

**OPTIMIZATION OF SHADE LEVEL, MEDIA AND
VASE LIFE FOR CUT FLOWER PRODUCTION IN
ANTHURIUM (*Anthurium andreanum* Linn)**

By

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DAPOLI- 415 712, DIST. RATNAGIRI (M.S.)**

NOVEMBER, 2021

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A thesis submitted to the

**Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli
(Agricultural University)**

Dist. Ratnagiri (Maharashtra State), India

in partial fulfillment of the requirements for the degree of

**DOCTOR OF PHILOSOPHY
(AGRICULTURE)**

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This is to certify that the thesis entitled “**OPTIMIZATION OF SHADE LEVEL, MEDIA AND VASE LIFE FOR CUT FLOWER PRODUCTION IN ANTHURIUM (*Anthurium andreanum* Linn)**” submitted to the Faculty of Horticulture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra State in the partial fulfillment of the requirements for the degree of **DOCTOR OF PHILOSOPHY (AGRICULTURE) in HORTICULTURE (FLORICULTURE AND LANDSCAPING)**, embodies the results of a piece of bonafide research work carried out by **MISS. PAWAR AMRUTA RAMESH** under my guidance and supervision. No part of this thesis has been submitted for any other degree or diploma. All the assistance and help received during the course of investigation and the sources of literature have been duly acknowledged by her.

Place: Dapoli.

Date: / /2022

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DECLARATION OF STUDENT

I hereby declare that the experimental work and interpretation of the thesis entitled “**Optimization of shade level, media and vase life for cut flower production in anthurium (*Anthurium andreanum* Linn)**” is a result of research work sincerely carried out by me which has neither been submitted for any other degree or diploma of any University, nor the data have been derived from any thesis/ publication of any University or Scientific Organization. Sources and material used and all assistance received during the course of investigation have been duly acknowledged.

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THESIS ABSTRACT

Considering the commercial importance of anthurium for production of cut flowers; an investigation entitled "Optimization of shade level, media and vase life for cut flower production in anthurium (*Anthurium andreanum* Linn)." was undertaken at college of Horticulture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli during 2019 to 2021. The research study included four sets of experiments 1. "Varietal performance of anthurium (*Anthurium andreanum* Linn)" under Konkan agro climatic condition which comprised of six varieties namely - Baby White, Baby Purple, Prince Orange, Princess Amellia, Fancy Red, Queen Black; 2. "Optimization of growing media for anthurium cultivation cv. Tropical Red had 7 different media combinations. 3. "Optimization of shade level for cultivation of anthurium cv. Tropical Red" was conducted with 3 different shade levels. 4. "Vase life studies by using different chemical solutions" was conducted with various concentrations and chemicals of different preservatives.

During the period of investigation, Fancy Red variety recorded maximum survival percentage (96.00 %), plant height (40.96 cm), leaf area (105.17 cm²), length of leaf petiole (21.72 cm), number of suckers

per plant (4.40), plant height (40.96 cm) was found significantly superior to all other varieties at various stages of growth till 16 MAP. The maximum number of leaves (11.85) was produced by variety Baby White which was significantly superior over all other varieties. The days taken (206.20 days) for flower bud initiation and days taken for unfurling of spathe (234.85 days) was observed minimum in Fancy Red. Longer flower longevity (62.79 days) was also recorded in variety Fancy Red. The highest flower stalk length (28.65 cm), spadix length (4.38 cm), length of spathe (6.07 cm), breadth of spathe (5.00 cm), vase life of flower (14.28 days), angle of spadix to spathe (38.51°) was registered in Fancy Red variety. The maximum numbers of flowers (5.30 flowers) at 16 months after planting were recorded by variety Baby White. Highest gross and net monetary returns per 100 sq. m (Rs. 276456/- and Rs. 193690, respectively) and B: C ratio (3.34) was recorded by Fancy Red. This shows that among 6 varieties tested, fancy Red was found to be superior for growth, flowering and quality attributing characters which was followed by baby White.

The results of growing media combinations revealed that treatment T₂ i.e., Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) recorded significantly maximum survival percentage (95.33 %), plant height (40.99 cm), number of leaves per plant (9.80), length of leaf (15.00 cm), breadth of leaf (9.65 cm), leaf area (176.33 cm²), number of suckers per plant (3.87), chlorophyll a (2.16 mg/g), chlorophyll b (1.33 mg/g), total chlorophyll (3.49 mg/g) values. The minimum days taken for inflorescence emergence (224.20 days), days for first flowering (248.80 days), period of inflorescence emergence to spathe unfurling (19.60 days) and maximum flower longevity on the plant (64.86 days) was observed in T₂ i.e., Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1). Maximum flower stalk length (27.43 cm), spadix length (4.55 cm), length of spathe (7.09 cm), breadth of spathe (6.17 cm), anthocyanin content (0.68 mg/g) and vase life of flower (14.76 days) on plant were recorded in T₂ i.e., Sand + FYM + coconut husk + brick pieces + charcoal

(1:1:1:1:1). Maximum number of flowers per plant during 24 months in anthurium (4.40 flowers), gross and net monetary returns per 100 sq.m (Rs. 264116.67/- and 207366.67, respectively) and B: C ratio (4.65) was noted in T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1).

Among different shade levels 90 per cent shade recorded maximum survival percentage (95.63%), number of leaves per plant (10.29), leaf area (174.90 cm²), plant spread (North- south) (26.56 cm), plant spread (East-West) (26.40 cm) and anthocyanin content (0.72 mg/g). Maximum plant height (41.11 cm), number of suckers per plant (4.00), length of leaf petiole (20.57 cm), chlorophyll a (2.29 mg/g), chlorophyll b (1.47 mg/g), total chlorophyll (3.76 mg/g) was found under 75 per cent shade level. Earliest flower bud initiation (213.57 days), days taken for unfurling of spathe (243.14 days) and flower longevity (64.65 days) was recorded under 75 per cent shade level. Highest length of flower stalk (28.02 cm), diameter of flower stalk (4.22 mm), length of spathe (7.16 cm), width of spathe (6.16 cm), length of spadix (4.47 cm), diameter of spadix (8.81 mm), number of flowers per plant at 24 months after planting (5.71 flowers), gross returns (Rs. 275375.00), net returns per 100 sq. m (Rs. 217934.00), B:C ratio (4.79) were recorded in 75 per cent shade level.

Results for vase life studies that maximum final weight of inflorescence (6.29 g) was recorded in treatment T₇ *i.e.*, BA 50 ppm. Holding solution of treatment T₆ *i.e.*, BA 25 ppm recorded minimum physiological loss in weight (32.20 %) and final volume of holding solution (79.56 ml). Maximum uptake of vase solution (20.45 %), days to spadix necrosis initiation (15.35 days), days to spathe blueing initiation (17.72 days), days to gloss loss (16.08 days) and more vase life of inflorescence (20.96 days) was recorded in T₆ *i.e.*, BA 25 ppm. Results reported that BA 25 ppm extended vase life of anthurium cut flower during storage in holding solution.

Based on the four experiments conducted, it can be concluded that for cultivation, Fancy Red and Baby White varieties are excellent. For good performance anthurium needs to be cultivated initially for 6 months under 90 per cent shade level followed by shifting under 75 per cent shade level with growing media combination of Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) in equal proportion. For extending vase life holding cut anthurium flowers in 25 ppm BA solution is beneficial.

CHAPTER I

INTRODUCTION

Flowers are the most beautiful creation of the earth. Flowers not only make house beautiful, but also make it homely. Flowers symbolize beauty, purity, love, affection, peace, honesty and bring joy and happiness in life. Birth and death of human being is associated with flowers. A flower has many uses in our day to day life like religious ceremonies, weddings, social customs and self-adornment. Flowers are most suitable and aesthetic item in any social occasions for conveying one's status and admiring sense.

Before two decades, floriculture was just a hobby of flower lovers, but now it has opened a new vista in agri-business i.e., commercial floriculture in the form of flora industry. Flowers have become best medium to convey feelings.

The total area under floriculture crops in India in 2019-20 was estimated to be 305.00 thousand hectares with approximate production of 2301 thousand tonnes of loose flowers and 762 thousand tones of cut flowers. The total export of floriculture products and flowers in India during 2020-2021 was costing Rs.575.98 Crores/77.84 million USD (Anon., 2020).

Maharashtra is one of the leading states of the country in flower production. Total area under floriculture in Maharashtra was estimated to be 23,000 hectare with the production of 119 thousand tons of loose flowers and 7914 lakh number of cut flowers (Anon., 2020^a).

Anthurium (*Anthurium andreanum* L.) is a herbaceous perennial ornamental plant which belongs to Araceae family. It is native to Central and South America. Anthurium has underground rhizome with adventitious roots which has habit of low creeping growth by using aerial roots for anchorage. Anthurium is tropical plant and mainly grown for its attractive foliage and showy cut flowers. It is

commonly called as pig tail flower and is very famous among florists due to its eye-catching bloom, elegance, smoothness, variety of dazzling colours and long lasting vase life. The anthurium plant possesses adventitious roots system. Anthurium cut-flower comprises of an inflorescence (spadix) subtended by a modified leaf (spathe) borne on a long stalk (peduncle). There are many colours in *Anthurium andreanum* flower spathe like red (light-red and dark red), purple, white, pink, salmon-pink, brown, green, lavender, cream or multi-colored. There are also differences in the shape and firmness of the spathe varying from flat to cup-shaped and firm to floppy, respectively. Heart shaped colourful attractive spathe of this high valued flower attracts spectators. These special characters of anthurium have created high demand in domestic as well as international markets.

It is one of the ten flowers in the global flower trade and most commercialized cut flower in the world therefore, it commands a good price not only for cut flower but also as a pot plant. Anthurium has classical cup shaped inflorescence and contains many flowers which are arranged closely on spadix with an outer colourful sheath called spathe. It contains more than 100 genera and about 1599 species, chiefly from tropics (Higaki *et al.*, 1994). Among these, four species viz., *Anthurium andreanum* (for cut flower), *A. scherzerianum* (as potted plant), *A. crystallinum* and *A. grande* (for foliage) are most commonly and economically grown in most of the anthurium growing countries.

Among all the cut flowers, anthurium ranks eleventh position in the flower commerce. Anthurium production in India is 3230 tonnes and highest anthurium production is recorded at Assam (2050 tonnes) and Meghalaya (740 tonnes) whereas, Karnataka with the production of 60 tonnes is positioned 4th in the anthurium cut flower production (Anon., 2019). There are export units in Kodagu district and chikkamagaluru district (Mudigere taluk) of Karnataka, whereas

Kodagu district of Karnataka is declared as an “Agri-export zone” for anthurium as there are around 45 anthurium growers and around 15,000 flowers are exported every day in Kodagu.

Anthurium production in traditionally growing countries has declined since 1986, due to bacterial blight (Galinsky and Laws, 1996) and the new production centres in other geographical areas are now contributing to the production of anthurium cut flowers. Climatic conditions of Konkan region are suitable for growing of anthurium therefore, optimization of various growing media is most important to obtain higher yield and quality of the flowers.

Anthurium plants growth depends on many factors such as good media, proper shade and nutrients. It is an epiphytic plant, therefore, growing medium plays vital role in growth, flowering, yield and quality of anthurium. Choice of good growing media is directly correlated with successful growth and production of export quality flowers in anthurium. It requires proper growing medium which has good physical characteristics like aeration and water holding capacity are probably the most important factors while, among the chemical characteristics, nutritional status and good drainage also have a crucial role on plant development (Dewayne *et al.*, 2003).

Anthuriums are shade loving plants and those cannot be grown in open conditions. They require appropriate shade facilities for their proper growth and development. Optimum light intensity for anthurium is 18,000-25,000 Lux and 18°C minimum to 28°C maximum temperature which encourage their growth and development (Anon., 2013). They require 60 to 80 per cent relative humidity. Therefore, to obtain export quality anthuriums, it is necessary to study the effect of different shade levels under Konkan climatic conditions on various aspects like growth, flowering, quality and yield of anthuriums.

About thirty to seventy per cent of potential losses in quality are predetermined at harvest. Under natural conditions, anthurium

flowers stay fresh for a period of about 10-12 days. Cut flowers are harvested from the parent plant. Therefore, flow of water column from roots to flower is disturbed and this results in the wilting and early senescence of flower. Water relations play a dominant role in the post-harvest physiology of cut flowers (Halevy and Mayek, 1974). Floral preservatives contain water to maintain turgidity, sugar to serve as an energy source, a biocide to inhibit the growth of microorganisms by directly or indirectly acidifying the pH of the vase solution. Use of floral preservatives at all stages of flower handling and marketing is known to improve the flower quality and results in better consumer acceptability.

In order to meet the ever increasing demand for fresh cut flowers, efforts are being made to increase the area under anthurium by improving agro-techniques, cultivation aspects such as suitable media, appropriate shade level and use of different pulsing and holding solutions for increasing vase life of anthurium cut flowers. So far very little information is available with regards to standardize climatic conditions, proper media for growth, ideal varieties for cultivation and post-harvest protocol for anthurium cut flowers. With this view present investigation on “Optimization of shade level, media and vase life for cut flower production in anthurium (*Anthurium andreanum* Linn.” was undertaken with the following objectives:

1. To study the varietal performance of different anthurium varieties.
2. To optimize growing media for anthurium cultivation
3. To optimize shade level for anthurium cultivation
4. To study the vase life of anthurium cut flowers by using various chemicals

CHAPTER II

REVIEW OF LITERATURE

Anthurium is one of the best domestic flowering plants in the world. Anthuriums are not only beautiful but also purify the surrounding air and remove harmful airborne chemicals like formaldehyde, ammonia, toluene, xylene, and allergens. Considering its importance of removing toxic substances from the air, NASA has placed it in the list of air purifier plants. Anthurium has larger economic importance because of its eye-catching and beautiful inflorescence and fetches a good market price.

