S_4V_4	$Y = 2.710 + 0.082\ X_1 + 0.021\ X_2 + 0.00007X_3$	-29.00

Y = Leaf breadth; X_1 = Temperature; X_2 = Humidity; X_3 = Light intensity

Table 36. Linear regression and coefficient of determination between meteorological factors and leaf area

Treatment	Regression Equation	(R^2 %)
S_1V_1	$Y = -685.83 + 16.78X_1 + 2.325\ X_2 + 0.003X_3$	76.20
S_1V_2	$Y = -450.416 + 11.752X_1 + 1.656\ X_2 + 0.001X_3$	62.10
S_1V_3	$Y = -270.18 + 5.849X_1 + 1.519\ X_2 + 0.004X_3$	32.30
S_1V_4	$Y = -67.59 + 2.997X_{1+}\ 1.322X_2 + 0.005X_3$	24.30
S_2V_1	$Y = 106.444 + 33.387X_1 – 2.372\ X_2 - 0.001X_3$	55.50
S_2V_2	$Y = -1102.278 + 22.82X_1 + 5.701\ X_2 - 0.002X_3$	51.40
S_2V_3	$Y = -294.353 + 6.948X_1 + 1.549X_2 - 0.001X_3$	46.50
S_2V_4	$Y = 668.301 – 10.590\ X_1 – 3.976X_2 - 0.002X_3$	78.10
S_3V_1	$Y = -325.760 + 8.858X_1 + 0.700X_2 - 0.005X_3$	62.60
S_3V_2	$Y = -534.290 + 13.031X_1 + 1.990\ X_2 - 0.004X_3$	55.80
S_3V_3	$Y = -246.962 + 7.837X_1 + 0.702\ X_2 - 0.0002X_3$	-3.10
S_3V_4	$Y = 51.218 + 0.692X_1 - 0.370X_2 - 0.0005X_3$	8.70
S_4V_1	$Y = -649.113 + 15.333X_1 + 2.424\ X_2 - 0.004X_3$	63.00
S_4V_2	$Y = -729.423 + 20.866X_1 + 1.976\ X_2 - 0.002X_3$	73.20
S_4V_3	$Y = -966.068 + 20.305X_1 + 4.841X_2 + 0.005X_3$	52.10
S_4V_4	$Y = -121.755 + 3.959\ X_1 + 0.913\ X_2 + 0.0005X_3$	-19.60

Y = Leaf area; X_1 = Temperature; X_2 = Humidity; X_3 = Light intensity

Table 37. Linear regression and coefficient of determination between meteorological factors and petiole length

Treatment	Regression Equation	(R^2 %)
S_1V_1	$Y = -65.92 + 2.204X_1 + 0.167 X_2 + 0.0007X_3$	51.80
S_1V_2	$Y = -45.91 + 1.635X_1 + 0.142 X_2 - 0.0005X_3$	64.50
S_1V_3	$Y = -35.547 + 1.077X_1 + 0.176 X_2 - 0.0002X_3$	23.70
S_1V_4	$Y = -32.644 + 0.927X_{1+} 0.207 X_2 - 0.0002X_3$	23.30
S_2V_1	$Y = -9.851 + 1.019X_1 – 0.121 X_2 - 0.0004X_3$	52.40
S_2V_2	$Y = -77.754 + 2.207X_1 + 0.268 X_2 + 0.000008X_3$	50.60
S_2V_3	$Y = -27.366 + 0.787X_1 + 0.191X_2 - 0.0001X_3$	19.60
S_2V_4	$Y = -32.397 + 1.080 X_1 + 0.162 X_2 - 0.00005X_3$	38.50
S_3V_1	$Y = -81.758 + 1.853X_1 + 0.366X_2 + 0.0008X_3$	57.20
S_3V_2	$Y = -120.634 + 2.973X_1 + 0.471 X_2 + 0.0007X_3$	76.80
S_3V_3	$Y = -33.595+1.195X_1 + 0.078X_2 + 0.0004X_3$	51.30
S_3V_4	$Y = -30.070 + 0.789X_1 + 0.182 X_2 - 0.0004X_3$	31.40
S_4V_1	$Y = -151.669+3.314 X_1 + 0.727 X_2 + 0.0007X_3$	51.70
S_4V_2	$Y = -93.909 + 2.423X_1 + 0.376 X_2 - 0.0007X_3$	66.00
S_4V_3	$Y = -29.812 + 1.180X_1 + 0.120X_2 + 0.0003X_3$	20.10
S_4V_4	$Y = -59.412 + 1.712 X_1 + 0.275 X_2 - 0.0004X_3$	63.00

Y = Petiole length; X_1 = Temperature; X_2 = Humidity; X_3 = Light intensity

Table 38. Linear regression and coefficient of determination between meteorological factors and leaf production interval

Treatment	Regression Equation	(R^2 %)
S_1V_1	$Y = 281.720 - 4.324X_1 - 1.426 X_2 - 0.0008X_3$	-34.50
S_1V_2	$Y = 215.047 – 2.110X_1 - 0.998 X_2 - 0.0054X_3$	19.60
S_1V_3	$Y = 1000.28 – 18.059X_1 – 5.176 X_2 - 0.002X_3$	-33.60
S_1V_4	$Y = 799.170 – 12.803X_1 – 4.427 X_2 - 0.006X_3$	30.80
S_2V_1	$Y = 578.299 – 9.861X_1 – 3.040 X_2 - 0.0005X_3$	-3.30
S_2V_2	$Y = -254.974 + 5.152X_1 + 1.786 X_2 – 0.0004X_3$	-31.70
S_2V_3	$Y = -545.453 + 12.006X_1 + 2.944 X_2 - 0.002X_3$	-11.70
S_2V_4	$Y = 92.370 – 0.161 X_1 – 0.672 X_2 - 0.001X_3$	-3.20
S_3V_1	$Y = -319.282 + 7.835X_1 + 1.308 X_2 - 0.0003X_3$	-5.00
S_3V_2	$Y = -375.525 + 8.818X_1 + 1.993 X_2 - 0.002X_3$	14.70
S_3V_3	$Y = 280.207 – 4.223X_1 – 1.233 X_2 - 0.002X_3$	-7.60
S_3V_4	$Y = 100.908 – 1.748X_1 + 0.098 X_2 - 0.001X_3$	12.10
S_4V_1	$Y = 650.112 - 10.69 X_1 – 30614 X_2 - 0.006X_3$	56.40
S_4V_2	$Y = 155.430 - 20685X_1 - 0.447 X_2 - 0.0002X_3$	16.30
S_4V_3	$Y\ 360.72 - 30327X_1 - 20639 X_2 - 0.005X_3$	49.30
S_4V_4	$Y = 330.574 - 9.060 X_1 - 0.270 X_2 + 0.004X_3$	39.80

Y = Leaf production interval; X_1 = temperature; X_2 = Humidity; X_3 = Light intensity

Fig.24. Prediction lines of vegetative characters of anthurium (var. Tropical) in relation to meteorological factors