Anthurium has gained importance as major cut flowers of the modern world but in India, anthurium industry is still in its starting phase. There are very few growers from Karnataka, Tamil Nadu, Kerala, Andhra Pradesh and North -Eastern states who send their flowers to big cities like Mumbai and Delhi, therefore it is necessary to increase production of anthurium and standardize its package of practices where natural climatic conditions are congenial for its commercial cultivation.

Until now, no comprehensive research work for two successive years has been carried out on the systematic cultivation of anthurium in Konkan region of Maharashtra. It is therefore, necessary to evaluate the best performing varieties for cut flower production and it is necessary to standardize the media and shade levels for its sustainable production. Also it is necessary to carry out studies for extending vase life of anthurium cut flowers by using different chemicals for long distance transportation.

In this view the present investigation was undertaken for two years with relevant literature available on anthurium crop. Literature on other cut and loose flower crops like gladiolus, tuberose, gaillardia, rose, gerbera, crossandra etc. has also been reviewed and presented under the following heads.

- 2.1 Varietal performance of anthurium
- 2.2 Growing media for anthurium cultivation
- 2.3 Shade level for anthurium cultivation
- 2.4 Vase life of anthurium cut flowers by using of various chemicals

2.1 Varietal performance of anthurium

Kamemoto and Nakasone (1963) conducted research on evaluation and improvement of anthurium clones at Hawaii Agricultural Experiment Station, University of Hawaii and reported that among all the accessions, Haga White, Nitta, Kaumana, Ozaki, Kansako No.1 and Hirose recorded maximum yield and quality and were favourable for cultivation.

Gelder *et al.* (1984) evaluated plant and inflorescence characteristics of 34 *Anthurium andreanum* cultivars of five different colour groups and reported five promising cultivars *viz.*, Favoriet, Mirjam, Rico, Sarina and Poolster.

Leeuwen (1984) carried out experiment on evaluation of the characteristics of 23 anthurium cultivars and reported that AVO-Nette, AVO-Tineke, Favoriet and Germa (Orange), AVO-Claudia, AVO-Ingrid and Nova- Aurora (red), AVO- Jose, Cuba and Jamaica (White), Hoenette and Sarina (Pearl) and AVO- Anneke (Pink) recorded maximum yield and quality.

Arndt (1991) developed a variety named 'Arabella' which produced uniform and compact leaves than Flamenco Red. It was an early flowering, medium sized plant with dark green, short leaves. The spathe was broad with free lobes, a shallow sinus and recurving spadix. Spathe and spadix were red in colour.

Henley and Robinson (1995) evaluated 21 potted anthurium cultivars. After 38 weeks growth, data were collected on plant foliage, canopy height and width, leaf and inflorescence count and colour of leaves (spathe and spadix). Variety Agnihotri was moderately tall, erect stout plant with sparse leaves, length of internodes being 2 cm,

deep green oblong leaves with overlapping leaf lobes at the base, length x breadth of the leaf measuring 26 cm x 24 cm, petiole 37 cm long, bulged near the leaf base, cordate dark red spathe of 8 cm x 9.5 cm.

Betionio (1996) conducted research on germplasm collection and evaluation of different anthurium cultivars at Department of Agriculture, Bukidnon (Philippines) and concluded that Gloria Angara recorded maximum yield of flowers (9) and suckers per plant per year and Pink Obake exhibited the largest flower with mean width of 13 cm. Economic analysis revealed that Gloria Angara had the highest net benefit of Rs.332.50/plant/year.

Jawaharlal *et al.* (1998) evaluated six *Anthurium andreaum* and two *Anthurium scherzerianum* cultivars. Among the six *A. andreaum*, 'Lady Jane' was the most prolific but produced small sized spathes. Among the two cultivars of *A. scherzerianum* 'Amazonica' produced more blooms per plant, maximum peduncle length, spathe length, width and spadix length which are ideally suited for pot plant. Twenty lines of *Anthurium andreaum* were evaluated under 50 per cent shade for eight important characters like stalk length, spathe length, spathe and spadix diameter, basal lobe length, number of flowers, lobes overlap and number of blisters.

Valsalakumari *et al.* (1998) studied six anthurium varieties viz., Eureka red, Hawaiian Red, Sweet Heart (red varieties), Nitta (orange), Lime (White) and Agnihotri (deep pink) under different levels of shade and reported that plant spread and leaf area were highest Lima; Eureka Red produced highest number of leaves, number of suckers, number of flowers per year.

Wang (1999) conducted research trial on greenhouse performance of six potted anthurium cultivars viz., 'Pink Aristocrat', 'Patty Anne', 'Purple Viking', 'Royal Pink', Royal Orange', and 'Royal Red' in a subtropical area and reported that 'Royal Pink' recorded

maximum plant and flower height. Pink Aristocrat' recorded maximum plant width, total flower count and no. of new buds.

Chandrappa (2002) carried out research on evaluation and effect of media, biofertilizers, and growth regulators on growth and flowering in anthuriums and reported that cv. Lady Jane recorded maximum plant height (76.78 cm) and Puruvadia Lavender recorded maximum number of leaves (20.44), number of suckers (2.32), number of flowers (15.44). Can Can recorded maximum leaf area (293.97 cm²), stalk length (48.05 cm), stalk girth (5.39 mm), spadix length (7.91 cm), spadix girth (8.23 mm) and spathe size (101.21 cm²).

Praneetha *et al.* (2002) studied performance of anthuriums under shadenet condition at Yercaud, Tamil Nadu Agricultural University, Coimbatore. Eight *Anthurium andraeanum* cultivars, AA-2, AA-15, AA-29, AA-40, AA-43, AA-55, AA-69 and Lady Jane and two *A. scherzerianum* cultivars, AS-1 and AS-2, were evaluated for their flower yield and floral characters under 50% shade net condition. *A. andraeanum* cultivars, AA-43 and Lady Jane recorded the highest number of flowers/plant per year (18.2), AA-2 produced the longest flower stems (60.6 cm), spathe length (16.3 cm), spathe width (13.4 cm), spadix length (13.0 cm) and longest vase life (19.20 days).

Talia *et al.* (2003) conducted research on evaluation of new anthurium cultivars in soilless culture at Mancini farm near Palagiano (Taranto) and reported that maximum flowers per plant (9.4) were recorded in variety Terra while variety Queen recorded bigger spathe with a mean length of 23 cm and width of 18 cm and stem height (53 cm).

Valdez (2003) carried out research on promising anthurium varieties for the lowlands at University of the Philippines and concluded that flower stems were longest in Anuenue. Flowering and floral development were fastest in RCM 12, vase life was longest in cut flowers of Kaumana. RCM 12 gave the highest cut flower yield per plant per year at (6.40). Consumer preference determines the cultivars that a grower will choose for cut flower production. A net income of

Rs. 71.58 and Rs. 57.27 per plant per year might be derived from growing Anuenues.

Tombolato *et al.* (2005) carried out research on new varieties of *Anthurium andraeanum* from Brazil and reported that among 12 new anthurium selections, which were named for Brazilian Indian tribes, variety IAC Eidibel recorded maximum no. of flowers per plant (6.41) and IAC Astral recorded maximum vase life (34 days).

Femina *et al.* (2006) conducted research on performance of anthurium (*Anthurium andreanum* Lind.) cultivars with respect to planting time in humid tropical plain at College of Horticulture, Kerala Agricultural University, Yellanikkara, Thrissur, Kerala. Four cultivars *viz.*, Tropical, Pistache, Mauritius Orange and Passion in three different planting times i.e., May, October and February were used for study. They reported that cultivar Pistache recorded maximum plant spread (22.41cm), leaf number (5.68) and leaf area (80.22 cm²) and cv. Tropical recorded early flowering (82.75 day after planting).

Srinivasa (2006) carried out research on performance of anthurium varieties for cut flower production. Five varieties *viz.*, Hondura, Senator, Pasricha, Tinora and Tropical were evaluated. He concluded that variety Hondura recorded maximum plant height (29.91 cm), number of leaves, canopy height (22.19 cm) and stalk length (35.44 cm) and spadix length (4.56 cm) and variety Senator produced maximum leaf length (16.45 cm), leaf width (8.91 cm) and canopy width (6.75 cm) as compared to other varieties.

Denita (2007) conducted research on evaluation of exotic anthurium cultivars under shade net. Number of leaves, leaf length, leaf width, stalk length and no. of flowers per plant were recorded maximum in variety Eternity. Variety Rosa recorded maximum plant height, spadix length, spathe length and Amego recorded maximum angle of spathe to spadix and spathe width of Anthurium cut flowers and hence may be selected for cultivation under 75 per cent green coloured shade net houses under Bangalore condition.

Rajeevan *et al.* (2007) carried out research on performance evaluation of cut flower varieties of anthurium (Esmeralda, Benicito, Jewel, Caesar, Akapana, Aymara and Lucia) under two agroclimatic conditions at College of Horticulture, Kerala Agricultural University, Vellanikkara, Thrissur, Kerala and reported that cut flower varieties of anthurium to ascertain the influence of two agroclimatic situations, Vellanikkara (Thrissur) and Nelliampathy (Palakkad) on growth and flowering and concluded that cultivar Esmeralda recorded maximum plant growth, number of flowers, spathe size and quality of flowers. Maximum number of flowers was recorded in Benicito.

Shetye (2007) carried out research on performance of different anthurium (*Anthurium andreanum* L.) cultivars under polyhouse. Seven varieties *viz.*, Aymara, Elan, Grace, Esmeraldy, Emperor, Flame and Jewel were studied and results revealed that number of leaves per plant per year (7.5), early flowering (160.4 days), yield per plant per year (5.7 flowers), stalk length (32 cm), spathe length (8.2 cm) and vase life (12.8 days) were recorded in variety Flame and Elan.

Shiva and Nair (2008) conducted research on performance of anthurium cultivars in Andamans at Indian Institute of Spices Research, Calicut and reported that cultivar Mirage recorded maximum number of suckers, leaves and plant height. Maximum leaf size, leaf area, leaf dry weight, number of flowers and plant spread were recorded in Honey. The cultivar, Wrinkled Orange registered maximum leaf fresh weight, peduncle length, shelf-life and recorded minimum time for flowering from flower initiation. The maximum spathe size was recorded in Mauritius. The cultivar Colarado produced maximum spadix length and number of coils per spadix. Based on these observations, the cultivars Mirage, Agnihothri and Deep Pink were found suitable for sucker production, whereas, Honey Mauritius and Wrinkled Orange for flower production in Andamans.

Shriram *et al.* (2008) carried out experiment on varietal performance of anthurium (*Anthurium andreanum* L.) under cost

effective polyhouse at Modibaug, College of Agriculture, Pune, to evaluate the performance and quality characters and reported that cv. Esmeralda performed best among all the cultivars.

Kalirana and Dubey (2009) carried out research on performance of anthurium under partially controlled conditions at Department of Horticulture, Indira Gandhi Agricultural University, Raipur, Chhattisgarh, India. 5 cultivars *i.e.*, Titicala, Grace, Esmeralda, Flame and Akapana were studied. They reported that cultivar Grace recorded the highest number of leaves/plant (7.21). The maximum leaf lamina diameter (15.67 cm), length of leaf sheath (19.82 cm) and early flowering (193.42 days) were recorded in Titicala. The highest plant height (45.06 cm), number of flowers/plant (5.35) and longest flower stems (31.20 cm) were recorded in Flame. The maximum spathe area (46.20 cm²) was recorded in Esmeralda.

Agasimani *et al.* (2010) carried out research on performance of anthurium varieties under greenhouse at Hi-Tech Horticulture Unit, Main Agricultural Research Station, Saidapur Farm, Department of Horticulture, University of Agricultural Sciences, Dharwad. Ten cut flower varieties of anthurium were selected for the study. The varieties under study were Flame, Caesar, Aymara, Grace, Ivory, Acapana, Jewel, Titicaca, Esmeralda and Chias. They concluded that Esmeralda produced maximum leaf length, leaf breadth, leaf area, flower stalk length, flower stalk diameter, spathe length, spadix length, number of flowers per plant per year. 'Ivory' recorded maximum number of suckers and longest vase life.

Agasimani *et al.* (2011) conducted research on anthurium varietal performance in rainy and winter seasons under greenhouse. Ten varieties of anthurium in two different seasons (summer and winter) were evaluated and variety Esmeralda performed well in both the seasons compared to other varieties.

Elibox and Umaharan (2012) conducted experiment on study of morphophysiological descriptors of cultivated *Anthurium andraeanum*

Hort. at commercial farm, Kairi Blooms Ltd., situated in Arima, Trinidad and Tobago. 82 anthurium accessions were grouped according to spathe colour viz., red, pink, white, green, orange, purple, coral and brown and obake types and on the basis of results and market information, an ideal anthurium ideotype adapted to the humid tropics was described. An anthurium ideotype for cut-flower production should be vigorous, producing a large number of narrow, small leaves held on long, erect petioles. The cut flowers should be held high above the leaves on long peduncles with glossy heart-shaped (symmetrical) spathes with a spadix (proportional to the size of the spathe) held at an angle less than 45°C.

Anand *et al.* (2013) conducted research on performance of anthurium (*Anthurium andraeanum* Linden Ex André) cultivars for yield and quality under Shevaroy's condition eastern ghat at Horticultural Research Station, Tamil Nadu Agricultural University, Yercaud. Ria Bamboo Red recorded the highest plant height (73.90 cm), Flamingo Blush Pink produced maximum number of leaves per plant (11), Lima White (4.21) and Peach (3.60) recorded maximum number of suckers, Linda De Mole recorded maximum plant spread (73.20 cm), Liver Red produced highest leaf length and breadth, Hawaii Red recorded highest stalk length (64.90 cm). Temptation recorded highest spathe length (18.10 cm), spathe width (15.00 cm), spadix length (11.5 cm) and the highest numbers of spikes per plant (9). Honduras (24 days) recorded maximum vase life in water and vase life of flower on plant (23.68 days). It was concluded that out of twenty nine cultivars evaluated the Temptation, Honduras, Peach Ria Bamboo Red and Verdun Red were found to be the best cultivars with superior in qualities for cut flower production under Shevaroy condition of eastern ghat.