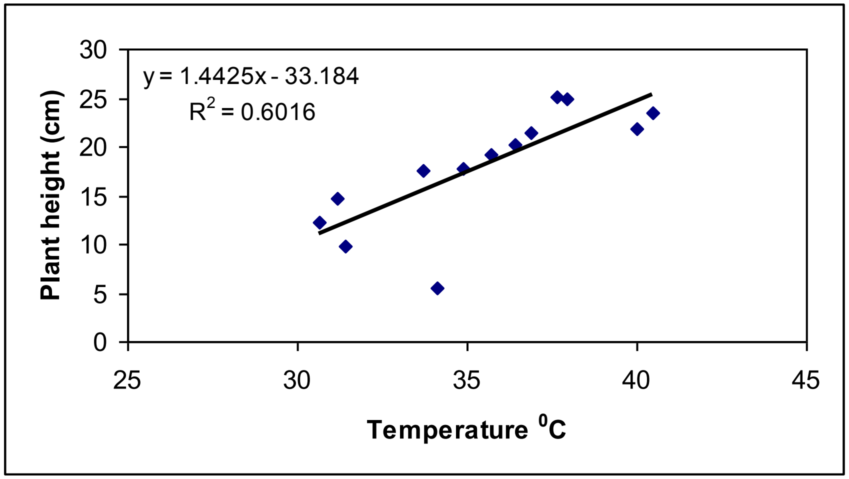


Fig. 24-1. Effect of temperature on plant height in growing structure 1

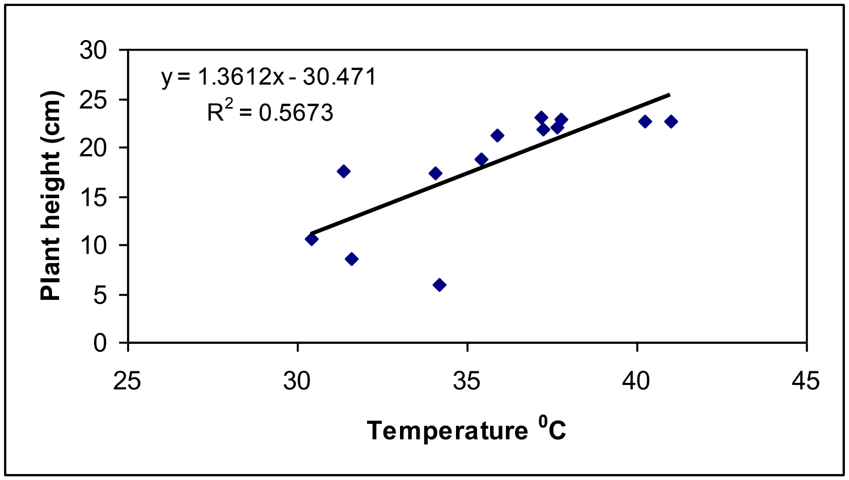


Fig. 24-2. Effect of temperature on plant height in growing structure 2

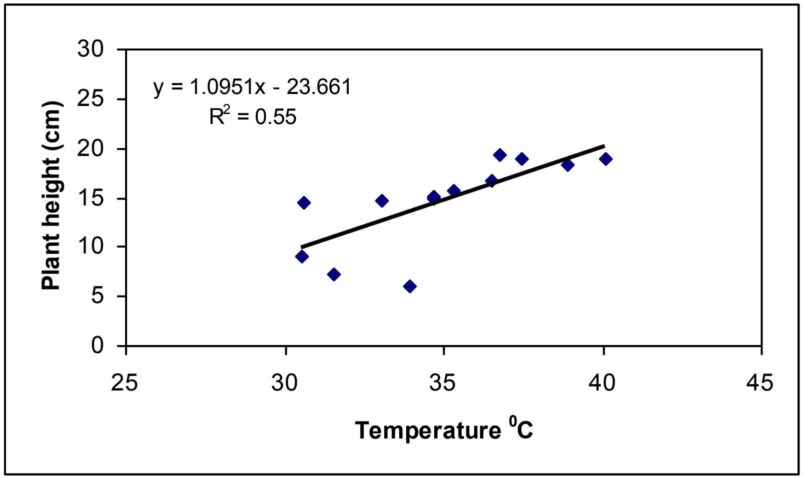


Fig. 24-3. Effect of temperature on plant height in growing structure 3

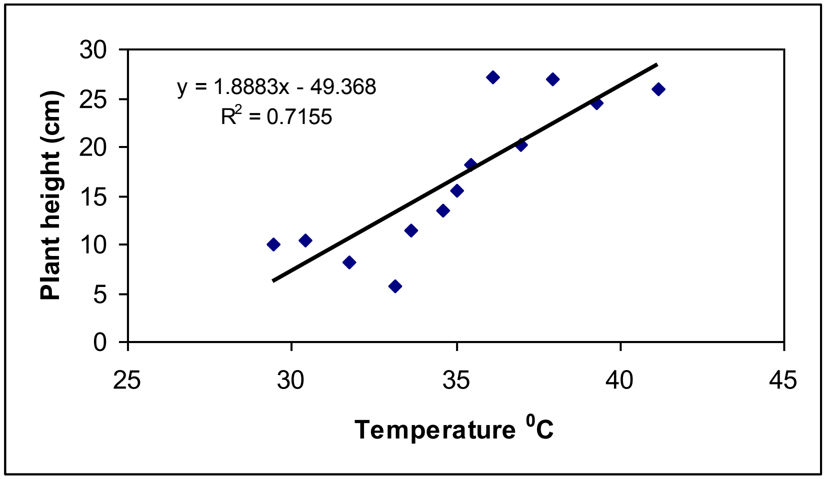


Fig. 24-4. Effect of temperature on plant height in growing structure 4

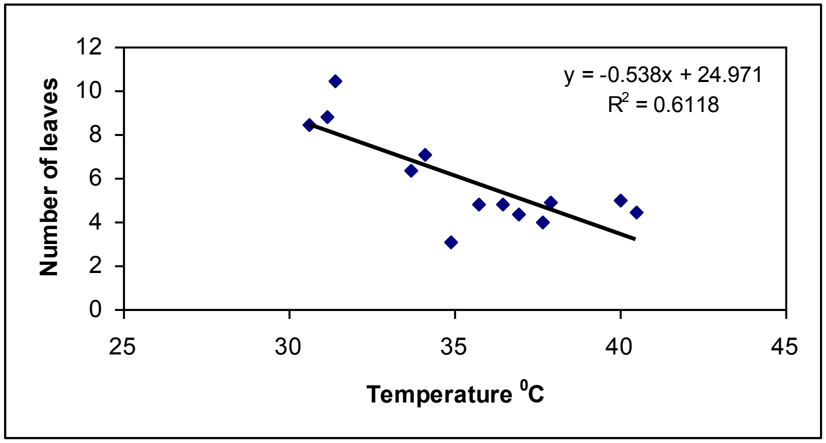


Fig. 24-5. Effect of temperature on number of leaves in growing structure 1

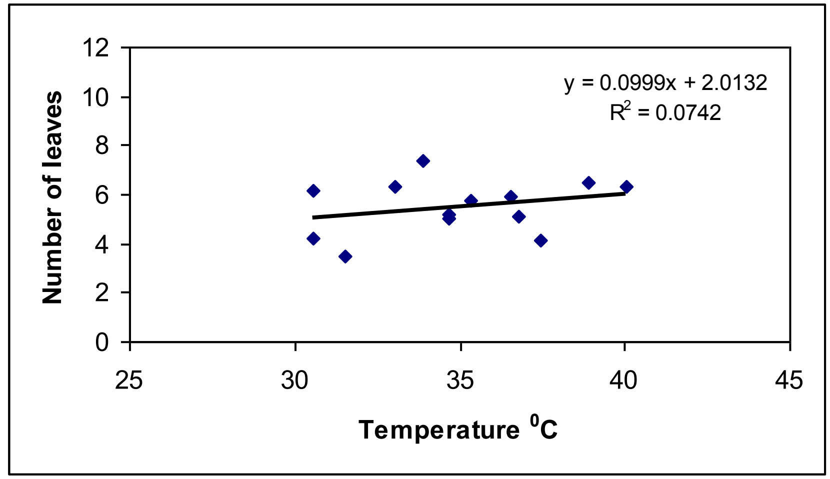


Fig. 24-7. Effect of temperature on number of leaves in growing structure 3

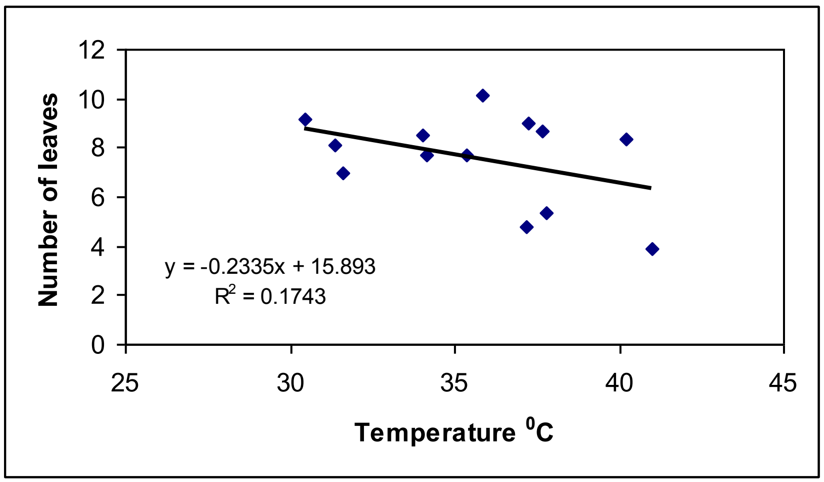


Fig. 24-6. Effect of temperature on number of leaves in growing structure 2

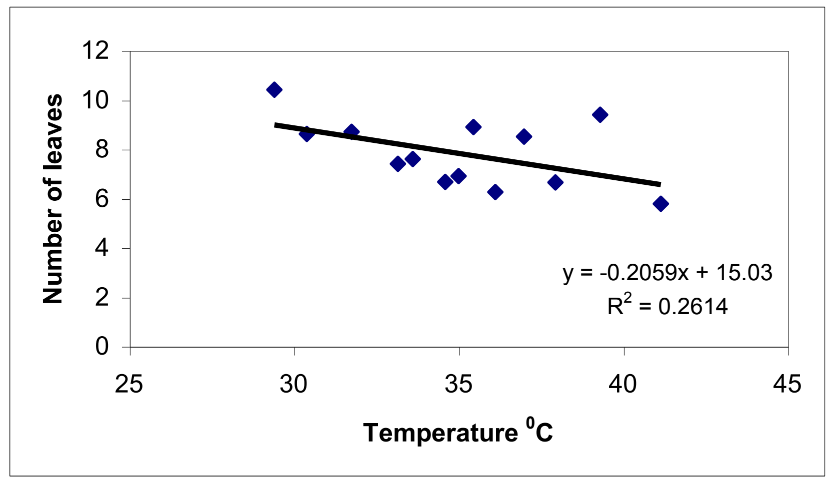


Fig. 24-8. Effect of temperature on number of leaves in growing structure 4

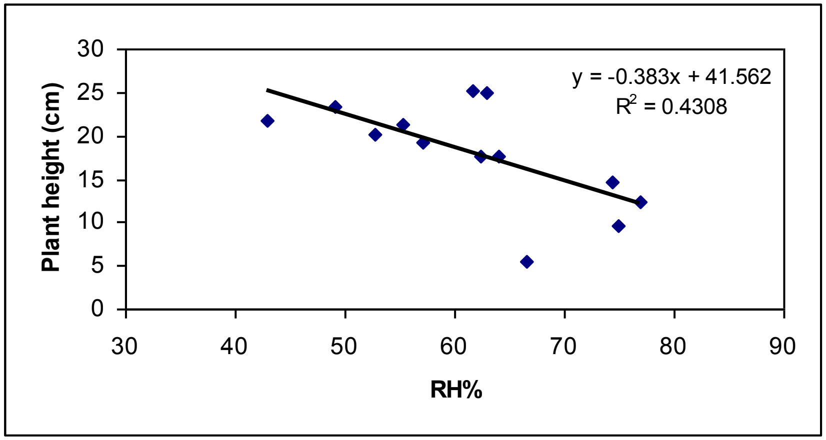


Fig. 24-9. Effect of RH on plant height in growing structure 1

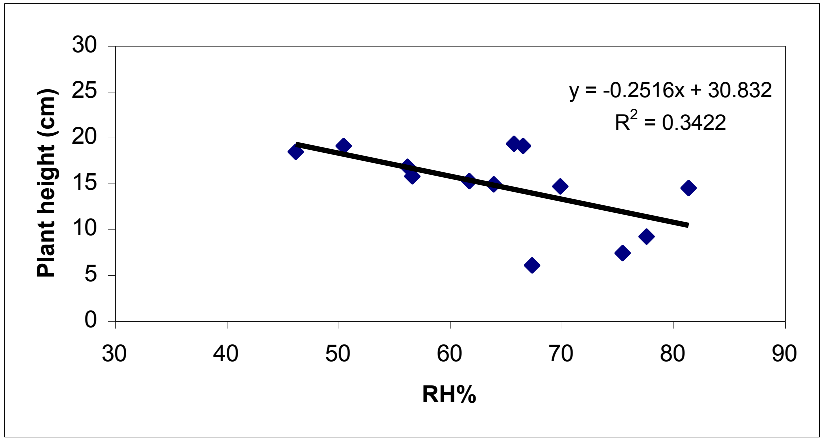


Fig. 24-11. Effect of RH on plant height in growing structure 3

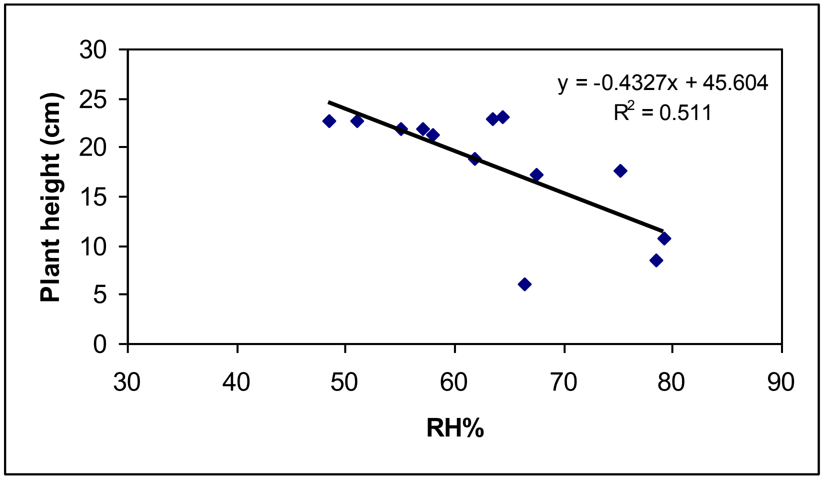


Fig. 24-10. Effect of RH on plant height in growing structure 2

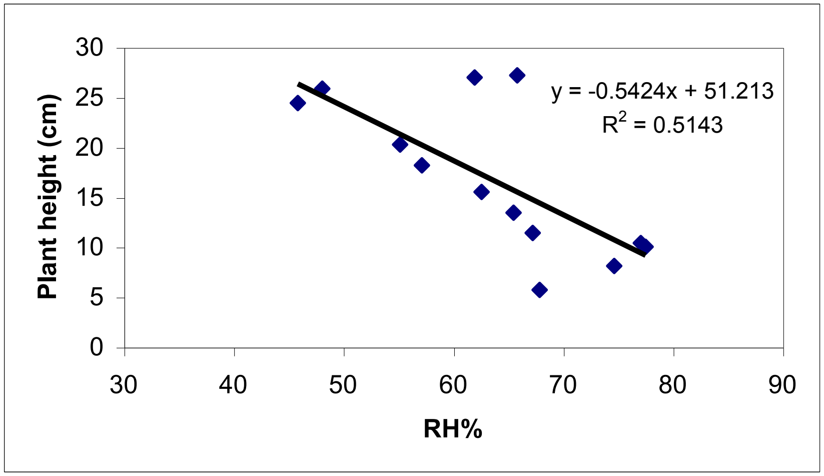