Islam *et al.* (2013) conducted research on varietal study of anthurium (*Anthurium andraeanum*) as a cut flower in Bangladesh at Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka. Five anthurium cultivars viz. Caesar, Aymara, Ivory, Jewel and

Triticaca were used for the study and they concluded that 'Triticaca' had maximum stalk length and diameter, spathe length and breadth, spadix length, vase life and flowers per plant.

Li *et al.* (2014) conducted research on responses of two anthurium cultivars to high daily integrals of diffuse light. Experiments were carried out with two *Anthurium andreanum* cultivars (Royal Champion and Pink Champion) and high daily integrals ($7.5 \text{ mol m}^{-2} \text{ d}^{-1}$ and $10 \text{ mol m}^{-2} \text{ d}^{-1}$) and it was reported that cultivar Pink champion at high daily integrals ($10 \text{ mol m}^{-2} \text{ d}^{-1}$) recorded maximum number of leaves (44.5), number of flowers (11.6), number of stems per plant (4.5) and plant height (35.00 cm).

Singh *et al.* (2015) carried out research on varietal performance and correlation studies in anthurium under agro-shade net at BC Krishi Viswavidyalaya, Mohanpur, Nadia. The varieties *viz.*, Salasaga, Chicas, Noblesse, Elan, Ivory, Jewel, Monroe, Grace, Aymara and Triticaca were taken for study. They reported that variety 'Triticaca' had maximum plant height (33.74 cm), average number of leaves per plant (7.36), leaf length (20.59 cm) and breadth (13.40 cm), maximum number of suckers per plant (3.75), stalk length (31.16 mm) and diameter (5.66mm), spathe length (16.41cm) and breadth (9.33 cm), spadix length (6.37cm), flowers per plant (10.20 flowers) and vase life (18.89 days).

Sahare (2015) studied varietal assessment of anthurium in greenhouse under South Gujarat conditions at ASPEE College of Horticulture and Forestry, Navsari Agriculture University, Navsari. 11 varieties of anthurium, namely, Tropical Red, Fire, Saffron, Zafira, Sharan, Cheers, Savana, Peruzzi, Sante Royal, Xavia and Moments were evaluated and it was concluded that Xavia and Sante Royal reported maximum plant height, leaf area per plant, plant spread in East-West and North- South direction and number of leaves, spathe angle, spadix length, spathe length, spathe width, flower stalk diameter, stalk girth, stalk length and number of flowers per meter square.

Roni *et al.* (2016) studied on morpho-physiological characteristics of five anthurium varieties at Horticulture Farm in the Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka and revealed that highest plant height (34.4 cm), flower stalk length (29.1 cm), higher leaf area and SPAD value were recorded in variety Pink anthurium (V₁) and candle position of spathe and spadix was found the best position in White anthurium (V₃) variety. Maximum number of flowers (6.4) and vase life (26.7 days) was recorded in White anthurium (V₃).

Anand *et al.* (2017) carried out research on evaluation of different varieties of anthurium (*Anthurium andraeanum* Linden Ex André) for cut flower production under Shevaroy Hills at Horticultural Research Station, Tamil Nadu Agricultural University, Yercaud. Thirteen anthurium cultivars *viz.*, Acropolis, Angel, Calisto, Cheers, DO 32, Fantasia, Fire, Lumina, Marysia, Midori, Rosa, Titicaca and Xavia were used for study. They reported that the cultivar Claisto recorded the highest plant height (66.00 cm), leaf length (33.54 cm), petiole length (37.00 cm) and highest stalk length (41.00 cm) and number of spikes per plant per year (8.00). Fantasia recorded the maximum plant spread (73.20 cm), spathe width of 13.50 cm and spadix length (6.59 cm). Fantasia and Calsito produced the maximum number of leaves per plant (5.0) and spathe length (12.67 cm). The maximum numbers of suckers were recorded in Lumina (3.14).

Tejaswini *et al.* (2018) studied effect of fertigation levels on yield and quality parameters of different varieties of anthurium (*Anthurium andreanum* Linn.) under shade house condition at Floriculture Section, Regional Horticultural Research and Extension Centre, University of Horticultural Sciences Campus, GKVK, Bengaluru and revealed that maximum stalk length (64.46 cm), stalk diameter (7.52 cm), spathe length (18.24 cm), grade I flowers (68.75%), cumulative water uptake (62.85 g), less cumulative transpiration loss (60.18 g), fresh weight (49.08 g) and vase life (25.83 days) were recorded in cv. Xavia, whereas, spathe width (12.12 cm), spadix angle (40.33°),

number of flowers per plant (7.63), per m² (53.43) and per hectare (4.27 lakh) were observed in cv. Tropical.

Kurniati *et al.* (2019) conducted research on morphological diversity of F1 population in anthurium through conventional breeding at Indonesian Ornamental Crop Research Institute, West java and reported that among F1 population of Anthurium cultivar Putri Gunning x Alvin, clone PA-11 recorded maximum spadix length (37 cm), no. of shoots and PA-9 recorded maximum spathe length (5.5-5.8 cm) and width (4.7 cm).

Nataraj *et al.* (2019) conducted research on performance of anthurium (*Anthurium andraeanum* Lindl) cultivars under hill zone of Karnataka at College of Horticulture, Mudigere, Karnataka. Experiment was conducted with seven anthurium cultivars *viz.*, Tropical, Midori, Cheers, Crinkle Red, Fantasia and Acropolis and it was reported that Tropical recorded maximum plant height, leaf area index, number of leaves, leaf area and highest B:C ratio. Cultivar Crinkle Red recorded maximum number of flowers per plant per year and cultivar Midori recorded maximum vase life.

Chowdhuri *et al.* (2021) carried out research on varietal performance of anthurium (*Anthurium andraeanum*) on growth and flowering in the subtropical zone of West Bengal at Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, West Bengal. 14 anthurium cultivars *viz.* Tropical, KalingPong Pink, Nitta, Tinora, Ozaki Red, Pistache, Regina, Alexis, Honduras, Marina, Agnihotri, Salmon, Anmol and Cancan as a pot plant were studied and they reported that highest plant height (42.4 cm) and number of flowers plant⁻¹ year⁻¹ (8.3) was recorded in Tropical. Ozaki Red recorded the largest flower (9.5 x 7.6 sq. cm), which was followed by Tropical (9.02 x 8.6 sq. cm). The longest flower spike length was observed in Agnihotri (38.2 cm). Maximum vase life was recorded in Pistache (10.1 days) closely followed by Tropical (9.9 days). Overall, among the fourteen cultivars, Tropical was the best cultivar regarding

both yield and quality flower production for commercial cultivation in the sub-tropical conditions of West Bengal.

2.2 Growing media for anthurium cultivation

Nakasone and Kamemoto (1957) studied wood shavings as a medium for anthuriums at Hawaii Agricultural Experiment Station and concluded that wood shavings: cow manure (5:1) recorded maximum number of flower per plant (4.80).

Nakasone and Kamemoto (1962^a) carried out research on effects of some induced environments on growth and flowering at Hawaii Agricultural Experiment Station, University of Hawaii and reported that wood shavings-manure (5:1) recorded maximum stem length (24 cm), spathe length and width (15.9 cm²) and no. of flowers per plant per year (6.1).

Goh and Haynes (1977) conducted study on evaluation of potting media for commercial nursery production of container-grown plants and reported that sawdust had a high total pore space (71.6 %), air space (42.3%), percent pore space (90 %), air capacity (14.9 %) and higher C/N ratio (61.38).

Higaki and Imamura (1985) studied performance of wood products as media for culture of anthuriums at Waiakea Agricultural Experiment Station in Hilo and concluded that plants grown in shredded wood bark of the *Eucalyptus robusta* tree recorded maximum flower size (193.5 cm²), length of flower stem (64.5 cm), length and width of the spathe and number of flowers per plant (3.6 flowers).

Jawaharlal *et al.* (2001) conducted an experiment on standardization of growing media for anthurium (*Anthurium andreanum*) cv. 'Temptation' under shade net house. Six types of potting media like FYM, river sand, loam soil, leaf mould, cocopeat and coconut fibre and their combinations were evaluated and it was reported that plants grown in coco peat medium as well as in

combination of leaf mould and coco peat produced highest number of branches and suckers per plant, number of flowers per plant (5.25), early flowering (288.5 days) and increased inflorescence longevity (88.5 days). The flower quality characters like spathe length (15.25 cm), spathe width (10.15 cm), spadix length (8.25 cm) and flower stalk length (39.15 cm) were also significantly highest in the plants grown in coco peat as well as its combination with leaf mould in anthurium cv. Temptation.

Dhananjaya and Sulladmath (2003) assessed substrate media among tissue culture derived plants of *Anthurium andreanum* cultivar Singapore Hybrid at Indian Institute of Horticultural Research, Hessaraghatta, Bangalore, Karnataka and reported that maximum number of suckers (6.1/plant) and early flower initiation (188.15 days after planting) were observed in the media of coffee cherry husk: FYM: soil and sand (2:1:1:1), respectively.

Grassotti *et al.* (2003) carried out research on effects of growing media and planting time on lily hybrids in soilless culture in Italy and reported that coconut fibre used both singly or as a mixture with perlite and clay pellets recorded maximum dimension of the inflorescence, maximum number of buds and length and weight of stem.

Arumugam and Jawaharlal (2004) studied effect of shade levels and growing media on growth and yield of *Dendrobium* orchid cultivar Sonia-17 and concluded that early flowering (177 days), maximum spike length (44.56 cm) and number of florets per spike (10) were recorded maximum in coconut fibre.

Mani and Nagaraju (2004) conducted studies on the effect of different substrates *viz.*, coco pith, coco pith + leaf mould, coco pith + leaf mould + tree fern, coco pith + leaf mould + tree fern + bricks pieces, coco pith + leaf mould + tree fern + bricks pieces + charcoal, coco pith + sand and leaf mould, on establishment and growth of tissue culture regenerated plants to find out the suitable media for *ex vitro* hardening and growth of *in vitro* raised plantlets of *Cymbidium*

hybrids. The results showed that the plantlets grown in coco pith resulted in maximum increase in shoot length (15.02%) with broad leaf, whereas the plantlets grown in coco pith along with sand resulted in maximum increase in leaf number (42.31 %) and leaf length (32.24%).

Gowda *et al.* (2005) carried out experiment on standardization of growing media for flower production and flower characteristics in anthurium cv. 'Lady Jane' and reported that coir pith produced maximum number of flowers (11.06), stalk length (35.62 cm) and spathe size (10.43 cm²) while, soil media recorded significantly less number of flowers (7.19), shorter stalk length (29.99 cm) and smaller spathe size (8.33 cm²) in anthurium cv. 'Lady Jane'.

Pawar *et al.* (2006) carried out experiment on effect of different substrates on *Anthurium andreanum* and reported that coconut coir pieces produced significantly higher number of leaves per plant (6.58) while the leaf area (9326.94 cm²) and length of leaf sheath (17.34 cm) were significantly higher in coconut coir pieces + brick piece + wooden charcoal followed by coconut coir piece + wooden charcoal.

Barman *et al.* (2008) conducted study on different potting mixture, nutrients and growth regulators for maximization of *Cymbidium* production under partially modified greenhouse. Plants grown in leaf mould + FYM + charcoal + coconut husk + rotten log (2:1:1:1:1) media and applied with N (200 ppm), P (100 ppm), K (100 ppm) + BA (100 ppm), GA (100 ppm) for breaking juvenility and N (200 ppm), P (200ppm), K (200 ppm) + BA (500 ppm) + GA (500 ppm) for enhancing flowering frequency significantly improved vegetative as well as flowering of *Cymbidium* over the other modules. This module significantly increased plant height, number of leaves/shoot, leaf length, number of shoot/plant, number of spike/pot, number of flowers/spike and spike length over farmers practice. Same module also improved the water holding capacity and porosity of the media.

Further, it maintained desirable pH and EC of the media for better production.

Kalirana and Dubey (2008) conducted research trial on effect of substrates on anthurium culture and reported that the total number of leaves produced ranged from 5.00 (FYM + Brick piece) to 7.66 (FYM + Cocofibre). Maximum value of leaf lamina diameter (20.40 cm), leaf sheath length (24.40 cm), plant height (48.73 cm), early flower initiation (206.33 days), maximum number of flowers (4.66), largest flower (33.60 cm²) and longest flower stalk (31.20 cm) were recorded in FYM + Cocofibre. FYM + Cocofibre were an efficient alternate substrate for anthurium cultivation.

Gowda and Ramakrishna (2009) carried out research on evaluation and effect of growing media, biofertilizers and growth regulator on growth and flowering in anthurium and concluded that coir pith produced maximum number of leaves, leaf area and suckers. Minimum number of leaves, leaf area and suckers per plant were produced in soil media in anthurium.

Singh *et al.* (2009) conducted research on standardization of growing media for anthurium (*Anthurium andreanum* L.) Cv. 'Flame' under protected conditions at Greenhouse Complex of ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, during 2007-2008 and concluded that saw dust + brick pieces + wooden charcoal + soil + sand + FYM (T7) in the ratio of 2:1:1:1:1:1 had maximum leaf area (229.11 cm²), petiole length (21.31 cm), minimum days to flowering (260.47 days), stalk length (36.16 cm), spathe length and width (8.5 cm and 8.08 cm) and number of flowers per plant (6.07). The maximum number of leaves per plant (7.40), highest number of suckers per plant (5.00) and longest inflorescence longevity (63.53 days) were recorded in treatment combination involving saw dust + wooden charcoal + soil + sand + FYM (T6) in the ratio of 2:1:1:1:1.