Fig. 24-12. Effect of RH on plant height in growing structure 4

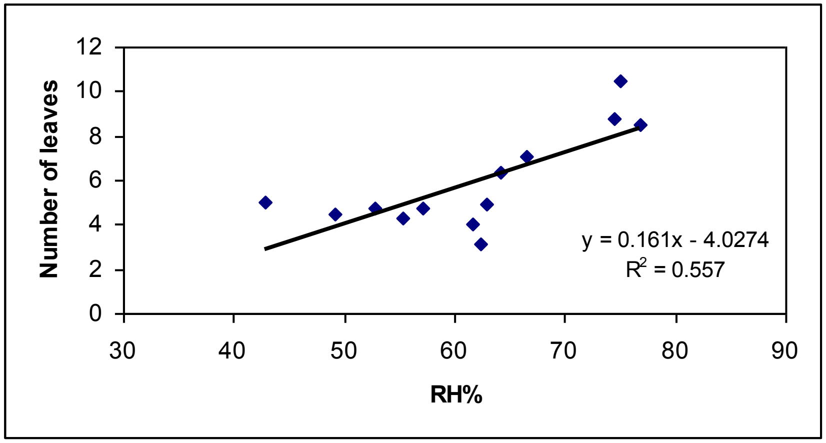


Fig. 24-13. Effect of RH on number of leaves in growing structure 1

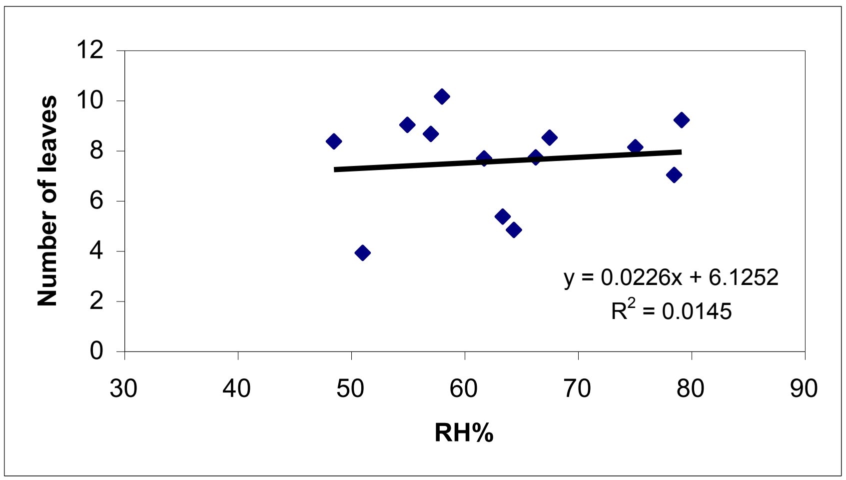


Fig. 24-14. Effect of RH on number of leaves in growing structure 2

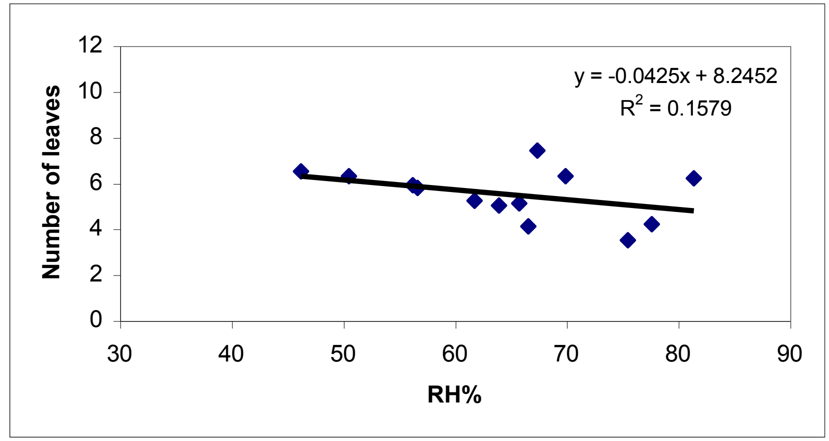


Fig. 24-15. Effect of RH on number of leaves in growing structure 3

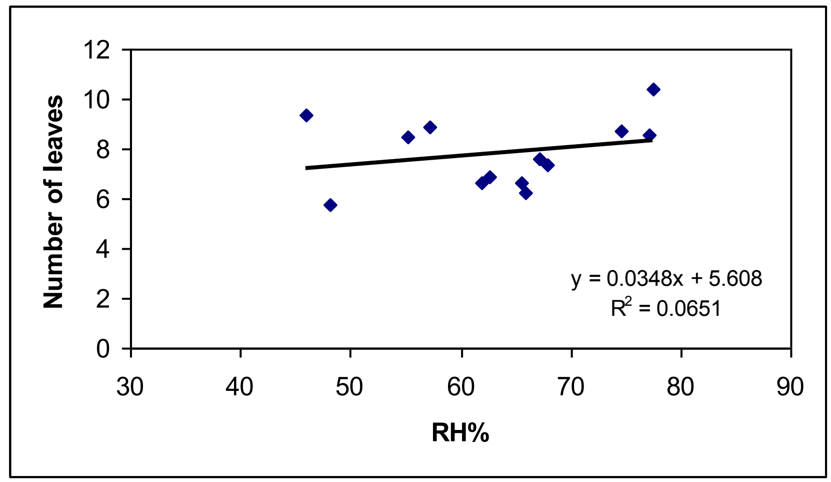


Fig. 24-16. Effect of RH on number of leaves in growing structure 4

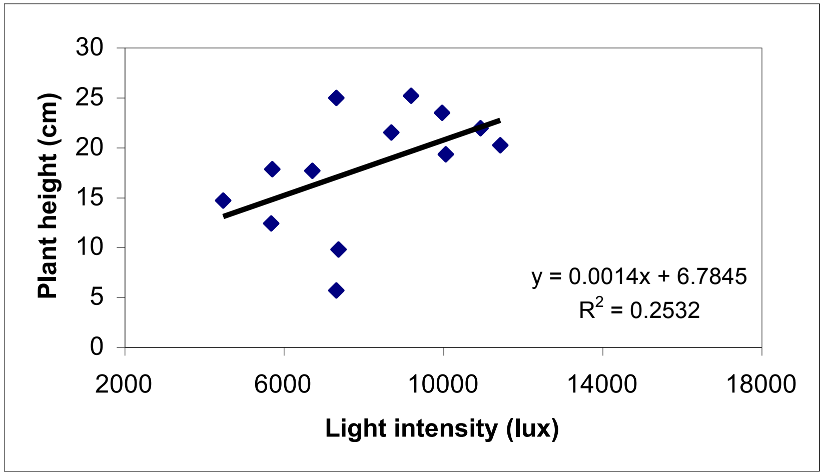


Fig. 24-17. Effect of light intensity on plant height in growing structure 1

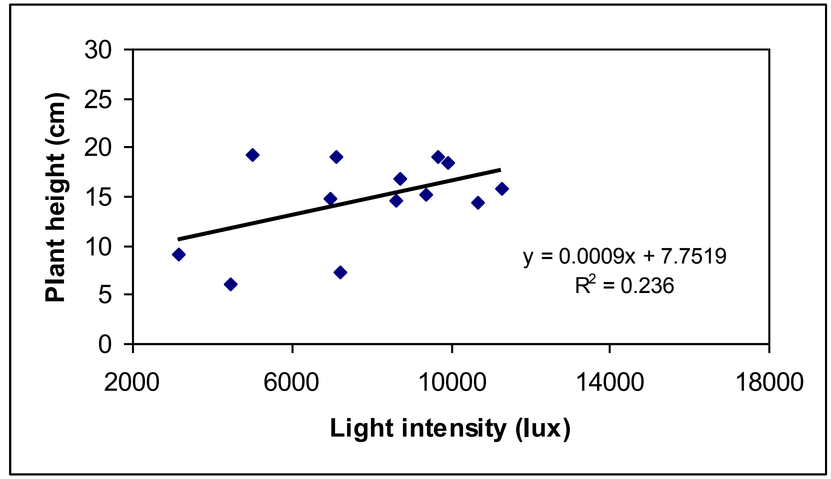


Fig. 24-19. Effect of light intensity on plant height in growing structure 3

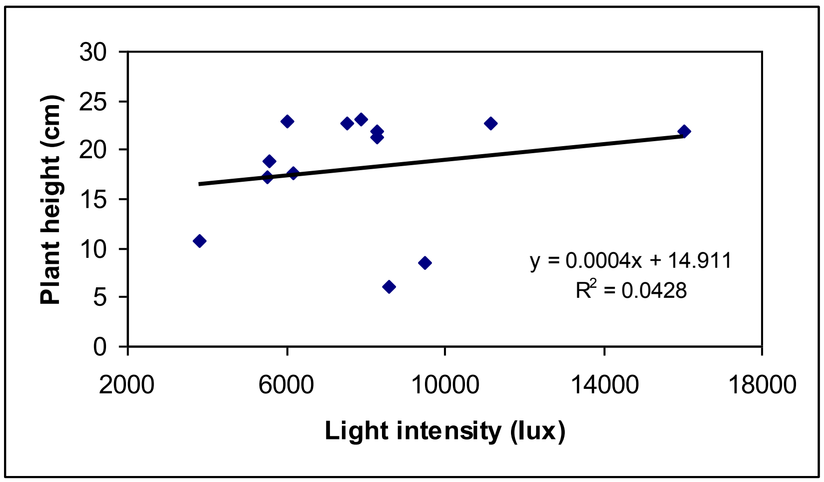


Fig. 24-18. Effect of light intensity on plant height in growing structure 2

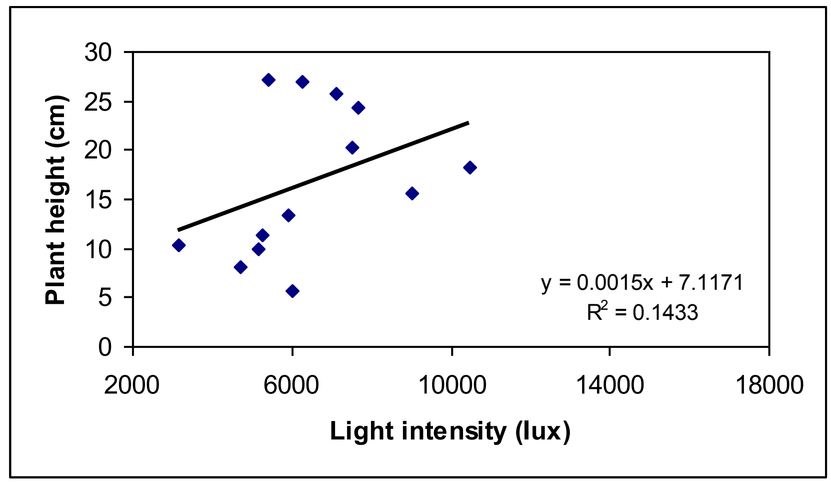


Fig. 24-20. Effect of light intensity on plant height in growing structure 4

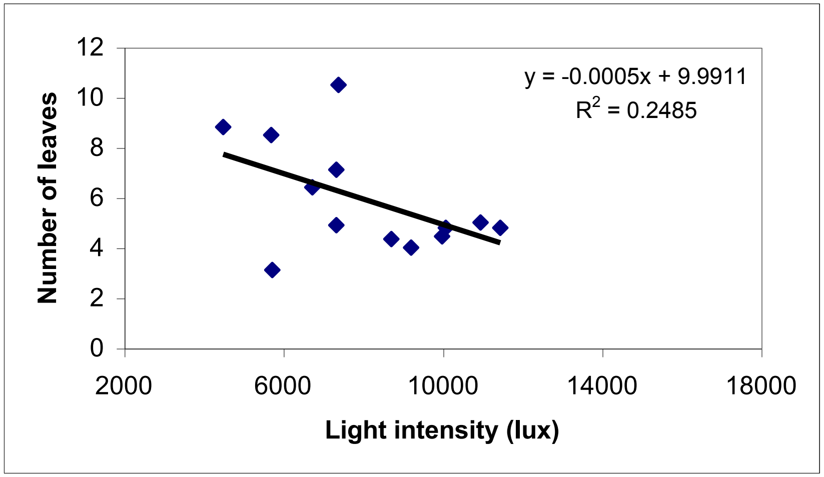
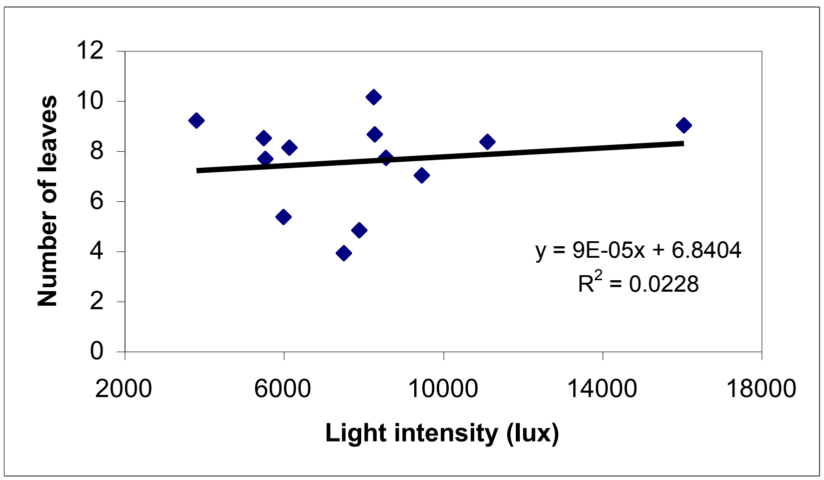


Fig. 24-21. Effect of light intensity on number of leaves in growing structure 1



ig. 24-22. Effect of light intensity on number of leaves in growing structure2

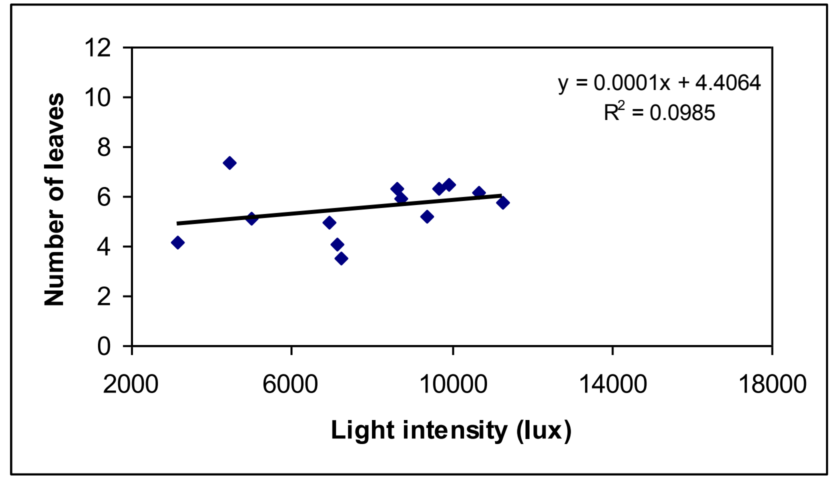