Bagci *et al.* (2011) carried out research on growth of *Primula* plant in coir dust and peat-based growing media at Ankara University, Turkey and reported that 25 per cent coir dust and 75 per cent moss peat recorded maximum number of flower shoots and number of flowers 75 per cent coir dust and 25 per cent moss peat recorded highest plant height in *Primula*.

Heng *et al.* (2011) conducted experiment on effects of growth medium on the growth and development of *Anthurium andraeanum* Lind., cultivated for cut flower production at Floriculture Research Center, Agriculture Research Institute, COA, Yun Lin, Taiwan and reported that the growth and yield of plants cultivated in the middle size coir, middle size coir mixed with fine size coir and middle size coir mixed with artificial textile fiber were superior to that cultivated in the artificial textile fibers.

Singh *et al.* (2011) carried out experiment on standardization of growing media for anthurium (*Anthurium andreanum* L.) under protected conditions and concluded that T₇ (saw dust + brick pieces + wooden charcoal + soil + sand + FYM, 2:1:1:1:1:1 v/v), T₆ (saw dust + wooden charcoal + soil + sand + FYM, 2:1:1:1:1v/v) and T₉ (coco peat + wooden charcoal + soil + sand + FYM, 2:1:1:1:1v/v) were found to be best growing media for vegetative growth, flowering and productivity of anthurium.

Basheer and Thekkayam (2012) studied effect of growing media and organic nutrition on vegetative growth in anthurium plants (*Anthurium andreanum* cv. Tropical) at Department of Pomology and Floriculture, College of Agriculture, Vellayani and revealed that sand + coir pith compost (M₂) was found to produce the maximum plant height (41.66 cm), leaf area (574.48 cm²) and petiole length (16.29 cm) at the fourth week after emergence.

Cuquel *et al.* (2012) studied fertigation and growing media for production of anthurium cut flower. Best flowers were produced in plants grown in the growing media prepared with wood shavings +

organic compost (1:1). Plant height, number of leaves per plant, maximum leaf area (229.11 cm²), plant spread (EW- 38.77 cm and NS- 37.22 cm), highest petiole length, earlier inflorescence bud emergence (232 days), first flowering (260.47 days), longest stalk (36.16 cm), largest spathe size *viz.* length and width of spathe (8.50 cm and 8.08 cm, respectively) , longer vase life (14.53 days), highest number of flowers per plant (7.80) were recorded in treatment T₇ (saw dust + brick pieces + wooden charcoal + soil + sand + FYM).

Talukdar and Barooth (2014) studied effect of different growing media on pseudobulb production of hybrid orchid cv. *Oncidium* and terrestrial orchid cv. *Spathoglottis* and revealed that coconut fibre + charcoal significantly increased the number of pseudo bulbs per plant (7.6) while in case of *Spathoglottis*, media composed of loamy soil + sand + coconut fibre + shredded wood produced significantly higher number of pseudo bulbs per plant (10.2).

Gupta and Dilta (2015) carried out research on effect of growing substrates and pot sizes on growth, flowering and pot present ability of *Primula malacoides* Franch at Dr Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan and concluded that maximum plant height, plant spread, number of inflorescence per plant, number of flowers per plant and duration of flowering was recorded in cocopeat : FYM : sand (1:1:1,v/v).

Kapane *et al.* (2015) studied influence of growing media and gibberellic acid on plant growth, biochemical constituents and flower quality of anthurium (*Anthurium andreanum* L.) cv. Tropical Red at greenhouse complex NAU, Navsari and reported that media M₃ *i.e.*, coconut husk had maximum plant height (33.54 cm), leaf area (126.15 cm²), plant spread E-W (28.42 cm), N-S (25.02 cm), minimum number of days taken for first flower initiation (126.23 days), highest spathe length (6.71 cm) and width (6.21 cm), maximum stalk length (27.41 cm), number of flowers per plant (3.60) and flower longevity on plant (58.42 days).

Muraleedharan and Karuppaiah (2015) conducted studies on the effect of shade and growing media on the growth and yield of anthurium (*Anthurium andreanum*) cv. Tropical at Floratech Floriculture Unit at Kottarakara, Kollam Dist, Kerala and reported that shade level of 75 per cent and growing media with coir pith + coconut husk envisaged maximum plant height, plant spread, number of flowers per plant, flower stalk length, spathe length and spathe breadth. The number of days taken for flower bud appearance was also earlier in this treatment.

Adeoluwa *et al.* (2017) studied growth and flowering response of flamingo flower on selected growth media at National Horticultural Research Institute, Ibadan, Oyo State, Nigeria and concluded that maximum percentage of surviving plants was in sawdust + poultry manure (3:1) (93.33 %).

Chavada *et al.* (2017) conducted experiment on effect of potting media on growth, flower yield and quality of rose (*Rosa hybrida* L.) cv. Top Secret under protected condition Hi-Tech Horticulture Park, Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh and reported that plant height (60.46 cm), leaf area (36.98 cm²), number of leaves per flowering stalk (20.23) and stalk length of cut flower (36.23 cm), number of days to bud initiation (13.23 days) and days taken to bud opening (12.72 day), flower diameter (8.23 cm), length of petal (3.76 cm), width of petal (3.85 cm) and number of flowers per plant (19.48), shelf life (7.35 days) and vase life of flower (8.18 days) were recorded maximum in soil + cocopeat + leaf mould (1:1:1) media combination.

Gupta and Saravanan (2017) conducted research trial on effect of different potting media on plant growth and spike yield of *Dendrobium* at orchidarium of the Department of Horticulture, SHIATS, Allahabad and reported that maximum plant height (33.72 cm), number of leaves per plant (10.94), leaf area (40.33 cm²), number of new shoots per plant (5.00), shoot girth (3.22 cm), root length (17.60 cm), number of roots per plant (23.50), total number of

spikes per plant (4.44), number of florets per spike (11.49), spike length (37.00 cm), longevity of spike (45.50 Days) was recorded in T₃ (plant potted in tile bits) followed by T₁ (rice husk).

Muraleedharan *et al.* (2017) conducted research on impact of humic acid along with growing media combination with *Azospirillum* and FYM on the growth, flowering and quality of *Anthurium andraeanum* at Flora-tech Floriculture Unit at Kottarakara, Kollam Dist. Kerala and reported that plant height (48.89 cm), plant spread (74.76 cm), number of leaves (8.63), stalk length (41.34 cm) and quality characters of flowers like spathe length (9.53 cm), spathe breadth (9.62 cm) and spadix length (7.39 cm) were found maximum in treatment T₂ (coco peat + *Azospirillum* + Humic Acid)

Tatte *et al.* (2017) studied effect of growing media and primary nutrients on postharvest life of cuflovers of anthurium var. Tropical and concluded that flowers of anthurium var. Tropical grown in media coconut husk + charcoal (3: 1) showed maximum total water uptake, weight retention, total soluble sugar, per cent absolute integrity on 4th, 8th and 12th day and vase life.

Thokchom and Maitra (2017) conducted research on micropopagation of *Anthurium andreanum* cv. Jewel from leaf explants at Plant Tissue Culture at Laboratory, Department of Floriculture, Medicinal and Aromatic Plants, UBKV, Cooch Behar and concluded that well rooted anthurium plantlets were successfully hardened in coconut husk with highest survival percentage of 96.17 per cent at vermiculite + coconut husk (1:1, w/w).

De *et al.* (2018) conducted studies on organic nutrient management in *Cymbidium* orchid through both spray and media treatment at midhills of Pakyong, Sikkim, India and reported that T₅ *i.e.*, cocochips + cocopeat + brick pieces + cowdung) (3:1:1:1) had maximum no. of leaves per pseudo bulb (5.5) and number of bulbs per plant (4.5). hChlorophyll content (72/100g) was found maximum in T₆ *i.e.*, cocochips + cocopeat + brick pieces + rice husk).

Tatte *et al.* (2018) conducted experiment on effect of different media and foliar spray of primary nutrients on anthurium (*Anthurium andreanum*) var. Tropical under fan and pad type greenhouse and reported that coconut husk + charcoal (3:1) *i.e.*, M₅ was found better for all vegetative growth attributes like plant height, number of leaves, plant spread, leaf area, length of leaf petiole and suckers per plant of anthurium. An advance flower bud appearance and early unfolding of spathe, maximum flower stalk length, flower stalk diameter, spathe length, spathe width, spadix length, spadix diameter, *in-situ* longevity, flowers per plant, flowers per plot, chlorophyll content in leaf and anthocyanin content in spathe was recorded in coconut husk + charcoal media (3:1).

Sabareeswaran *et al.* (2018) conducted a study on standardization of growing media for hardening plantlets of *Dendrobium* var. Thongchai Gold at Horticultural Research Station, Pechiparai, Tamil Nadu Agricultural University and reported that combination of coconut husk and broken pot pieces in 1:1 ratio significantly enhanced the plant height (9.02 cm) and number of leaves per plantlet (4.61) while the control recorded the plant height of (7.47 cm) with 3.50 leaves per plant. The leaf length (6.96 cm), root length (6.90 cm) and shoot girth (3.20 mm) were the highest in the treatment combination of coconut husk and broken pot pieces in 1:1 ratio. The highest survival per cent of 83.49 was recorded in the same treatment whereas the survival per cent in the control was 62.55. Hence, it can be concluded that the treatment combination of coconut husk and broken pot pieces in 1:1 ratio was the best medium for hardening the *in vitro* plantlets of *Dendrobium* var. Thongchai Gold.

Selvaraj and Bharathi (2018) conducted experiment on standardisation of pre hardening and hardening techniques for *in vitro* derived plantlets of orchid and anthurium at Department of Horticulture, Coconut Research Station, Tamil Nadu Agricultural University (TNAU) and concluded that maximum survival percentage

(91.53 %), plant height (31.4 cm) and number of leaves (20.67) of anthurium under shade net was observed in T₂ i.e., (leaf mould + charcoal + brick (1:1:1) and maximum survival percent (91%), plant height (33.13 cm) of orchid was also recorded in T₂.

Dabral *et al.* (2019) assessed different substrates for pot culture in calla lily (*Zantedeschia sprengeri*) at College of Horticulture, VCSG UHF, Bharsar and concluded that cocopeat recorded maximum number of leaves per plant (9.20), plant spread (22.51cm) and leaf area (247.97 cm²). Earliest first flower bud initiation (30.97 days) and first flower bud opening (8.68 days) was recorded by the use of garden soil + perlite (1:2). Maximum stalk length of flower (54.21 cm), stalk diameter of flower (1.09 cm), spathe length (11.08 cm), spathe diameter (7.77 cm) and weight of fresh flower (35.45 g) was recorded when garden soil + perlite (1:1) was used as a growing media. Thus it could be concluded that growing media combination of garden soil + cocopeat (1:2) i.e., T₈ can effectively be used for improving the overall quality attributes of flower for its use as a cut flower or as a pot plant.

Lakshanthi and Seran (2019) studied effect of survival rate and growth performance of *in vitro* raised plantlets of orchid (*Dendrobium* sp.) in different hardening substrates and reported that T₈ - coconut husk: brick pieces: charcoal: chip stones at ratio 1:1:1:1 had maximum survival percentage (90%) at four weeks after transplanting, shoot length (4.46 cm), number of leaves per plant (9.00), leaf width (1.87 cm), number of root per plant (14.86), length of longest root (13.26 cm) after transplanting to *ex vitro* conditions.

Muraleedharan *et al.* (2019) studied response of *Anthurium andreanum* cv. Tropical to different media and nutrients grown under shade conditions at Flora-tech Floriculture Unit at Kottarakara, Kollam Dist, Kerala state and concluded that treatment T₃ i.e., cocopeat and wood residues + seaweed extract resulted with maximum plant height (31.82 cm), plant spread (52.05 cm), days taken for flower bud initiation (82.91 days), number of flowers per

plant (5.13), flower stalk length (31.17 cm), spathe length (7.62 cm) and spathe breadth (7.21 cm).

Tatte *et al.* (2019) conducted experiment on standardization of growing medium and primary nutrients for anthurium cultivation under greenhouse at Greenhouse Complex, Department of Floriculture and Landscape Architecture, ASPEE College of Horticulture and Forestry, Navsari Agricultural University and concluded that plants grown in coconut husk and charcoal as growing media had maximum plant height (46.77 cm), number of leaves per plant (8.14), leaf area (180.46 cm²) and plant spread (33.08 cm), flower stalk length (39.12 cm), spathe length (10.87 cm), spathe width (8.53 cm) and maximum number of flowers per plant (8.04).

Sanghamitra *et al.* (2019) studied the effect of different potting media on physiological growth, yield and vase life of *Dendrobium* orchid cv. Sonia 17 under shade net conditions in high altitude tribal zone of Andhra Pradesh at the Horticulture Research Station, Chintapalli (Humid sub-tropical zone), Visakhapatnam during two consecutive years and reported that T₆ i.e., coconut husk chips + brickpieces + charcoal + gravel (2:1:1:1) had maximum dry weight of plant (10.75 g), root length (17.54 cm), number of roots (32.51), chlorophyll content (1.05 mg/g), yield of spikes per plant per year (3.58), vase life (15.86 days) and longevity of spike on plant (41.23 days).

Muraleedharan *et al.* (2020) conducted experiment on response *Anthurium andreanum* to different growing media on flowering at Flora-tech Floriculture Unit at Kottarakara, Kollam Dist, Kerala state, India and reported that coco peat + FYM was found to be the best growing medium for anthurium cultivation which recorded maximum plant height (19.89 cm), plant spread (25.91 cm), number of flowers per plant (2.97), flower stalk length (29.02 cm), spathe length (5.11 cm) and spathe breadth (5.32 cm) followed by rice husk + FYM.

2.3 Shade level for anthurium

Pierson *et al.* (1989) conducted research on effect of shading (full sunlight, 60 per cent or 90 per cent) on photosynthesis, growth, and re-growth following defoliation for *Bromus tectorum* and concluded that plants grown under 90 per cent recorded highest leaf length and specific leaf area.

Armitage (1991) conducted research trial on effect of shade on yield and stem length of field grown cut flower species at U. S. Dept. of Agriculture. He studied four different crops *i.e.*, *Centaurea americana* Nutt. 'Jolly Joker', *Eryngium planum*, *Echinops ritro* L. 'Taplow Blue' and four varieties of *Zantedeschia* like Magestic Pink. Pink Perfection, Pacific Pink and Black Magic under different shade conditions *i.e.* full sunshine, 55 per cent or 67 per cent for 2 to 3 years and concluded that yield (6.8 stems/ plant) and stem length (107.5 cm) of *Echinops ritro* L. 'Taplow blue' was found to be highest under 55 % shade. Scape length of all four varieties of *Zantedeschia* was highest under 55% shade and spathe width of Magestic Pink (5.4 cm) and Pink Perfection (7.1) was highest in 55 % shade net.

Stamps (1995) studied effect of shade levels (63 per cent and 73 per cent) and fertilizer rate (448, 896, 1344 or 1792 kg N/ha) on yield and vase life of *Aspidistra elatior* 'Variegata' leaves at Florida Agricultural Experiment Station and reported that higher yield of variegated and green leaves was obtained under 63 per cent as compared to 73 per cent shade. Combined yield of green and variegated leaves produced under 63 per cent shade was 42 per cent greater by weight and 47 per cent greater by number than under 73 per cent shade and the leaves harvested from 63 per cent shade lasted 14 per cent longer than 73 per cent shade produced leaves.

Salvi *et al.* (1997) conducted an experiment by growing anthurium variety Hawaiian Red at four shade levels *viz.*, 50 per cent, 60 per cent, 70 per cent and 80 per cent at Kerala Agriculture University. Shade levels showed significant effect on the growth and

development of plants. The highest plant spread (20.13 cm), number of leaves (9.29), leaf area (423.25cm²) and leaf area index (0.43) were recorded under 80 per cent shade in one year after the experiment. Sucker production started earlier under 80 per cent shade. Leaf longevity was highest in 70 per cent shade while the aerial root production decreased with decrease in shade intensity. Flowering was earliest (8 months) under 50 per cent but flowers were small and flowers under 80 per cent flowered 13 months after planting were big in size. The chlorophyll content in leaves decreased with decrease in the intensity of shade, but the anthocyanin pigment in spathe was not influenced by the different shades.

Sawwan and Ghunem (1999) carried out research on light acclimatization of *Schefflera arboricola* at University of Jordan, Amman, Jordan. *Schefflera* plants were grown under 0, 40, 60 or 80 per cent light for 0, 4, 8 or 12 weeks. They concluded that plants grown under 80 per cent shade recorded highest chlorophyll content (chlorophyll a, b and a:b ratio).

Jimenez *et al.* (2001) conducted experiment on shade intensity (30, 48, 58, 78, and 92 %) and its effect in morphology and physiology of poinsettia (*Euphorbia pulcherrima* Willd.) and concluded that plants grown under 48 per cent shade intensity recorded maximum bract area, shoot dry weight, foliar area and plants grown under 92 per cent shade intensity recorded maximum chlorophyll a, b and total chlorophyll.

Kuehny *et al.* (2002) carried out research on cultural studies in ornamental ginger at a 0 per cent (1,860 $\mu\text{mol/s/m}^2$), 30 per cent (922 $\mu\text{mol/s/m}^2$) or 60 per cent (352 $\mu\text{mol/s/m}^2$) shade. The number of days from first flower to second flower was extended by approximately 12 days when plants were grown under 60 per cent shade. Days from emergence to first flower of cv. Parviflora 'White Angel' was significantly extended by approximately 13 days when grown under 60 per cent shade.

Scuderi *et al.* (2003) conducted research on response of *Ficus benjamina* L. to shade levels (50, 70 and 90 per cent shade net) at Università degli Studi di Catania, Catania, Italy and reported that plants grown under 90 per cent shadenet recorded maximum plant height, internode length, leaf area, average leaf area and leaf length.

Arumugam and Jawaharlal (2004) studied effect of shade levels and growing media on growth and yield of *Dendrobium* orchid cultivar Sonia-17 and found that among the various shade levels, 75 per cent shade recorded the maximum plant height, highest number of spikes/plant, length of spike and longevity of spike with the minimum number of days taken for flowering.

Muhammad *et al.* (2004) conducted research on impact of light intensity (29 per cent, 43 per cent, 54 per cent, 60 per cent or 68 per cent) along with control (no shade) on flowering time and plant quality of *Antirrhinum majus* L. cultivar Chimes White at Gomal University, Pakistan and concluded that earlier flowering, highest number of flower buds and high quality pot-plants were recorded in plants grown under 29 per cent shade.

Hatema and Fathi (2007) conducted experiment on effect of external shading (open and 75 per cent shade) for greenhouse on growth and quality of ornamental plants (*Aglaonema crispum*, *Dieffenbachia amoena*, *Ficus benjamina*, *Schefflera actinophylla* and *Codiaeum variegatum*) at Agricultural Engineering Department, Faculty of Agriculture, Cairo University, Giza, Egypt and reported that *Dieffenbachia* and *Schefflera* grown under 75 per cent shade recorded maximum plant height and number of leaves. *Aglaonema* recorded highest number of leaves and *Codiaeum* recorded highest stem diameter under 75 per cent shade. Quality and coloration of the plants grown under shade were better than those grown in open fields.

Jeong *et al.* (2007) carried out research on response of six *Begonia* species *B. albopicta*, *B. cucullata* var. *cucullata*, *B.*

echinosepala var. *elongatifolia*, *B. holtonis*, *B. foliosa* var. *miniata*, and *B. 'Fuchsifoliosa'* (*B. fuchsioides* x *B. foliosa*) to different shading levels (41, 62, and 76 per cent of full sunlight) at Ornamental Plant Germplasm Center, Ohio State University, Columbus campus and reported that the 62 per cent shading was found optimal for begonia plant growth.

Scuderi (2008) conducted research on influence of shading levels (50, 70 and 90%) on growth and quality of foliage plants (*Ficus benjamina* L. (weeping fig) and *Codiaeum variegatum* (L.) Bl. (croton) at University of Catania, Italy and concluded that plants of *Ficus benjamina* L. grown under 50 per cent shade recorded maximum total leaf area and chlorophyll content and *Codiaeum variegatum* plants grown under 90 per cent shade recorded maximum stem diameter, specific leaf area and chlorophyll content.

Mayoli *et al.* (2009) conducted research trial on effect of GA₃ (0, 100, 500 and 1500 mg/L) and shade (0%, 40% and 80% shade) on growth of *Ranunculus* cut flower in tropics and reported that early flowering, highest quality flower stem diameter, flower bud initiation, flower head diameter and tuberous root fresh weight were found in 40 per cent shade and 80 per cent shade promoted significantly sprouting per cent and longer stems.

Hlatshwayo and Wahome (2010) carried out research on effect of Shading (0 (no shading/control), 20, 40, 60 and 70 per cent) on growth, flowering and cut flower quality in carnation (*Dianthus caryophyllus*) at Horticulture Department, Faculty of Agriculture, Luyengo Campus, at the University of Swaziland and reported that the highest plant height, number of nodes, cut flower stem length were obtained from carnations grown under 70 per cent shade.

Khawlhring *et al.* (2012) conducted research on plant performance of *Anthurium andreaeanum* as affected by shade conditions *viz.*, Netlon with 75 per cent shade and natural tree and different conventional nutrient sources at Mizoram University Campus, Tanhril, Mizoram and reported that better performance in terms of

consistent growth as well as highest plant heights were obtained from those grown under 75 per cent shade house.

Lykas and Katsoulas (2012) carried out research on use of shading nets *viz.*, 70 per cent (30% shading) and 40 per cent (60% shading) to improve quality characteristics of compact gardenia (*Gardenia jasminoides* Ellis) potted plant and reported that it was found that plants grown under the 60 per cent shading net had more vivid green colour compared to the rest of the plants.

Sudhakar and Rameshkumar (2012) conducted experiment on effect of different shading conditions on growth, flowering and yield of heliconium (*Heliconia* sp) cv. Golden Torch at Floriculture Unit, Department of Horticulture, Faculty of Agriculture, Annamalai University, Tamil Nadu to study different shading conditions (*viz.*, N₁ 75 per cent shade, N₂ 50 per cent shade and N₃ open condition) on growth and yield parameters and concluded that highest stalk length (30.21 cm), rachis length (13.21 cm) and number of flowers per plant (4.02) were recorded in N₂ (75 per cent shade) and lowest was recorded into N₃ (open condition). The maximum flower yield per hectare was obtained in N₂ (173411 flowers) followed by N₁ (154512 flowers).

Srikrishnah *et al.* (2012) carried out experiment on effects of three shade levels (50 per cent, 70 per cent and 80 per cent) on leaf area and biomass production of three varieties ('Gold', 'Victory' and 'White') of dracaena (*Dracaena sanderiana* L.) in the dry zone (Batticaloa district) of Sri Lanka and reported that plants grown at 50 per cent and 70 per cent shade levels produced the highest leaf area and biomass than plants grown under 80 per cent shade.

Zhao *et al.* (2012) studied effect of shading on some morphological and physiological characteristics of *Begonia semperflorens* and concluded plant height, leaf number, stem diameter, branch number, node number and plant crown width, were higher in plants grown with sun exposure compared to those grown in

shade but opposite trends were observed for the top and middle leaf areas of the plant. In contrast with sun exposure, shade reduced photosynthetic capacity, light saturation point (LSP) and light compensation point (LCP) and increased the apparent quantum yield (AQY), primarily due to reduced stomatal conduction which led to delayed initial flowering date, prolonged flowering time, reduced flower fresh weight and increased flower diameter.

Dolatkhahi *et al.* (2013) studied shading impact (0, 25, 50, and 65 per cent shading) on qualitative characteristics and chlorophyll content of cut rose (*Rosa hybrida* cv. Avalanche) at Department of Horticultural Science, Tabriz University, Iran. Shading significantly affected bud sprouting, flowering stem fresh and dry weight and flowering stem length and diameter and specific leaf area increased with shading percentage increment at 65 per cent shade. Results of total chlorophyll content as well as chlorophyll a and b showed a decrement with increasing of shading percentage.

Youssef and Mady (2013) conducted research to study the effect of light intensity *i.e.*, full sunlight, 63 per cent and 73 per cent shade and benzyladenine (BA) treatments *i.e.*, 0.0 ppm (control), 25 ppm, 50 ppm and 75 ppm on growth and chemical composition of *Aspidistra elatior* plants for two seasons (2010-11 and 2011-12) and concluded that plant height, length and width, leaf area, leaf blade and fresh and dry weights of leaf were obtained by 75 ppm BA-sprayed plants grown under 73 per cent shade conditions.

Gaurav *et al.* (2014) studied the effect of different shade levels (0%, 35%, 50%, 75% and 90%) on the growth and quality of *Dracaena fragrans* at Research Farm of the Division of Floriculture and Landscaping, IARI, New Delhi and reported that highest number of leaves (30), higher leaf area (508.60 cm²), fresh weight (22.72 g), dry weight (4.55 g), leaf chlorophyll content, photosynthetic rate (6.49 mol CO₂/m²/s) and harvest index (70.86%) was recorded in 50 per cent shade level.

Gaurav *et al.* (2015) carried out research on effect of shade levels (35%, 50%, 75% and 90%) on production and quality of cordyline (*Cordyline terminalis*) at Division of Floriculture and Landscaping, IARI, New Delhi and concluded that overall shade net with 50 per cent shading was found best for commercial production of cordyline cut greens.

Muraleedharan and Karuppaiah (2015) conducted studies on the effect of shade and growing media on the growth and yield of anthurium (*Anthurium andreanum*) cv. Tropical. The result indicated that shade level of 75 per cent and growing media with coir pith + coconut husk envisaged maximum plant height, plant spread, number of flowers per plant, flower stalk length, spathe length and spathe breadth. The number of days taken for flower bud appearance was also earlier in this treatment.

Singh *et al.* (2014) conducted experiment on effect of shade levels (open field conditions, 50 per cent and 75 per cent shadenet) on growth and frond production in Boston fern [*Nephrolepis exaltata* (L.) Schott] and reported that best growth was obtained under 75 per cent shade and the plants exhibited maximum plant height, plant spread , growth index, average frond length, numbers of fronds, length of the longest frond, mean lamina length, leaf area, number of fronds per plant, chlorophyll content during both the growing years.

Rupasinghe *et al.* (2015) conducted research on adaptability of cut rose (*Rosa hybrida* L.) varieties for shade (Aluminet (25 % shade), Black shade net (50% shade) and without shade) and high temperature conditions in tropical greenhouses at Dodangolla, Kundasale in the Mid Country Intermediate Zone MCIZ, Kandy district, Sri Lanka and reported that rose varieties viz., Black Magic, Grand Gala and White Success grown under 25 per cent shade recorded highest plant height, leaf area, number of flowers per plant and flower diameter.