Fig. 24-23. Effect of light intensity on number of leaves in growing structure 3

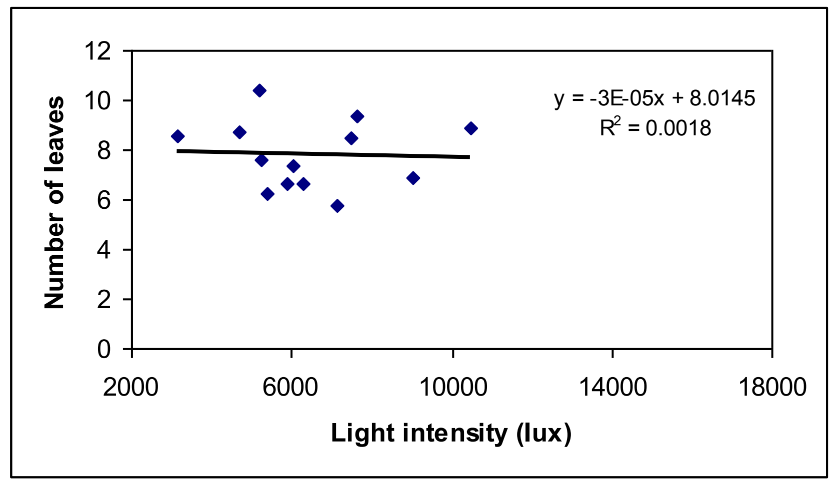


Fig. 24-24. Effect of light intensity on number of leaves in growing structure 4

Plate 1. Anthurium varieties selected for the experiment

Tropical (V_1)

Pistache (V_2)

Mauritius Orange (V_3)

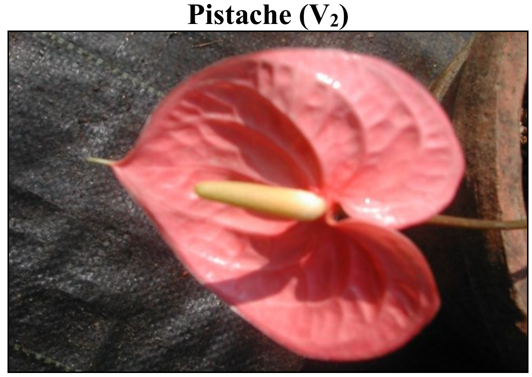
Passion (V_4)

Plate 2. Flowers of anthurium varieties selected for the experiment

Tropical (V_1)

Pistache (V_2)

Mauritius Orange (V_3)



Passion (V_4)

Plate 3. Growing systems

Structure 1

Structure 2

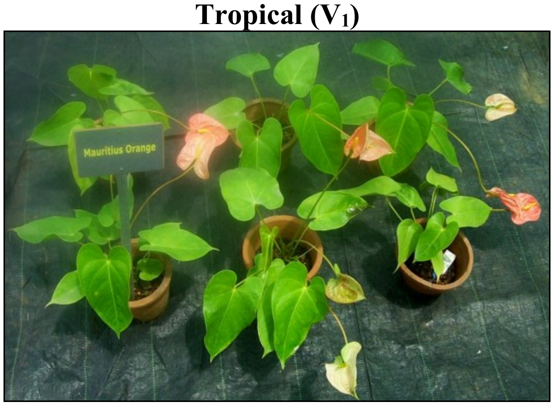
Structure 3

Structure 4

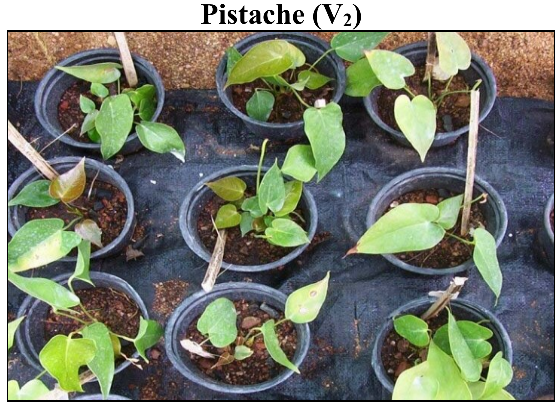
Plate 4. Performance of anthurium varieties in May planting (P_1)

Tropical (V_1)

Pistache (V_2)



Mauritius Orange (V_3)



Passion (V_4)

Plate 5. Performance of anthurium varieties in October planting (P_2)

Tropical (V_1)

Pistache (V_2)

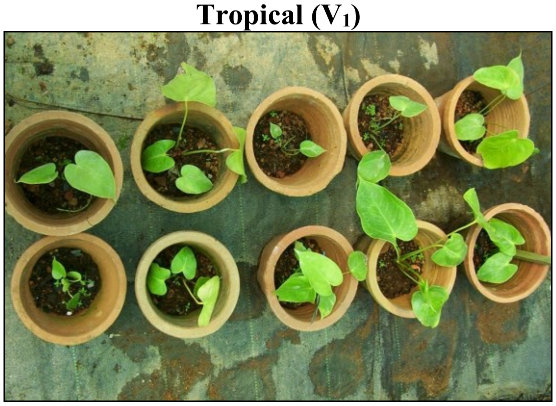
Mauritius Orange (V_3)

Passion (V_4)

Plate 6. Performance of anthurium varieties in February planting (P_3)

Tropical (V_1)

Pistache (V_2)



Mauritius orange (V_3)

Passion (V_4)

Plate 7. Performance of anthurium varieties in growing system - S_1

Tropical (V_1)

Pistache (V_2)

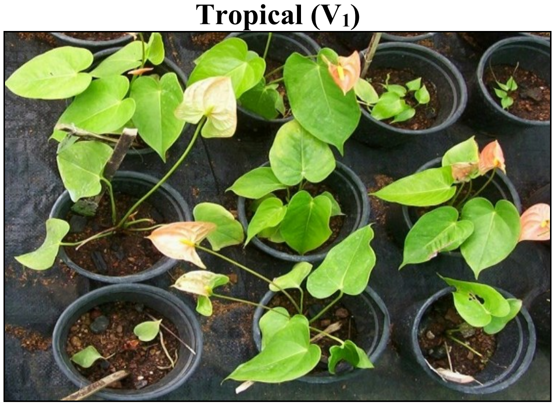
Mauritius Orange (V_3)

Passion (V_4)

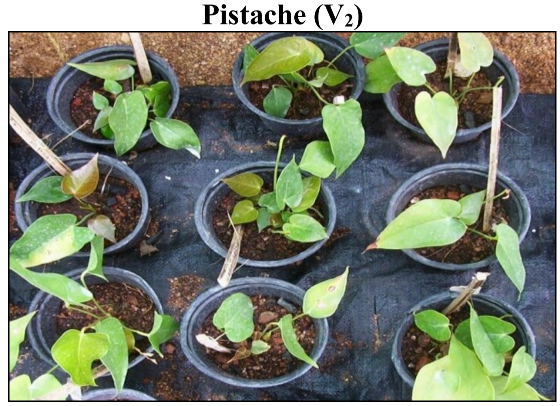
Plate 8. Performance of anthurium varieties in growing system – S_2

Tropical (V_1)

Pistache (V_2)



Mauritius Orange (V_3)



Passion (V_4)

Plate 9. Performance of anthurium varieties in growing system – S_3

Tropical (V_1)

Pistache (V_2)

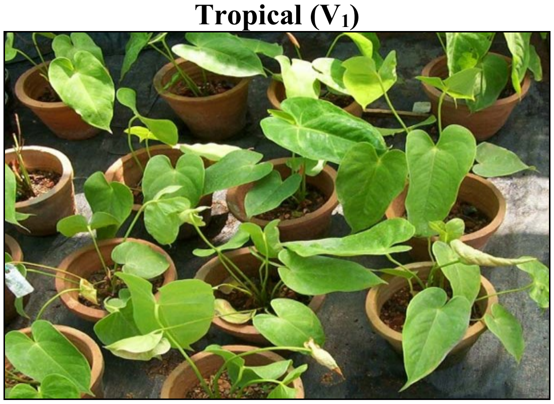
Mauritius Orange (V_3)

Passion (V_4)

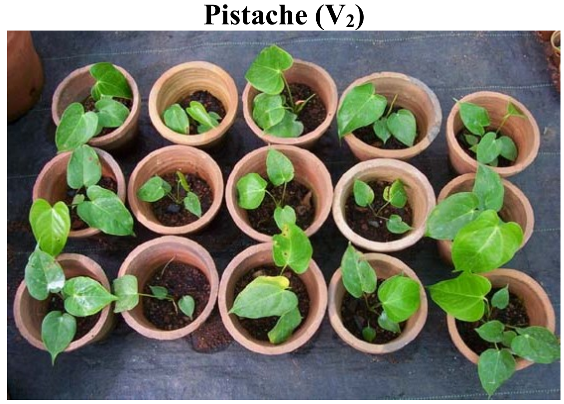
Plate 10. Performance of anthurium varieties in growing system – S_4

Tropical (V_1)

Pistache (V_2)



Mauritius Orange (V_3)



Passion (V_4)

Discussion

5. DISCUSSION

Results of the investigations on the "Microclimatic relations on the growth, yield and quality of anthurium (*Anthurium andreanum* Linden) under different growing systems" are discussed here.

Anthurium is a tropical flower which has gained global importance as a major cut flower crop of the modern world. It is an important tropical ornamental plant largely cultivated for its long lasting flowers. The popularity of growing anthurium as a cut flower crop has risen in the past few years and it has now become an important export oriented crop. It can be grown easily provided the plants are given the right green house conditions.

Anthurium is sensitive to high light intensity, temperature, rainfall and aeration. The system of growing is very important in anthurium, which determines the yield and quality of flowers. Experiments conducted in Kerala Agricultural University, Thrissur, Kerala have shown that it is ideal to grow anthurium in the plains under 75-80 per cent shade using UV stabilized shade nets (Salvi, 1997). Practical experience has revealed that high temperature combined with poor aeration delays the emergence of flower buds and the plants become susceptible to diseases. Covering the sides of the shade house with 25-35 per cent shade net and providing top ventilation improve growth and yield of plants. The shade house does not provide protection from rainfall and external temperature and hence the risk of damage to plants and flowers is great. Moreover rain washes away fertilizers in the medium. Hence it may be necessary to provide poly film on the roof for protection from rainfall.

5.1. PLANTING TIME

In the present study, four anthurium varieties (Tropical, Pistache, Mauritius Orange and Passion) were grown in four growing structures. There were three planting times, viz., May, October and February. The effects of each of these factors and their interactions were studied. Results revealed that *influence of planting time differed significantly irrespective of variety and growing structure. May planting was significantly superior with respect to plant height and spread while October planting was significantly superior in respect of leaf characters (leaf length, breadth and area) and days to first flowering. In October planting the plants came to flowering in 52.56 days while in May planting the first flowering occurred 74.56 days after planting.*

The importance of time of planting of anthurium on growth and flowering was emphasized based on the results of the study. The time taken for first flowering could be reduced by three weeks by planting in October instead of planting in May. The significant influence of planting time on growth in terms of shoot production, plant height, first leaf production, leaf area and flower yield in anthurium and other flower crops were reported by several scientists like Kalasareddi *et al.,* (1997) and Salvi *et al.*, (2003) in gladiolus and Dubey and Shukla (2002) in tuberose.

The influence of planting time on cut flower quality is also well established. In *Alstroemeria* cultivars delaying planting after November, the traditional planting time for the crop, delayed flowering by three weeks (Lisiecka, 1993). Better quality of flowers was also reported in *Lilium spp* by early planting (Su et al, 1999). Cut flower quality was highest in chrysanthemum when potted between February and September that flowered between April and November (Bres and Jeizy, 2004). Flowering could be advanced and longer flower stems with more flowers per inflorescence were obtained in *Lathyrus latifolius* from seeds that were sown earlier in January than in June (Koike *et al.*, 2004).

In the present investigation the reason for early flowering in anthurium planted in October compared to May planting could be attributed to better leaf growth in plants in terms of leaf length, breadth and area. The leaf area was 67.74 cm^2 in plants of October planting after six months while it was 61.32 cm^2 in plants of May planting. In Kerala anthurium is grown in shade houses where the main purpose is to protect plants from high temperature/solar radiation. UV stabilized polyethylene film is also used in the structure. This will also provide protection from rainfall. Under this system, where the growth of the plant is controlled by weather parameters like air temperature, relative humidity and solar radiation, the growth and flowering could be advanced by adjusting the planting time.

5.2.VARIETY

The four varieties of anthurium used in the present study, Tropical, Pistache, Mauritius Orange and Passion, differed significantly with respect to vegetative and floral characters. An ideal anthurium variety should have compact plants with short internodes; producing suckers profusely; bright clear coloured, showy, heart shaped spathe with plenty of blisters and symmetrical overlapping of basal lobes; spadix shorter in length than the spathe, reclining to the spathe, oriented at an angle less than 30^o; an erect, long flower stem, about five times the length of the spathe and resistance to common diseases and pests (Rajeevan *et al* 2002).

Varietal differences in plant and flower characters, growth, production and post harvest qualities of anthurium have already been reported. In a study using five varieties of *A. andreanum,* Bindu and Mercy (1994) observed the largest spathe size was for the variety ‘Pink’ and the smallest for ‘Lady Jane. In a similar study, Sindhu (1995) found that the varieties ‘Pink’ and ‘Kalimpong Red’ produced super large flowers and the smallest flowers were produced in the variety ‘White’. Henny (1999) recorded that the new variety ‘Red Hot’ had 6 to 7 cm long and 4 to 5 cm wide spathes. Renu (1999) compared 10 varieties, which showed significant variation in height ranging from 29.7 cm in 'Midori' to 70.9 cm in 'Pompon Red'. According to Rajeevan *et al.* (2002) the spathe size ranged from 7 cm in ‘White’ 17 cm in ‘Pink’ and 'Kalimpong Red'.

In the present studies, among the four varieties, plant spread, leaf number and leaf area were the highest in the variety Pistache (V_2) compared to the other varieties. Among the varieties, which flowered regularly, the time taken for first *flowering was the shortest in Pistache (65.67 days). The most popular variety Tropical, flowered 82.75 days after planting.*

Leaf longevity was also higher in Pistache (163.32 days) compared to Tropical (152.43 days). With respect to spathe characters also Pistache was significantly superior to other varieties. Longevity of spike in the plant was the highest in Pistache (153.00 days). Vase life was also highest in Pistache (19.58 days) compared to 13.00 days in Tropical.

The assortment of cut flower varieties is annually expanding. Red colour was preferred most in Dutch market and there were nine colour groups like red, pink, green edged, mixed, white, cream, green orange and miscellaneous (Rajeevan, et al. *2002). Among the four varieties included under the study Tropical is preferred because of its bright red colour. The variety Pistache comes under the green colour group.*

The colour preference for anthurium varies throughout Europe. Since the flowers satisfy an aesthetic need rather than a physical need the demand for certain colours may change drastically. Light colours and novelty colours are slowly gaining importance in place of bright colours. In this case Pistache along with Tropical can be considered good for commercial cultivation.

5.3.GROWING SYSTEM

A green house system mainly consists of three aspects, viz., structure, environment control and crop management. The first two aspects provide favourable environment for successful growing of the crop, whereas the third one facilitates production of large quantity of high quality produce.

In countries with tropical climate, a shade hall is the most widely used green house system for anthurium. In consists of a wooden or steel frame on which a permanent, 75 per cent shade curtain is erected. The curtain diverts 75 per cent of the light. With this relatively small investment, anthurium can be protected from too much sunlight.

The shade hall does not provide protection from rain and extreme temperature, so that the risk of damage to plants or flowers is great. Moreover, rain rinses away the fertilizers and there is still a high risk of infection. Shade halls can be improved by adding a plastic rain screen. Since the plastic screen blocks the ventilation, temperature can rise sharply. It is therefore important to make large ventilation openings in the screen construction.

In the present study, four structures viz, poly house with shade net on sides with top ventilation (S_1), poly house with ventilation on both sides and side curtains of poly film (S_2), a low cost structure with poly film and shade net on top and side curtains of shade nets (S_3) and shade house with shade net on top and sides without poly film (S_4) were used for growing four varieties of anthurium. Shade nets were used in such way as to divert 75-80 per cent of light.

The results revealed that the growing structures differed significantly with respect to their effects on growth and flowering of anthurium, irrespective of planting time and variety. Growing structure S_3 (low cost structure) was superior to the other growing structures in terms of plant height, spread and leaf area. Days taken to first flowering varied from 43.71 days in S_2 to 78.76 days in S_1. In S_3, plant came to flowering 62.96 days after planting. Longevity of spike on the plant was the highest in S_1 (124.25 days), which was on par with that in S_3 (116.60 days).