Nair *et al.* (2017) carried out experiment on influence of light intensities (388.50 to 647.50 $\mu\text{ mol m}^{-2}\text{s}^{-1}$ (25% shade net), 314.5 to 481 $\mu\text{ mol m}^{-2}\text{s}^{-1}$ (50% shade net) and 240.50 to 370 $\mu\text{ mol m}^{-2}\text{s}^{-1}$ (75% shade net) and seasonal variations on yield and quality of selected cut foliage crops at ICAR-IIHR, Hesaraghatta and reported that *Dracaena reflexa* var. Variegata, *Dracaena reflexa* var. Green and *Melaleuca bracteata* performed well under the light intensity range of 388.50 to 647.50 $\mu\text{ mol m}^{-2}\text{s}^{-1}$ (25% green shade net) for cut foliage production. *Philodendron* 'Xanadu' yielded maximum number of superior quality cut foliage when cultivated in the light intensity range of 240.50 to 370 $\mu\text{ mol m}^{-2}\text{s}^{-1}$ (75% shade net).

Srikrishnah *et al.* (2017) carried out experiment on effect of graded shade levels (viz., 0 per cent (open sunlight -T₁), 50 per cent (T₂), 60 per cent (T₃), 70 per cent (T₄) and 80 per cent (T₅) on the growth and qualities of *Dracaena sanderiana* var. 'Celes' at Crop Farm, Eastern University of Sri Lanka, Vantharumoolai, Batticaloa. They concluded that plants grown at 70 per cent shade level showed significantly better performance in growth parameters like plant height and leaf area. In quality assessment, plants subjected to 70 per cent shade showed highest score.

Dev *et al.* (2018) conducted research on effect of shade levels (25%, 50%, and 75%) on growth, and biomass production of Cactus (*Opuntia ficus india* (L.) Mill.) at Central Arid Zone Research Institute, Regional Research Station Kukma, Bhuj- Gujarat and concluded that plants grown under 50 per cent shade levels produced the highest number of leaves (cladodes), leaf area and fresh biomass and plants grown under 75 per cent shade level recorded highest plant height, cladode length.

Goh *et al.* (2018) carried out research on breaking dormancy and effects of shade levels (full sun, 30 per cent and 50 per cent shade levels) and NPK fertilizer rates (BAP, 0, 50, 100, 150, 200, and 250 mg/L) and ethephon (0, 150, 300, 450, 600, and 750 mg/L) on yield

of *Zingiber zerumbet* (L.) Smith (Lempoyang) at University Putra Malaysia and reported that plants grown under 30 per cent shade produced highest rhizome fresh weight, dry weight and yield and plants grown under 50 per cent shade recorded highest plant height and number of tillers per plant.

Narmhikaa *et al.* (2018) carried out experiment on influence of different shade levels (open field, 50, 60, 70, and 80 per cent) on the growth and quality of *Codiaeum variegatum* var. 'Bush on Fire' at Crop Farm, Eastern University, Vantharumoolai, Batticaloa dry zone of Sri Lanka and concluded that plants grown under 50 per cent shade level showed significantly better performance in growth parameters like plant height, plant biomass and biomass partitioning.

Rezai *et al.* (2018) carried out experiment on effect of light intensity (full sunlight (0% shade) as well as 30, 50, or 70 per cent shade levels) on leaf morphology, photosynthetic capacity, and chlorophyll content in sage (*Salvia officinalis* L.) at Department of Horticulture, College of Agriculture, Isfahan University of Technology and reported that leaf size was greatest under 50 per cent shade level. Decreasing light intensity led to an increase in chlorophyll and carotenoid content.

Rezazadeh *et al.* (2018) conducted experiment on the effect of light intensity and temperature on flowering and morphology of potted Red Firespike at Mississippi State University, Poplarville, USA. Treatments *viz.*, 0, 45, or 65 per cent shade and two photoperiod conditions *i.e.*, long-day (LD = 14 h) and short-day (SD = 9 h), for 16 weeks and reported that plants grown under 45 per cent shade net and long-day (LD = 14 h) recorded maximum plant height, leaves below inflorescence and plant dry weight.

Khawlhring *et al.* (2019) conducted experiment on productivity and quality of *Anthurium andreanum* influenced by growing conditions (75% shade net and tree shade plants cultivated under the shade of natural forest trees) and fertilizers at Herbal Garden, School of Earth

Sciences and Natural Resources Management, Mizoram University, Tanhril, Mizoram and concluded that plants grown under 75 per cent shade recorded maximum number of suckers per pot (5.41), number of leaves (25.93), leaf area (261.83 cm²), flower stalk length (43.90 cm), flower stalk diameter (6.76 mm), spadix length (68.20 cm), spadix diameter (10.68 mm), spathe area (105.00 cm²), vase life (19.28 days) and number of flowers per plant (3.57).

Thakur *et al.* (2019) conducted research trial to study different shade levels (open sunny conditions as compared to 25 per cent and 50 per cent shade levels and mulch types that influence the growth, flower yield and essential oil profile of *R. damascene* at experimental farm of CSIR-Institute of Himalayan Bioresource Technology, Palampur, India for two consecutive years and reported that the plants grown under 50 per cent shade level recorded significantly higher plant height, plant spread and the lowest numbers of branches as compared to control.

Tejukumar (2019) studied effect of different shade levels (35 %, 50%, 75 % and 90 %) on growth and development of Peace lily at Punjab Agriculture University, Ludhiana and reported that plants grown under 75 per cent shade net showed best vegetative parameters such as plant spread, leaf length, number of leaves per plant, leaf thickness, petiole girth, fresh and dry weight of leaves and flowering parameters *viz.*, number of flowers per plant, flower stalk diameter. Plants grown under 90 per cent shade net recorded highest plant height, leaf breadth and chlorophyll content of leaves, flower stalk length, spathe length, spathe breadth and vase life.

2.4 Use of various chemicals for extending vase life of anthurium cut flowers

Ketsa *et al.* (1995) carried out research on the effect of AgNO₃ on the vase life and bud opening of cut flowers of *Dendrobium* 'Pompadour' at Department of Horticulture, Xasetsart University, Bangkok, Thailand and reported that AgNO₃ must be present

continuously together with 8-Hydroxyquinoline Sulfate (HQS) and glucose in order to maximize water uptake and vase life. AgNO₃ was more effective than silver thiosulfate (STS) in controlling microbial growth and in maximizing bud opening and vase life. This suggests that AgNO₃ in the holding solution act as an antimicrobial agent.

Salvi (1997) studied effect of holding solutions on cut anthurium flowers at Department of Pomology and Floriculture, College of Horticulture, Vellanikkara, Trichur, Kerala. The basal portion of the inflorescence stalk was kept dipped in vase solutions (200 ml) of AgNO₃, 10 and 20 ppm, BA 25 and 50 ppm, CCC 25 and 50 ppm, sucrose 5 per cent and tap water as control and concluded that BA at 25 ppm recorded minimum physiological loss in weight of flower and maximum total vase life of 22 days.

Anjum *et al.* (2001) studied effect of some chemicals on keeping quality and vase- life of tuberose (*Polianthes tuberosa* L.) cut flowers at University College of Agriculture, Bahauddin Zakariya University, Multan, Pakistan. Cut spikes of tuberose were kept in CaCl₂.2H₂O, AgNO₃, ascorbic acid and Tri-Miltox Forte (a fungicide) solutions with various concentrations and tap water to see their effects on keeping quality and vase-life of the flowers. They concluded that CaCl₂.2H₂O at concentrations of 750 to 1250 ppm and Tri-Miltox Forte at 1500 ppm resulted in minimum flower wilting after six days. AgNO₃ was found to have adverse effects on fragrance of the flowers. However, AgNO₃ 50 and 200 ppm solutions resulted in maximum vase-life (8 days) of cut flowers.

Butt (2005) carried out research on extending the vase life of Roses are (*Rosa hybrida*) with different preservatives at Hill Fruits Research Station, Sunny Bank, Murree, Pakistan and reported that silver nitrate, gave better performance than the sucrose in enhancing the shelf life of cut flowers of both the cultivars. In all the treatments containing sucrose and silver nitrate, the concentration of 150 ppm of AgNO₃ prolonged the maximum number of days in both the cultivars,

which were 4.3 and 3.2 days more in Whisky Mac and Trika, respectively as compared to control.

Jowkar and Salehi (2005) conducted research on effect of different preservative solutions on the vase life of cut tuberose flowers at usual home conditions at Azad University of Jahrom, Fars, Iran. In the first experiment the preservative solutions were sucrose (1, 2 and 3%), silver thiosulphate (0.4, 0.8 and 1.2 mM), silver nitrate (50, 100 and 150 mg l⁻¹), citric acid (150, 300 and 450 mg l⁻¹) and tap water as the control. The longest vase life belonged to citric acid, followed by the control (tap water). The second experiment was conducted for determining the role of the water quality. In this part the treatments were: sterilized distilled water, citric acid made with sterilized distilled water (150, 300 and 450 mg l⁻¹) and tap water as the control. The longest and the shortest vase life belonged to sterilized distilled water and the control (tap water), respectively.

Soumen and Roychowdhury (2005) carried out research on effect of pulsing and holding solutions on postharvest life of cutflowers in *Anthurium andraeanum* Lind. cv. Nitta at Department of Floriculture and Landscaping, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal. 8-Hydroxyquinoline Sulphate (8-HQS) 400 ppm + sucrose 5% recorded maximum water uptake (38.02 ml) and water loss (40.17 ml), postharvest longevity was 28.17 day. Flowers treated with distilled water showed the lowest postharvest life (13.33 days).

Meman and Dabhi (2006) conducted research on effect of different stalk lengths and certain chemical substances on vase life of gerbera (*Gerbera jamesonii* Hook.) cv. 'Savana Red' at Department of Horticulture, Navsari, Gujarat Agricultural University. Twenty treatment combinations consisting of four chemicals viz., sucrose 4 %, sucrose 4% + 8-HQC 250 ppm, sucrose 4% + aluminum sulphate 100 ppm, sucrose 4 % + citric acid 250 ppm, along with control (distilled water) and four lengths of stalk viz., 30, 40, 50, and 60 cm. The vase

solution of sucrose 4% + 8-HQC 250 ppm and stalk length of 60 cm, individually and in combination increased fresh weight of flowers by promoting solution uptake, vase life of flowers and useful life of flowers, opening of disc florets with bright, shining red colour and freshness for a longer duration.

Singh *et al.* (2008) studied effect of plant growth regulators *viz.*, gibberellic acid (GA₃) and benzyl adenine (BA) and sucrose on post-harvest physiology, membrane stability and vase life of cut spikes of gladiolus and reported that vase solution treatment combinations of GA₃ and BA with sucrose significantly increased the membrane stability index and enhanced the vase life as compared to the sucrose alone treatments or the controls. Vase solution treatment of GA₃ (50 mg l⁻¹), followed by BA (50 mg l⁻¹) with sucrose (50 g l⁻¹) significantly increased solution uptake, fresh weight and dry weight of cut spikes and increased vase life of gladiolus spikes.

Asil and Karim (2010) studied efficiency of benzyladenine reduced ethylene production and extended vase life of cut *Eustoma* flowers at University of Guilan, Rasht, Iran and reported that water uptake (2.05 ml g⁻¹ FW) and vase life (16.26 day) was recorded maximum by BA (25 mg L⁻¹).

Kumar *et al.* (2010) carried out research on effect of floral preservatives on vase life of gladiolus (*Gladiolus grandiflorus* L.) at Department of Horticulture, Sh. F.H. (P.G.) College, Nidhauli Kalan, Etah (U.P.) India. The spikes were treated with different holding solutions *viz.*, sucrose (2% and 4%), aluminium sulphate (300 ppm), cobalt chloride (400 ppm), sodium hypochloride (50 ppm) and 8-hydroxy quinoline citrate (250 ppm) and control (treated with distilled water) alone and in combinations and reported that treatment 4 % sucrose + 300 ppm Al₂(SO₄)₃ recorded maximum vase life (10.07 days), vase solution uptake (31.30 ml) and longevity of first five florets.

Danaee *et al.* (2011) conducted research on effect of GA₃ and BA on postharvest quality and vase life of gerbera (*Gerbera jamesonii*). cv.

Good Timing) cut flowers at Islamic Azad University, Tehran, Iran. Freshly cut flower stems of gerbera cultivar 'Good Timing', with four outer disc florets open, were put in vases containing 0, 50, 100, 150, 200, or 300 mg/L⁻¹ GA₃ and 0, 10, 25, 50, 100, or 150 mg/L⁻¹ of BA for 48 hr. Vases were placed in chambers at 25°C with a relative humidity about 70%. Results revealed that vase life, fresh weight, solution uptake, membrane stability, total soluble solid were maximum in GA₃ 50 mg L⁻¹ and BA 50 mg L⁻¹. Cytokinins and gibberelins have potential to enhance post-harvest quality of cut gerbera.

Chand *et al.* (2012) conducted research on effect of pulsing and holding solutions on postharvest life of cut flowers in rose Lind. cv. Nitta at Department rose of Horticulture, C.C.S. University Campus, Meerut, India. Treatments *viz.*, 50 ppm and 100 ppm solution of AgNO₃ and 100 ppm and 200 ppm 8-HQC under ambient condition of 32 ± 2°C temperature and 50-75% relative humidity. In the experiment, vase life of cut flower under different treatments was determined in vase holding solution i.e., 50 ppm, 100 ppm, AgNO₃ and 100 ppm, 200 ppm 8-HQC. 8-HQC 100 ppm and 200 ppm enhanced the fresh weight, water uptake and vase life of roses at 100 ppm and 200 ppm.

Elhindi (2012) conducted trial on evaluation of several holding solutions for prolonging vase-life and keeping quality of cut sweet pea flowers (*Lathyrus odoratus* L.) at laboratory of Plant Production Department, College of Food and Agricultural Sciences, King Saud University, Saudi Arabia. Five different preservative solutions (treatments) were used as follows T₁- 2% sucrose, T₂- 200 ppm 8-hydroxyquinoline sulfate (8-HQS), T₃- pulsing the spikes with 200 ppm 8-HQS in combination with 2% sucrose for 12 h, T₄- pulsing the spikes with 0.2 mM silver thiosulfate (STS) for 1 h, T₅- pulsing the spikes with 0.2 Mm STS for 1 h followed by 2% sucrose solution, T₆- deionized water (control). He concluded that T₂- 200 ppm 8-

hydroxyquinoline sulfate (8-HQS) recorded maximum vase life (14.33 days) and water uptake (5.65ml/flower/day).