The effect of growing structure on growth and flowering of cut flowers was reported in earlier studies. The more suitable shade level for vegetative characters, uptake of nutrients and flower quality in anthurium was reported to be 80 per cent while flowering was earlier under 70 per cent shade (Valsalakumari *et al.* 2001). Performance of rose varieties was reported to be better in plastic green house with automated roof ventilation (Cooman *et al.*, 1999). Performance of *Alstroemeria* varied significantly in different green houses (Beltran *et al.*, 2003). In Yercaud, Tamil Nadu *Gerbera* varieties performed better under low cost poly houses covered with 25 per cent shade net (Jothi *et al.*, 2003) and anthurium varieties under 50 per cent shade net (Praneetha *et al.*, 2002).

In all the structures the outside air temperature influenced the inside air temperature (Tables 15-18). In S_1 and S_4 inside temperature was slightly lower than the outside temperature. In S_2 inside temperature was slightly higher than the outside temperature. This structure had its sides covered with polyethylene film instead of shade nets as in other three structures. This might be the reason for the higher temperature. In S_3 there was not much difference between inside and outside temperature. Since the light intensity, temperature and relative humidity did not vary significantly in the four systems, the better performance of S_3 with respect to plant growth and flowering could be attributed to better ventilation provided for the plants. This structure did not have side walls when S_1 and S_4 had side walls of 0.5 m height. The positive effect of ventilation on plant growth and flowering in green houses has been reported earlier.

It is revealed from the present studies that in the four systems, use of shade nets did not significantly reduce the temperature. Day temperature of 25-32^{0}C and night temperature of 21-24^{0}C are found to be the optimum for the crop. Variations recorded in temperature, taking into account of all the four structures, were from 29.41^{0}C in August to 41.15^{0}C in March. This maximum light intensity was obtained in December (16062.35 lux in S_2). Light intensity was the lowest in July (3129.76 lux in S_4), due to cloudy weather. The requirement of light intensity in anthurium is reported to be 11,000 - 16000 lux.

The cost of construction of the four structures in the study was worked out as S_1 – Rs. 780 / m^2, S_2 – Rs. 830 / m^2, S_3 – Rs. 300 / m^2 and S_4 – Rs. 500/ m^2. The low cost structure S_3 proved to be the best among the four structures with respect to plant growth, flowering and flower quality irrespective of the time of planting and variety. This structure was constructed with a metal frame work as a support for UV stabilized polyethylene film and shade net. There were no side walls and the sides were covered with 25 per cent shade nets. The UV film (polyethylene) and shade nets were provided at a single level whereas in other structures the polyethylene film and shade net were provided at two levels. Structures S_1 and S_4 had side walls with brick wall of 0.5 m in height. Though there was no side walls for S_2 it had side curtain of UV stabilized polyethylene sheets which may block aeration to plants grown in pots kept on the ground.

5.4.MICROCLIMATIC EFFECTS

Weather parameters, viz., temperature, relative humidity and light intensity outside and inside growing structures were correlated with plant characters of four varieties grown in each structure and were compared. Simple correlation coefficients between plant characters and weather parameters both inside and outside each growing structure were worked out.

There was not much variation in air temperature and relative humidity inside and outside the growing structures. The correlations obtained with meteorological factors inside the structure and outside the structures were similar showing the influence of outside weather parameters on plants grown in shade houses which are naturally ventilated and without environmental control.

5.4.1. Temperature

Temperature both inside and outside the growing structures showed positive correlation with plant characters, except in leaf number. Increase in plant height, spread, leaf length and breadth was observed with increase in temperature. Salvi (1997) in studies conducted earlier in the same place has reported increase in plant growth of anthurium under lower light intensity (70 per cent) which caused increase in temperature. Results of the experiment conducted by Chen *et al.* (2003) on effect of temperature on the flower quality of *Oncidium* showed that high temperature had significant positive effect on stem length. Low temperature controlled the floret number. The required growth days from harvesting to next shoot initiation was determined using high temperature studies.

Leaf number showed significant negative correlation with temperature in variety Tropical (V_1), Pistache (V_2) and V_3 (Mauritius Orange) in S_1. In S_2 and S_3 this character did not show any relationship with temperature. In S_4 leaf number was positively correlated with air temperature in Pistache (V_2) and Mauritius Orange (V_3). In all the growing structures growth parameters, except leaf number, increased with increase in temperature. These results are in conformity with that of Moe *et al* (1990) who reported that lateral branching and stem elongation could be controlled by temperature.

In anthurium young plants have a monopodial growth which corresponds to the juvenile and vegetative phase. After this the plant has a sympodial growth, with a flower produced from each leaf. Increase in temperature increases juvenile growth rate and vigour of plants (Schenk *et al.*, 1981; Dufour and Guerin, 2003 b). The number of leaves produced was found to be negatively correlated with temperature. Anthurium grows accordingly to a leaf – flower – leaf – flower cycle. Inflorescence is formed at the axil of each leaf. This will cause flower production to equal leaf production. Earlier reports showed that the leaf plastochron duration varied during the different months of an year and flower production fluctuated strongly. Maximum flower production was related to high leaf production (Klapwijk, 1988).

With higher temperature and low light intensity the need for assimilates in the plant is much higher and the flower bud may find competition from leaves and roots. Suda *et al* (1998) reported that high temperature caused reduction in number of flowers in anthurium. After flowering, low light intensity and associated low temperature is favourable for better leaf and flower production (Dufour and Guerin, 2003 b).

The positive correlation of plant characters like height, spread and leaf area could explain the early flowering obtained in October planting. Referring to mean monthly temperature for six months after two planting times, May and October (Table 14-17), it is seen that temperature ranged from 30.08^0C to 33.68^0C

in the former (May planting) while it ranged from 33.68^{0}C to 40.37^{0}C in the latter (October planting). The number of leaves produced in October planting was the lowest (4.55) since temperature also showed a negative correlation with leaf production. Though the temperature requirement in juvenile phase is high, flower production and quality were better under low temperature.

In aster it was reported that growing temperature influenced post harvest quality (Oren *et al.*, 2000). Flower longevity was 40 per cent shorter in plants grown under 29^{0}C day temperature compared to those grown under 17^{0}C. In rose shorter flower stems are produced at 30^{0}C than at 20^{0}C (Yamaguchi *et al.*, 1999)

5.4.2. Relative humidity (RH)

In all the varieties plant height showed significant negative correlation with relative humidity in all the growing structures. Plant spread was also negatively correlated with relative humidity in most of the cases. Number of leaves in most of the cases showed significant positive correlation. In a few cases the correlation coefficients obtained were not significant. Reports of Mortensen (2000) are in line with the present findings that low relative humidity is associated with the development of more compact plants. High relative humidity enhanced the plant dry weight as well as quantity and quality of flowers.

Anthurium requires high relative humidity and low temperature for flower production. Number of leaves, which is directly related to flower production, showed positive correlation with relative humidity. Normally each leaf produces a single flower in the axil in anthurium. When the leaf production increases number of flowers also increases.

In the present study growth parameters like height, spread and leaf area increased with increase in air temperature. As the temperature increased, there was a corresponding decrease in relative humidity, resulting in a negative correlation of relative humidity with growth parameters like height and spread. Number of leaves showed a positive correlation with relative humidity. These results emphasize the advantages of a temperature integration and process based relative humidity control in green houses which was tried in chrysanthemum by Korner and Challa (2004). The commonly applied fixed set point RH of 80-85 per cent reduced the potential for growth. The availability of assimilates will be more under high RH combined with more dry weight of plants. The competition for flower buds from leaves is lesser and the plant is able to develop more number of flower buds. This explains the reduction in flower yield in anthurium consequent of high temperature in tropical areas. When the temperature increases and relative humidity decreases, the availability of assimilates for plants is less.

It was reported that in the green house yearly energy consumption could be reduced by 23.5 per cent with a joint regime of temperature and relative humidity. Total plant weight was 39 per cent higher. Thus energy saving and crop yield increase could be achieved simultaneously (Korner and Challa, 2004).

It is clearly evident from the previous studies and present studies that in anthurium flower production could be increased by maintaining proper temperature – relative humidity regime in the growing structure. Similar result has been obtained in cut rose (Blindeman, 2000). High relative humidity was reported to have enhanced plant dry weight of poinsettia and *Kalanchoe* (Mortensen, 2000).

Plant height being negatively correlated with relative humidity indicates that high relative humidity may reduce plant height in anthurium. When the internode length and plant height increase in anthurium after flowering, the plant shows a tendency to creep and hence taller plants are not preferred. The negative relationship of plant height with relative humidity obtained in the present study shows that increase in relative humidity in the growing system favours the production of compact plants with better flower yield in anthurium in tropical areas.

5.4.3. **Light intensity**

Anthurium is a semi shade plant which under natural conditions is protected by the leaf covering of trees and bushes. During the entire cultivation, the plant must be protected against excess sunlight. In commercial practice anthurium is grown under partial shade. The intensity of light affects the morphological characters, flower production and quality of flowers. Shade threshold varies with variety. Even the cultivation system can influence its sensitivity of light.

Singh (1987) and Antoine (1994) observed that shade requirement of anthurium ranges from 60 to 80 per cent. In the previous studies conducted at the Kerala Agricultural University, Thrissur, Kerala it was proven that among the four levels of shade tried for the variety Hawaiian Red, 80 per cent shade was the best with respect to growth, production and quality of flowers (Salvi, 1997; Valsalakumari, *et al.* 2001). In a study conducted to investigate the effects of different light intensities in anthurium the largest leaves and flowers and the highest photosynthesis rate were observed under the highest light intensity of photosynthetically active radiation (PAR) 3.6 mole photons / day per m. Under this condition, a brief increase of the incident PAR enhanced the net photosynthetic rate (Dufour and Guerin, 2003 a).

In the present study four varieties of anthurium were grown under four growing systems. Correlation studies with growth parameters and light intensity showed that in variety Tropical, the plant characters like height, spread, leaf area and petiole length were positively correlated with light intensity in S_1 and S_3. Number of leaves was positively correlated with light intensity in Mauritius Orange in S_4. In other varieties significant correlations were not obtained.

Effect of light intensity on flowering was different in different varieties of anthurium (Suda and Fukuda, 1999). In the present studies also anthurium varieties differed with respect to their response to light intensity. The variety Tropical showed positive correlation of growth parameters with light intensity indicating that the light threshold is higher in this variety compared to the other varieties studied. This may be the reason for the better performance of this variety in tropical areas and it is very popular among the anthurium growers of Kerala.

All the four structures used for this study were provided with shade nets so as to divert 75 per cent of light intensity. The light level received by plants varied monthly, highest being in December and the lowest in July. There were slight variations among the different structures with respect to inside light intensity. In S_1 it varied from 5702.30 to 11461.54 lux, in S_2 from 3825.12 to 16062.35 lux, in S_3 from 3156.59 to 11280.48 lux and in S_4 from 3129.76 to 10470.63 lux.

Positive correlations of some of the plant characters with light intensity were obtained in growing structures which received comparatively lesser, intensity of light. Within the required level, a slight increase of incident light might have increased the net photosynthetic rate and growth of plants as stated earlier by Dufour and Guerin (2003 a).

Number of days taken for first flowering was the lowest in S_2 in which light intensity was higher compared to other structures. Studies conducted in Kerala Agricultural University, Vellanikkara (Salvi, 1997) have shown that flowering was advanced under 70 per cent shade compared to 80 per cent, but the flower quality was poor. After flowering, a low light intensity is recommended for anthurium for better leaf and flower production. In the present studies also it was observed that the flower quality was poor under higher light intensity as the lowest flower longevity was recorded in flowers produced in S_2. The light intensity and temperature were higher in S_2 compared to other growing structures, though flowering was earlier.

5.5. MULTIPLE REGRESSION ANALYSIS

The R^2 values obtained in multiple regression analysis showed that in certain characters the contribution towards variation by microclimatic factors was high. The variations controlled by meteorological factors were higher in leaf characters (79.60% in leaf length; 78.10% in leaf area) and plant height (76.20%). The percentage contribution of meteorological factors towards variation was the highest in S_2V_4.

The treatments varied significantly showing the variations in response of different varieties and the growing systems and their interactions to microclimatic factors inside the growing system. The trend curves obtained also confirmed the correlations obtained in growth parameters with microclimatic factors.

5.6. CONCLUSION

The following conclusions could be derived from the present studies conducted in anthurium.

Adopting suitable planting time, the growth, flowering and flower qualities of anthurium grown in naturally ventilated shade houses could be improved. October was the best planting time irrespective of variety and growing system.

Importance of the selection of varieties for tropical areas is emphasized by the fact that the varieties differed significantly with respect to growth parameters, time taken for flowering, flower qualities and their response to microclimatic factors. Variety Pistache and Tropical could be recommended as most suitable varieties.

The growing system influenced the growth, production and quality. Low cost structure with UV stabilized shade net to divert 75- 80 per cent light intensity and UV stabilized polyethylene film (120 gsm) to provide protection from rainfall on top, sides covered with 25 per cent shade nets and with irrigation facilities was suitable for growing anthurium in tropical areas. The cost of construction of this structure was Rs. 300/m^2.

The interaction effects, which were significant, showed that growth, production and quality of anthurium could be maximized by an integrated planting time – variety – growing system approach.

Pre-harvest growing conditions influenced the post harvest quality of flowers.

Correlation studies and multiple regression analysis of microclimatic factors with growth parameters revealed the significant influence of temperature, relative humidity and light intensity inside the growing system on growth, flowering and quality of flowers in anthurium. Temperature inside the growing system could not be reduced much by providing shade nets.

For anthurium, a light intensity ranging from 11,000 – 16,000 lux is recommended ideal with a day temperature of 25-32^{0}C. In tropical areas the best growth is reported under 75 – 80 per cent shade. Under this shade level, the availability of light intensity ranged from 3,953.46 lux in July to 12,318.75 lux in December during 12 month period; air temperature from 30.50^{0}C in July to 40.67^{0}C in March and relative humidity from 45.90 per cent in February to 77.70 per cent in July.

The study brings out the need for an integrated air temperature – relative humidity - light intensity regime to maximize growth, production and quality of anthurium. Under hitech cultivation providing the suitable air temperature – relative humidity – light intensity regime for each variety could maximize yield.

If more light is available for the plant as in tropical conditions, the temperature may be high to obtain maximum production. The rate of photosynthesis increases with increase in availability of light. The rate of increase is directly proportional to temperature up to the optimum temperature for the crop. It has been reported that the temperature should remain below 30^{0}C and the relative humidity, at least 50 per cent for anthurium.

In shade houses which are used for growing anthurium in the plains of Kerala with tropical climate, the most important requirement is to reduce temperature. There are various ways to lower a temperature that is too high. First, this can be done by using a plant spray system. This lowers the plant temperature, so that dryness stress will not easily occur. When using this method, the chance of certain diseases is greater. The plant should not be wet at night. Otherwise, it would be better to use a mist system, which increases humidity while keeping the plant dry.

Anthurium may be a suitable crop for higher elevations in Kerala where the ambient temperature is low. The crop may receive the required light which need not be associated with an increase in temperature. An attempt to increase the availability of light in shade houses in the plains may result in increase in temperature which is not favourable for the crop. Anthurium growers in the plains are often confronted with high temperatures, especially during summer months. A height between 600 and 1000 meters above sea level is often preferred.

Summary

6. SUMMARY

Results of the investigations on "Microclimatic relations on the growth, yield and quality of anthurium (*Anthurium andreanum* Linden) under different growing systems" are summarized below.

In anthurium, planting time, variety, growing structure and their interactions differed significantly. The effect of months of planting on growth parameters showed that May planting (P_1) was superior with respect to plant height (16.89 cm) and plant spread (EW, 21.60 cm and NS, 21.30 cm). With respect to leaf characters P_2 (October planting) was superior with the highest leaf length (13.55 cm), leaf breadth (7.03 cm) and leaf area (67.74 cm^2). Number of days for first flowering was lowest (52.06 days) in P_2 (October planting) and the highest (74.56 days) in P_1 (May planting). February planting (P_3) was superior in terms of number of leaves (16.79 cm).

There was significant difference in the performance of varieties with respect to growth parameters. The mean plant height was the highest (17.05 cm) in V_4 (Passion). Plant spread (EW and NS, 22.41 cm and 22.26 cm, respectively), leaf number (5.88), leaf breadth (6.94 cm) and leaf area (80.22 cm^2) were the highest in the variety V_2 (Pistache). Highest leaf longevity was recorded for the variety V_3 (Mauritius Orange, 177.36 days) which was on par with V_2 (Pistache, 165.32 days).

Number of days for first flowering was lowest (35.08 days) in V_4 (Passion) which was significantly lower to al other varieties but the flowering was irregular. Variety Tropical came to flowering 82.75 days and Pistache, 65.67 days after planting.

The floral characters differed significantly with respect to varieties. Mean peduncle length (20.22 cm), girth of peduncle (1.82 cm), spathe length (7.57 cm), spadix length (4.73 cm) and spike longevity (153 days) were the highest in the variety V_2 (Pistache). Angle of orientation was the lowest (32.91^0) in the variety V_1 (Tropical) Nature of Peduncle of all the varieties (Tropical, Pistache and Passion) was straight except that of Mauritius Orange which was slightly bending.

There was significant variations in post harvest characters with respect to varieties. Water uptake (16.25 ml) and total vase life (19.58 days) were the highest in the variety V_2 (Pistache).

The growing structures showed significant variations with respect to growth and flowering of plants. The mean plant height (18.06 cm), mean plant spread (EW, 22.49 cm), petiole length (16.67 cm) and leaf longevity (190.89 days) were the highest in S_3 (low cost growing structure). The lowest leaf production interval was recorded in S_1 (33.09 days) which was on par with that in S_3 (33.80 days).

The highest value for plant spread (22.22 cm, NS), leaf length (14.48 cm) leaf breadth (7.62 cm) and leaf area (68.27 cm^2) were recorded in the growing structure S_2 and the longest leaf production interval was recorded in S_4 (34.71

days) which was on par with S_2 (34.67 days). Number of days to first flowering was lowest (43.71 days) in S_2 which was significantly lower than that all other structures and the highest (78.96 days) in S1. The mean length of peduncle was the highest (21.34 cm) in S_4.

There was no significant difference among the growing structures with respect to spathe characters. Mean spadix length was the highest (4.56 cm) in S_4. Mean angle of orientation was the lowest (29.16^0) in S_1.

The highest leaf longevity was recorded in S_1 (124.25 days) which was on par with that in S_3 (116.60 days). The lowest (94.58 days) was in S_2 which was on par with S_4 (100.67 days).

With respect to the post harvest longevity of flowers, mean water uptake (21.60 ml) and total vase life (19.50 days) were the highest in flowers produced in S_3 which were significantly superior to those in all other growing structures.

The availability of light intensity in the growing systems, on an average, ranged from 3,953.46 lux in July to 12,318.75 lux in December; temperature from 30.50^0C in July to 40.67^0C in March and humidity from 45.90% in February to 77.70% in July during 12 month period.

In all the varieties, temperature was positively and significantly correlated with plant height, spread, leaf length, leaf breadth, leaf area and petiole length in all growing structures. Number of leaves showed negative correlation which was significant in varieties Tropical, Mauritius Orange and Passion in growing structure S_1. Number of leaves was positively correlated with temperature in S_4 in varieties P_2 (Pistache) and P_3 (Mauritius Orange). In other cases the correlation was not significant.

In all growing structures, all the varieties showed significant and negative correlation of relative humidity with plant height, plant spread, petiole length, leaf length and leaf area. Varieties Tropical, Mauritius Orange and Passion showed positive and significant correlation of humidity with number of leaves in growing structure S_1 and Mauritius Orange in S_4.

Light intensity was positively correlated with plant characters like height, spread and leaf area and petiole length in variety Tropical in S_1 and S_3. In other varieties and other structures the correlations were not significant.

The coefficients of determination between weather elements (temperature, humidity and light intensity) and plant height (76.2%), plant spread (EW, 66.6%), number of leaves (77.0%) and petiole length (76.8%) were the highest in the treatment combinations S_3V_3, S_4V_4, S_2V_1, and S_3V_2, respectively.

In case of plant spread (NS, 79.8%) and leaf breadth (66.6%) the coefficients of determination between weather elements (temperature, humidity and light intensity) were the highest in the treatment combination S_1V_2 and for leaf length (73.9%) and leaf area (76.2%) the highest in the treatment combination S_1V_1.