Ajithkumar *et al.* (2013) conducted research trial on effect of pulsing and holding solutions on vase life of *Dendrobium* cv. Sonia 17 at College of Horticulture, Kerala Agricultural University, Thrissur (Kerala) H₁ - HQ (200ppm) + sucrose (5%), H₂ - HQ (400ppm) +sucrose (5%), H₃ - Ag NO₃ (25ppm) + sucrose (5%), H₄ - BA (25 ppm), H₅ - BA (25ppm + sucrose (5%)), H₆ - AgNO₃ (25ppm) + HQ (400 ppm) + sucrose (5%) and concluded that AgNO₃ (25 ppm) + sucrose (5%) recorded maximum vase life of 35 days, number of days for wilting of first flower (17.3 days) and number of days for wilting of all flowers (53.7 days).

Banaee *et al.* (2013) conducted research on interaction effect of sucrose (0 and 30g l⁻¹), salicylic acid (0, 100 and 150 mg l⁻¹) and 8-hydroxyquinoline sulfate (0 and 200 mg l⁻¹) on vase-life of cut gerbera flowers at Department of Horticulture, Karaj branch, Islamic Azad University, Karaj, Iran and reported that 8-HQS increased vase life (12.9 days), dry weight, wet weight, flower diameter, mean absorbed preservative solution, quality score and combination of SA (100 mg L⁻¹) + 8-HQS (200 mg L⁻¹) which recorded longest vase life of 15.6 days.

Sankari *et al.* (2013) studied influence of holding and pulsing solution on cut spikes of anthurium (*Anthurium andreaeanum*) at Horticultural Research Station (T.N.A.U.), Yercaud, Salem (T.N) with H₁-NaOCl - 50 ppm, H₂- Al₂ (SO₄)₃. 16H₂O - 300 ppm, H₃-Kinetin - 25 ppm, H₄- Al₂ (SO₄)₃. 16H₂O - 300 ppm + kinetin - 25 ppm, H₅- NaOCl - 50 ppm + kinetin - 25 ppm, H₆-Sucrose 5% + NaOCl-50 ppm, H₇- Sucrose 5% + Al₂(SO₄)₃, 16H₂O-300 ppm, H₈- Sucrose 5% + kinetin-25 ppm, H₉-Sucrose 5% + Al₂(SO₄)₃, 16H₂O-300 ppm + kinetin-25 ppm, H₁₀-Sucrose 5% + NaOCl. 16H₂O-50 ppm+ kinetin-25 ppm, H₁₁- Control (Double distilled water) and concluded that holding solution of sucrose 5 per cent + NaOCl, 16H₂O – 50 ppm + kinetin – 25 ppm took

maximum days for anther bursting (18 days), discolouration of the spathe (29d) and vase life period (30 days).

Vaidya and Collis (2013) carried out research on effect of biocides and sucrose on vase life and quality of cut gerbera (*Gerbera jamesonii*) cv. Maron Dementine at Department of Horticulture, Dr. PDKV, Akola (M.S.). Nine treatments of holding solutions viz. T₀-control (distilled water), T₁-Sucrose 3%, T₂-Sucrose 4%, T₃-Sucrose 3% + silver nitrate @ 20 ppm, T₄- Sucrose 4% + silver nitrate @ 40ppm, T₅-Sucrose 3% + aluminium sulphate @ 200 ppm, T₆-Sucrose 4% + aluminium sulphate @ 400 ppm, T₇-Sucrose 3% + 8-Hydroxyquinoline citrate @ 200 ppm and T₈- Sucrose 4% + 8-Hydroxyquinoline citrate @ 400ppm were used for experiment and they reported that T₄- Sucrose 4% + silver nitrate @ 40ppm recorded maximum vase solution uptake/stem (22.4 cm), attractiveness (15.3 days) and vase life (15.8 days).

Kumar (2014) studied effect of different floral preservatives solutions on post harvest quality of gladiolus (*Gladiolus hybridus* Hort.) cv. Peater Pears at Post Harvest Laboratory, Department of Horticulture, SVPUAT, Meerut. Nine holding solutions, viz. T₁ : 5% Sucrose+ 50ppm AgNO₃, T₂ : 5% Sucrose+ 100ppm AgNO₃, T₃ : 5% Sucrose+ 200ppm Al₂(SO₄)₃, T₄ : 5% Sucrose+ 400ppm Al₂(SO₄)₃, T₅ : 5% Sucrose+ 200ppm Citric Acid, T₆ : 5% Sucrose+ 400ppm Citric Acid, T₇ : 5% Sucrose+ 200ppm 8HQC and T₈ : 5% Sucrose+ 50ppm Calcium hypochlorite, T₉ : Control (Deionized water) and concluded that T₇ : 5% Sucrose+ 200 ppm 8HQC recorded maximum vase life (10.67 days), solution absorption/spike (65.07 ml).

Naznin *et al.* (2015) conducted research on effect of different preservatives on vase life of tuberose at Bangladesh Agricultural Research Institute, Gazipur, Bangladesh. These preservative solutions (treatments) were: T₁-2% sucrose + 200 mg/l AgNO₃, T₂-2% sucrose + 200 mg/l AgNO₃ + 25 mg/l citric acid, T₃- 2% sucrose + 300 mg/l HQS, T₄-2% sucrose + 300 mg/l HQS+ 25 mg/l citric acid, T₅-2% sucrose + 200 mg/l AgNO₃ + 300 mg/l HQS, T₆- 2% sucrose + 200

mg/l AgNO₃ + 300 mg/l HQS+ 25 mg/l citric acid, T₇-0.01 % sodium hypochloride, T₈-0.05 % sodium hypochloride, T₉- 0.10 % sodium hypochloride and T₁₀- tap water (control). They reported that T₆-2% sucrose +200 mg/l AgNO₃ + 300 mg/l HQS+ 25 mg/l citric acid recorded maximum water uptake, water loss uptake ratio, percentage of maximum increase in fresh weight of the cut flower stem and vase life.

Matak and Hashemabadi (2016) studied increasing the vase life of alstroemeria cut flowers using Cycloheximide, benzyladenine and coconut juice at Islamic Azad University, Rasht, Iran and concluded that 5% coconut juice recorded maximum vase life (17.39 days) which was followed by benzyladenine 200 mg l⁻¹ (15.87 days).

Simi *et al.* (2017) carried out research on effect of pre-cooling and holding solutions on the keeping quality of cut flower *Anthurium andrianum* 'White King' at All India Co-ordinated Floriculture Improvement Programme, College of Horticulture, Vellanikkara. (T₇) (5%) + Al₂ (SO₄)₃.16H₂O, 300 ppm) (T₇) recorded maximum vase life (14 days).

Vilas *et al.* (2017) conducted research on effect of biocides {AgNO₃, Al₂ (SO₄)₃, 8-HQC and sucrose} on the post harvest life of carnation (*Dianthus caryophyllus* L.) at Department of Horticulture, R.B. (P.G.) College, Muri Crossing Agra, Dr. Bhim Rao Ambedkar University, Agra (U.P.). Holding solution treatments *viz.*, T₁ AgNO₃ 25ppm , T₂ AgNO₃ 30 ppm, T₃- Al₂ (SO₄)₃ 200ppm, T₄- Al₂ (SO₄)₃ 400 ppm, T₅-8 HQC 20 ppm, T₆-8 HQC 40 ppm, T₇-Sucrose 2%, T₈-Sucrose 4 % and T₉- distilled water were used and they reported that uptake of solution and vase life was recorded maximum in T₁ (AgNO₃ 25 ppm).

Pranuthi *et al.* (2018) conducted research on effect of holding solutions on biochemical and microbial observations in extending the vase life of cut carnation cv. Kiro at Dr. Y.S.R. Horticultural University, Venkataramannagudem, (Andhra Pradesh), India. Sucrose

4% + 8-HQS 200 ppm was used as common holding solution. There were 11 treatments, T₁: Sucrose 4% + 8-HQS 200 ppm + GA₃ 25 ppm, T₂: Sucrose 4% + 8-HQS 200 ppm + GA₃ 50 ppm, T₃: Sucrose 4% + 8-HQS 200 ppm + BA 25 ppm, T₄: Sucrose 4% + 8-HQS 200 ppm + BA 50 ppm, T₅: Sucrose 4% + 8-HQS 200 ppm + Al₂ (SO₄)₃ 150 ppm, T₆: Sucrose 4% + 8-HQS 200 ppm + Al₂ (SO₄)₃ 300 ppm, T₇: Sucrose 4% + 8-HQS 200 ppm + STS 0.25 mM, T₈: Sucrose 4% + 8-HQS 200 ppm + STS 0.50 mM, T₉: Sucrose 4% + 8-HQS 200 ppm + Salicylic acid 25 ppm, T₁₀: Sucrose 4% + 8-HQS 200 ppm + Salicylic acid 50 ppm, T₁₁: control. They concluded that holding solution (sucrose 4% + 8-HQS 200 ppm) along with GA₃ at 25 ppm recorded maximum vase life (20.32 days)

Abd-Allah *et al.* (2019) carried out experiment on changes in post-harvest life of cut chrysanthemum as influenced by different holding solutions and two cultivars at Cairo University, Giza, Egypt. Holding solution treatments used for study were T₁-Distilled water (D.W), T₂-Sucrose (Suc.) (2%), T₃-Sucrose (4%), T₄-4- Sucrose (2%) + 8-Hydroxyquinoline citrate (8-HQC) (200 mg/l), T₅-Sucrose (4%) + 8-Hydroxyquinoline citrate (200 mg/l), T₆-Sucrose (2%) + Gibberellic acid (GA₃) (0.001 %), T₇ Sucrose (4%) + Gibberellic acid (0.001 %), T₈- 8- Sucrose (2%) + 8- Hydroxyquinoline citrate (200 mg/l) + Gibberellic acid (0.001%) + Citric acid (150 mg/l), T₉- 9- Sucrose (2%) + Citric acid (150 mg/l), Sucrose (4%) + Citric acid (150 mg/l)= T₁₀, T₁₁- Sucrose (4%) +8- Hydroxyquinoline citrate (200 mg/l) + Gibberellic Acid (0.001%) + Citric Acid (150 mg/l) they concluded that maximum water uptake and vase life was recorded in T₈ i.e sucrose at (2 %) + 8-HQC (200 mg/l) + GA₃ (0.001 %) + CA (150 mg/l).

Sanghamitra *et al.* (2019) carried out research on effect of holding solutions on *Dendrobium* orchids cv. Sonia 17 for improving the vase Life of cut spikes at College of Horticulture, Dr. YSR Horticultural University, Venkataramannagudem, Tadepalligudem, West Godavari district, Andhra Pradesh, India with T₁: 8HQC (200

ppm) + 2% sucrose, T₂: 8HQC (300 ppm) + 4% sucrose, T₃: AgNO₃ (30 ppm) + 2% sucrose, T₄: AgNO₃ (40 ppm) + 4% sucrose, T₅: Citric acid (300 ppm) + 2% sucrose, T₆: Citric acid (400 ppm) + 4% sucrose, T₇: Distilled water and reported that T₂: 8HQC (300 ppm) + 4% sucrose recorded maximum vase life (31.50 days), physiological loss of weight (36.39%), days for fading of first flower (18.14 days), days for fading of last flower (52.38 days), percent bud opening per spike (86.06%) and minimum number of unopened and abscised buds per spike (13.88%) on *Dendrobium* cut spikes cv. Sonia 17 when compared to control.

Mawlong *et al.* (2020) carried out research on studies on preservation and shelf life of cut anthurium flower at Department of Post Harvest Technology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal. Spikes were subjected to preservative solution with treatments T₁-Sucrose @ 2% + CA @ 200 ppm, T₂-Sucrose @ 2% + CA @ 200 ppm + HQS @ 200 ppm, T₃-Sucrose @ 2% + CA @ 200 ppm + Al₂SO₄ @ 200 ppm, T₄- Sucrose @ 2% + CA @ 200 ppm + BA @ 50 ppm, T₅ - Sucrose @ 2% + CA @ 200ppm + HQS @ 200 ppm + BA @ 50 ppm, T₆-Sucrose @ 2% @ + CA @ 200 ppm + Al₂SO₄ @ 200 ppm + BA @ 50 ppm, T₇-BA @ 50ppm, T₈-Distilled water. They reported that T₄ recorded maximum uptake of water and total water loss, T₅ increased fresh weight and vase life. T₂ recorded maximum retention in spadix colour and maximum days for blackening of spadix and blueing of spathe was recorded in T₆.

CHAPTER III

MATERIAL AND METHODS

The present investigation entitled “Optimization of shade level, media and vase life for cut flower production in anthurium (*Anthurium andreanum* Linn) is a Ph.D. research work. The information with respect to the material used and methods followed during studies on different shade levels and media for enhancing growth, quality and yield of anthurium (*Anthurium andreanum* Linn.) as well as extending vase life by using different holding solutions have been described in this chapter with four sets of experiments.

3.1 Experimental site

The experiment was conducted at the Hi-Tech unit, College of Horticulture, Dapoli, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist- Ratnagiri (M.S) during the period 2019-20 and 2020-21.

3.2 Place and weather conditions

Dapoli represents tropical humid climate having average humidity 78% throughout the year. The average minimum and maximum temperature was 18.5°C and 30.8°C, respectively with an average precipitation of 3,500 mm, distributed mainly during four months from June to September. Dapoli lies on West coast of Maharashtra at 17°45' N latitude and 73°12' E longitude. It has an altitude of 240 m from the MSL. The soil is lateritic, sandy clay loam and acidic in reaction having pH ranging from 5.6 to 6.5.