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Appendices

APPENDICES

Appendix 1 – Analysis of variance for the treatment effects on plant characters (month 1)

Plant character	A	B	AB	C	AC	BC	ABC
Plant height	14.78**	78.31**	11.44**	112.21**	9.83**	13.63**	5.82**
Plant spread(EW)	87.62**	17.15**	5.14**	33.32**	29.03**	5.69**	6.94**
Plant spread(NS)	25.68**	2.84**	3.12**	15.64**	3.19**	5.98**	2.00**
No. of Leaves	305.41**	1.93*	1.48	13.87**	3.97**	1.34	1.58
Leaf Length	32.28**	29.88**	7.35**	58.46**	17.05**	7.33**	10.34**
Leaf Breadth	8.57**	27.63**	6.67**	21.88**	4.11**	2.90**	5.75**
Petiole Length	7.42**	75.53**	13.26**	92.06**	9.21**	17.00**	6.63**

Appendix 2 – Analysis of variance for the treatment effects on plant characters (month 2)

Plant character	A	B	AB	C	AC	BC	ABC
Plant height	15.61**	13.39**	7.99**	96.75**	3.97**	6.30**	5.70**
Plant spread(EW)	69.86**	24.50**	32.99**	41.79**	11.86**	4.90**	4.24**
Plant spread(NS)	27.26**	11.22**	20.47**	50.94**	8.80**	5.24**	7.23**
No. of Leaves	334.81**	22.72**	10.04**	4.69**	4.26**	4.93**	5.25**
Leaf Length	6.53**	10.13**	20.66**	43.96**	6.51**	2.52**	9.38**
Leaf Breadth	32.31**	17.29**	15.98**	22.59**	6.67**	3.54**	7.33**
Petiole Length	18.34**	15.62**	11.50**	75.62**	4.00**	5.17**	5.36**

Appendix 3 – Analysis of variance for the treatment effects on plant characters (month 3)

Plant character	A	B	AB	C	AC	BC	ABC
Plant height	4.67*	9.55**	4.68**	57.58**	2.88**	4.95**	4.13
Plant spread(EW)	66.00**	10.45**	6.78**	1.49	12.36**	5.06**	3.96**
Plant spread(NS)	41.74**	15.15**	3.57*	4.13**	21.93**	8.80**	7.71**
No. of Leaves	77.01**	0.12	6.14**	15.18**	18.50**	3.10**	1.41
Leaf Length	9.04**	12.91**	11.52**	35.99**	3.80**	7.40**	3.64**
Leaf Breadth	0.53	5.15**	8.85**	26.48**	2.20	2.88**	2.55**
Petiole Length	4.92*	1.80	5.10**	32.77**	4.06**	6.82**	4.41**

Appendix 4 – Analysis of variance for the treatment effects on plant characters (month 4)

Plant character	A	B	AB	C	AC	BC	ABC
Plant height	2.60	8.53**	1.81	54.43**	7.43**	4.83**	6.07**
Plant spread(EW)	10.88**	3.08**	6.09**	18.95**	7.33**	8.70**	4.41**
Plant spread(NS)	8.83**	4.36*	5.49**	27.56**	10.15**	5.27**	3.75**
No. of Leaves	60.43**	7.86**	1.82	10.05**	8.04**	3.11**	1.80*
Leaf Length	5.16*	2.63	9.74**	44.54**	7.19**	13.22**	6.85**
Leaf Breadth	0.34	3.09**	6.31**	32.83**	3.66**	8.86**	2.55**
Petiole Length	17.37**	5.16**	3.88**	37.90**	4.44**	7.42**	4.79**

Appendix 5 – Analysis of variance for the treatment effects on plant characters (month 5)

Plant character	A	B	AB	C	AC	BC	ABC
Plant height	2.54	15.93**	3.79**	64.32**	7.40**	8.03**	1144**
Plant spread(EW)	51.52**	4.10*	7.90**	43.17**	10.96**	9.95**	12.37**
Plant spread(NS)	138.97**	8.20**	10.80**	26.96**	7.97**	5.37**	14.16**
No. of Leaves	22.06**	9.32**	5.15**	8.96**	4.08**	3.43**	3.78**
Leaf Length	2.54	10.61**	5.85**	64.20**	7.35**	6.85**	17.23**
Leaf Breadth	4.61*	1.95	7.38**	34.81**	2.17	3.52**	7.16**
Petiole Length	43.35**	14.09**	5.49**	57.70**	4.61**	5.58**	10.84**

Appendix 6 – Analysis of variance for the treatment effects on plant characters (month 6)

Plant character	A	B	AB	C	AC	BC	ABC
Plant height	17.58**	36.21**	14.88**	71.06**	17.58**	7.94**	15.72**
Plant spread(EW)	3.59*	13.13**	16.93**	20.09**	4.28**	4.79**	7.66**
Plant spread(NS)	8.54**	27.06**	37.74**	38.82**	4.26**	11.11**	16.15**
No. of Leaves	93.28**	13.29**	13.09**	14.40**	2.87*	2.36*	3.34**
Leaf Length	5.52**	4.41*	2.96*	18.79**	2.56*	4.76**	1.68
Leaf Breadth	5.68**	5.09**	9.62**	31.13**	3.02*	7.33**	5.02**
Petiole Length	77.42**	22.62**	13.77**	72.89**	31.75**	12.85**	14.90**

Appendix 7 – Analysis of variance for the treatment effects on length of peduncle

Source	df	Sum of squares	Mean square	F
S	3	192.902	64.301	14.258**
V	3	268.489	89.496	19.845**
S * V	9	156.085	17.343	3.846**
Error	32	144.313	4.510	
Total	47	761.790		

Appendix 8 – Analysis of variance for the treatment effects on girth of peduncle

Source	df	Sum of Squares	Mean Square	F
S	3	0.515	0.172	3.194*
V	3	5.585	1.862	34.636**
S * V	9	0.617	0.069	1.275^{ns}
Error	32	1.720	0.054	
Total	47	8.437		

Appendix 9 – Analysis of variance for the treatment effects on spathe length

Source	df	Sum of Squares	Mean Square	F
S	3	2.777	0.926	1.425^{ns}
V	3	32.509	10.836	16.677**
S * V	9	18.405	2.045	3.147**
Error	32	20.793	0.650	
Total	47	74.485		

Appendix 10 – Analysis of variance for the treatment effects on spathe width

Source	df	Sum of Squares	Mean Square	F
S	3	0.456	0.152	0.532^{ns}
V	3	6.952	2.317	8.119**
S * V	9	10.374	1.153	4.038**
Error	32	9.133	0.285	
Total	47	26.915		

Appendix 11 – Analysis of variance for the treatment effects on length of spadix

Source	df	Sum of Squares	Mean Square	F
S	3	15.766	5.255	40.883**
V	3	20.352	6.784	52.777**
S * V	9	14.237	1.582	12.306**
Error	32	4.113	0.129	
Total	47	54.468		

Appendix 12 – Analysis of variance for the treatment effects on angle of orientation of spadix

Source	df	Sum of Squares	Mean Square	F
S	3	668.750	222.917	9.511**
V	3	860.417	286.806	12.237**
S * V	9	618.750	68.750	2.933**
Error	32	750.000	23.438	
Total	47	2897.917		

Appendix 13 – Analysis of variance for the treatment effects on longevity of spike

Source	Df	Sum of Squares	Mean Square	F
S	3	6823.417	2274.472	16.701**
V	3	57771.750	19257.250	141.402**
S * V	9	12784.750	1420.528	10.431**
Error	32	4358.000	136.188	
Total	47	81737.917		

Appendix 14 – Analysis of variance for the treatment effects on longevity of leaf

Source	df	Sum of Squares	Mean Square	F
S	3	43987.101	14662.367	35.597**
V	3	47978.594	15992.865	38.828**
S * V	9	42225.077	4691.675	11.390**
Error	32	13180.620	411.894	
Total	47	147371.392		

Appendix 15 – Analysis of variance for the treatment effects on leaf production interval

Source	df	Sum of Squares	Mean Square	F
S	3	21.641	7.214	5.103**
V	3	195.889	65.296	46.191**
S * V	9	228.597	25.400	17.968**
Error	32	45.236	1.414	
Total	47	491.363		

Appendix 16 – Analysis of variance for the treatment effects on day of harvest

Source	df	Sum of Squares	Mean Square	F
S	3	6.333	2.111	1.013
V	1	1.500	1.500	0.720
S * V	3	10.167	3.389	1.627
Error	16	33.333	2.083	
Total	23	51.333		

Appendix 17 – Analysis of variance for the treatment effects on day to total necrosis

Source	df	Sum of Squares	Mean Square	F
S	3	105.792	35.264	10.850**
V	1	260.042	260.042	80.013**
S * V	3	337.125	112.375	34.577**
Error	16	52.000	3.250	
Total	23	754.958		

Appendix 18 – Analysis of variance for the treatment effects on day s of water uptake (ml)

Source	df	Sum of Squares	Mean Square	F
S	3	510.792	170.264	18.745**
V	1	222.042	222.042	24.445**
S * V	3	209.792	69.931	7.699**
Error	16	145.333	9.083	
Total	23	1087.958		

* Significant at 5% level
** Significant at 1% level

MICROCLIMATIC RELATIONS ON THE GROWTH, YIELD AND QUALITY OF ANTHURIUM (*Anthurium andreanum* Linden) UNDER DIFFERENT GROWING SYSTEMS

By
FEMINA

ABSTRACT OF THE THESIS
Submitted in partial fulfilment of the requirement for the degree of

Master of Science in Horticulture

Faculty of Agriculture
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ABSTRACT

Investigations on "Microclimatic relations on the growth, yield and quality of anthurium (*Anthurium andreanum* Linden) under different growing systems" were carried out at the Department of Pomology and Floriculture, College of Horticulture, Kerala Agricultural University, Vellanikkara, Thrissur during 2003-05.

Four cut flower varieties of *Anthurium andreanum* were grown under four growing structures adopting three times of planting in a year, at an interval of four months. Weather parameters viz., air temperature, relative humidity and light intensity were recorded daily both inside and outside the four growing structures.

The results showed that planting time, variety and growing system differed significantly with respect to growth, flowering and flower quality of anthurium. Based on the results obtained, October planting is recommended for anthurium. Varieties recommended are 'Pistache' and 'Tropical'. Low cost structure with UV stabilized shade net to divert 75- 80 per cent light intensity and UV stabilized polyethylene film (120 gsm) to provide protection from rainfall on top and sides, covered with 25 per cent of shade net and with irrigation facilities at a cost of construction of Rs. 300/ m^2 was found suitable for growing anthurium in tropical areas.

The significant interaction effects showed that a suitable planting time – variety – growing system combination could maximize growth and production in

anthurium. Pre-harvest growing conditions influenced the post harvest longevity of flower.

Air temperature both inside the growing systems showed positive correlation with all plant characters except in leaf number. In all the varieties plant height and spread showed significant negative correlation with relative humidity in all the growing structures. The number of leaves in most of the cases showed significant positive correlation. Correlation studies with growth parameters and light intensity showed that in variety Tropical plant characters like height, spread, leaf area and petiole length were positively correlated with light intensity in S_1 and S_3.

The R^2 values obtained in multiple regression analysis showed that in certain characters the contribution towards variation by microclimatic factors was high. The variations controlled by meteorological factors were higher in leaf characters (79.60% in leaf length, 78.10% in leaf area) and plant height (76.20%).

The treatments varied significantly showing the variations in response of different varieties and the growing systems and their interactions to microclimatic factors inside the growing system. The trend curves obtained also confirmed the correlations obtained in growth parameters with microclimatic factors.

In tropical areas the best growth is obtained under 75 – 80% shade in anthurium. Under this shade level, the availability of light intensity on an average ranged from 3,953.46 lux in July to 12,318.75 lux in December; air temperature from 30.50^{0}C in July to 40.67^{0}C in March and relative humidity from 45.90% in February to 77.70% in July during the 12 month period.

The study brings out the need for an integrated air temperature – relative humidity - light intensity regime to maximize growth, production and quality of anthurium. The most important requirement is to reduce air temperature by increasing relative humidity. This could be achieved by providing humidifiers in shade houses. Under hitech cultivation providing the suitable air temperature – relative humidity – light intensity regime for each variety could maximize yield.

In shade houses which are used for growing anhurium in the plains of Kerala with tropical climate, the most important requirement is to reduce temperature. This can be done by using a plant spray system or a mist system, which increases humidity. An attempt to increase the availability of light in shade houses in the plains may result in increase in temperature which is not favourable for the crop. Anthurium may be a suitable crop for higher elevations in Kerala where the ambient temperature is low. The crop may receive the required light which need not be associated with an increase in temperature.