3.3 Details of material used and methodology followed

3.3.1 To study the performance of different Anthurium varieties.

3.3.1.1 Experimental details:

Treatments	: 6 varieties
Replications	: 4
Design	: Randomized Block Design
Age of plants	: 6 months

Number of plants/treatment	: 25
Total plant population	: 600
Pot size	: 20 cm diameter and 18 cm height
Period of experiment	: December, 2019 to May 2021
Duration of study	: 16 months
Treatment details	: V ₁ - Baby White V ₂ - Baby Purple V ₃ - Prince Orange V ₄ - Princess Amellia V ₅ - Fancy Red V ₆ - Queen Black

3.3.1.1a Source of planting material

In first experimental block, well grown up flowering size plants suckers of different varieties of anthurium were procured from Rise and Shine nursery, Pune to conduct the research trial on varietal performance of anthurium.

3.3.1.2 Details of cultivation practices

3.3.1.2a Preparation of cultivation/growing site

Anthuriums grow well in warm humid with tropical climate. As anthuriums are shade loving plants, they cannot be grown in open conditions without appropriate shading facilities. Therefore shade structure was constructed in the field using shade net of 90 per cent for this experiment.

3.3.1.2b Preparation of media

Media required for the experiment *i.e.*, sand, cowdung clumps, coconut husk, wood shaving, charcoal, brick pieces was washed with water and then sun dried for sterilization. Small pieces were made of coconut husk, brick pieces and all the media was dipped in fungicide solution (Bavistin 0.2 %) for 5 minutes before filling the pots.

3.3.1.2c Pot filling and Planting

Pots with uniform size were used for planting. Media was

filled $\frac{3}{4}$ the volume of the pots and then they were arranged under 90 per cent shade net structure. Suckers of different varieties were dipped in 0.1% bavistin and then planted into the pots of size 20x18 cm. Light irrigation was given after planting.

3.3.1.2d Application of fertilizers

Application of fertilizers for proper growth and development at regular interval was followed for anthuriums. Foliar spray of water soluble fertilizer (19:19:19) 2g/litre twice in a week and magnesium sulphate (1g/l) and calcium nitrate (1g/l) was given at one month interval. Micronutrient spray was given at one week interval @ 1g/litre.

3.3.1.2e Irrigation

Daily irrigation through mist nozzles was fixed at the top of the plants as overhead sprinkler inside greenhouse was given; Relative humidity 75-85 per cent level and temperature at about 20-28 °C was maintained throughout the cropping period, inside the shade net house.

3.3.1.2f Shade house management

A proper hygienic condition of plants was maintained in the shade. The door of the greenhouse was always kept closed so that relative humidity and temperature were maintained uniformly without external interference.

3.3.1.3 Other cultural operations

3.3.1.3a Weeding

Weeding was done manually depending on the weed population to keep anthurium pots free from weeds and reduce competition with the crop.

3.3.1.3b Removal of leaves

Adequate no. of leaves were retained by removing old, yellow leaves on the plants without any adverse effect on the flower production and quality.

3.3.1.3c Removal of suckers

Anthurium produces suckers at the base of the plant. The sucker takes nutrition from the parent plant and also leads to overcrowded situation for the crop. Suckers were removed by separating them with hand during early stage of plant.

3.3.1.3d Plant protection

Plant protection measures were taken whenever noticed with appropriate chemicals to prevent incidence of diseases and pest. Anthuriums are more tolerant to diseases and pests. A disease like anthracnose was controlled by spraying 0.1% carbendazim and leaf spot by spraying Diathane M-45 fungicides.

3.3.1.3e Harvesting

Anthurium spikes were harvested with their long stalk when spathes were fully grown and one third of the flowers on the spadix were opened. Harvesting was done early in the morning (7.00 to 8.00 AM) to retain freshness of flower spike with the help of secateur and after harvesting spathes were dipped in the bucket containing water. The harvested flower spikes were further used for recording post harvest floral observations.

3.3.1.3f Sampling procedure

For the purpose of recording observations of all the parameters, randomly five plants in each net plot were selected. Biometric observations like number of leaves, plant height, leaf area, length and breadth of leaf plant spread and length of leaf petiole of plants were recorded at regular interval (4 months interval) till 2 years (720 days) after planting. Same marked plants were utilized for aspects like flowering parameters, quality parameters and yield parameters. The data recorded from all the plots from each replication under each treatment were used to worked out average values.

3.3.1.3g Attributes recorded

The observations recorded under broad heads are as follows:

1. Vegetative parameters
2. Flowering parameters
3. Quality parameters
4. Yield parameters

1. Vegetative parameters

i) Survival percentage (%)

Total plants survived during two years investigation period were counted and recorded. Survival per cent was calculated by dividing the number of survived plants with number of planted plants and calculates in percentage.

$$\text{Plant survival rate} = \frac{\text{Number of remaining plants}}{\text{Number of plants originally}} \times 100$$

ii) Plant height (cm)

Plant height observations were recorded by measuring plant from base of media level to the leaf tip with the help of wooden meter scale at 4 months interval after planting of plants for 16 months period and average plant height was worked out.

iii) Number of leaves per plant

The numbers of leaves per plant were counted at the time of recording height of plants at 4 months interval for 16 months period and average numbers of leaves per plant were worked out.

iv) Leaf area (cm²)

Leaf area was calculated with the help of digital leaf area meter at 4 months interval for 16 months period where leaf area could be directly obtained. Leaf area of five youngest fully matured leaves was measured from each plant and average was worked out in cm².

v) Length of leaf petiole (cm)

Petiole length was recorded from the point of its emergence to the base of leaf lamina with the help of the wooden meter scale at 4 months interval for 16 months period and average was worked out in centimeters.

vi) Number of suckers per plant

Total number of suckers produced per plant were recorded during 16 months period from planting and average was worked out.

2. Flowering parameters

i) Days taken to flower bud initiation (days)

The number of days taken from planting to flower appearance was recorded and expressed in days.

ii) Days taken to unfolding of spathe (days)

The number of day required from flower bud emergence to opening or unfolding of the spathe was recorded in every treatment.

iii) Flower longevity on the plant (days)

The number of days for which flower remained fresh on the plant from spathe unfurling till the colour fading of the flower or senescence was recorded and expressed in days.

3. Quality parameters

i) Flower stalk length (cm)

Flower stalk length was measured with the help of one meter scale from the base of the stalk (leaf axil) to the base of the spathe during flowering and the average was expressed in centimeters.

ii) Spadix length (cm)

Length of spadix was measured from the point of its attachment to the spathe to the tip of the spadix with the help of scale and the average length was expressed in centimeters.

iii) Length and breadth of spathe (cm)

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

iv) Vase life of flower (days)

The flowers of uniform size were selected and harvested after complete unfolding of the spathe. The selected flowers were cut with

stalk at base and each flower was placed in 250 ml conical flask with 150 ml water and kept under room conditions (ambient temperature). The vase life was expressed in terms of days from the date of harvest till the flowers were found unfit for vase decoration.

v) Angle of spadix to spathe ($^{\circ}$)

Angle of spadix to spathe was measured from the point of its attachment to the spathe to the tip with the help of protractor and the average was expressed in degree.

4. Yield parameters

i) Number of flowers produced per plant

The number of flowers produced from each plant during the experimental period under each treatment were recorded at 2 months interval upto 16 months period and average number of flowers produced were counted and expressed as number of flowers produced per plant.

3.3.2 To optimize growing media for anthurium cultivation

3.3.2.1 Experimental details

Treatments	: 7
Replications	: 3
Design	: Randomized Block Design
Variety	: Tropical Red
Number of plants/treatment	: 25
Total plant population	: 525
Pot size	: 20 cm diameter and 18 cm height
Period of experiment	: March, 2019 to March, 2021
Duration of study	: 24 months
Treatment details	: T₁ - Coconut husk + charcoal (3:1) T₂ - Sand+ FYM+ coconut husk + brick pieces + charcoal (1:1:1:1:1) T₃ -Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1)

- T₄**- Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1)
- T₅**- Brick pieces + wood shavings + Sand+ FYM + coconut husk + charcoal (1:1:1:1:1)
- T₆**- Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1)
- T₇**- Sand + cowdung clumps + coconut husk + wood shaving + charcoal + earthen crocks + brick pieces + cocopeat (2:1:2:1:0.5:0.5:1:1)

3.3.2.1a Source of planting material

Uniform size tissue cultured plants of anthurium cv. 'Tropical red' were utilized as planting material in the experimental block. One month old tissue culture plants were procured from AV Thomas and company, Kerala to conduct the research on studies on various media and shade levels under Konkan agro climatic conditions.

3.3.2.2 Details of cultivation practices

3.3.2.2a Preparation of site

Shade was constructed in the field using shade nets of 90 per cent for this experiment.

3.3.2.2b Preparation of media

All the media material required for the experiment i.e sand, cowdung clumps, cocopeat, coconut husk, wood shavings, charcoal, earthen crocks, brick pieces and saw dust was washed with good quality of water to remove excess soluble salts and then sun dried for sterilization. Small pieces were made out of coconut husk, bricks and earthen crocks. Potting mixture of different ratio was made by mixing of material by volume (v/v) basis manually. After preparation of different media combinations as per the treatments, media were dipped in fungicide solution (Bavistin 0.2 %) for 5 minutes before filling the pots.

3.3.2.2c Pot filling and Planting

Pots with uniform size 20x18 cm were used for planting. Media was filled $\frac{3}{4}$ the volume of the pots and then they were arranged in 50% shade net for 3 weeks as per the different treatments and replications for decomposition of the media.

One month hardened tissue cultured plants of cv. 'Tropical Red' were dipped in 0.1% bavistin and then transplanted into the pots filled with respective media combination. Light irrigation was given after transplanting. Transplanting was done during March, 2019.

3.3.2.2d Application of fertilizers

Application of fertilizers for proper growth and development at regular interval was followed for anthurium plants. Fertilizers were given two weeks after transplanting. Foliar spray of water soluble fertilizer (19:19:19) 2g/litre twice in the week and magnesium sulphate (1g/l) and calcium nitrate (1g/l) was given at one month interval. Micronutrient spray was given at one week intervals @ 1g / litre.

3.3.2.2e Irrigation

Daily irrigation was given through mist installed in the nozzles were fixed at the top of the plants overhead greenhouse. Relative humidity level 75-85 per cent was maintained in the green house and temperature at about 20-28 °C was maintained throughout the cropping period. Proper care was taken to drain out the excess water from the pots and maintain proper drainage facilities in pots at experimental site

3.3.2.3 Other cultural operations

3.3.2.3a Weeding

Weeding was done manually depending on the weed population to keep anthurium pots free from weeds and reduce competition with the crop.

3.3.2.3b Pruning of leaves

Adequate number of leaves was retained on the plants without any adverse effect on the flower production and quality.

3.3.2.3c Removal of sucker

Anthurium produced suckers at the base of the plant. The sucker takes nutrition from the parent plant and also leads to overcrowded situation for the crop. Suckers were removed by pulling them with hand at early stage of plant.

3.3.2.3d Plant protection

Plant protection measures were taken whenever noticed with appropriate chemicals to prevent diseases and pest. Anthuriums are tolerant to diseases and pests. A disease like anthracnose was controlled by spraying 0.1% carbendazim and leaf spot by spraying Diathane M-45, fungicides.

3.3.2.3e Harvesting

Spikes were harvested with their long stalk when spathes were fully grown and one third of the flowers on the spadix were opened. Harvesting was done early in the morning (7.00 to 8.00 AM) to retain freshness of flower spike with the help of secateur and after harvesting spikes were dipped in the bucket containing water. The harvested flower spikes were further used for recording floral observations.

3.3.2.3f Attributes recorded

The observations recorded are as follows:

1. Vegetative parameters
2. Flowering parameters
3. Quality parameters
4. Yield parameters

1. Vegetative parameters

i) Survival per cent (%)

Total plants survived were counted. Survival per cent was calculated by dividing the remaining number of survived plants with number of planted originally used plants and calculated in percentage

$$\text{Plant survival rate} = \frac{\text{Number of remaining plants}}{\text{Number of plants originally}} \times 100$$

ii) Plant height (cm)

Plant height observations were recorded by measuring plant from base of media level to the leaf tip with the help of wooden meter scale at 4 months intervals for 24 months period after planting of plants and average plant height was worked out in centimeters.

iii) Number of leaves per plant

The number of leaves per plant were counted at the time of recording height of plants at 4 month intervals for 24 months period after planting of plants and average number of leaves were worked out.

iv) Length and breadth of leaf (cm)

Length of leaf was measured from basal lobe of the plant to the tip of the plant and breadth of the plant was measured at the centre of leaf by using wooden meter scale at 4 month intervals for 24 months period after planting and average was worked out.

v) Leaf area (cm²)

Leaf area was calculated with the help of digital leaf area meter at 4 months intervals for 24 months period after planting where leaf area could be directly obtained. Leaf area of five youngest fully matured leaves was measured from each plant and average was worked out.

vi) Number of suckers per plant

Total number of suckers produced per plant during the course of investigation for 24 months period from planting and average was worked out.

vii) Chlorophyll content (mg/g)

Chlorophyll content of leaves was measured by using a Spectronic 20 as described by Starnes and Hadley, (1965). Fully matured second terminal green leaf was used for estimation. One gram of the representative sample collected from five plants chosen at random, under each treatment, was used for analysis. Standard procedure was followed for the preparation of sample (Starnes and Hadley, 1965). The OD (A) of an aliquot was measured at wave length of 645 nm and 663 nm. The contents of chlorophyll 'a', 'b' and 'total' were then estimated using the following relationships. The data were recorded and the average was expressed in mg/g.

$$\text{Chlorophyll 'a'} = 12.72 (A\ 663) - 2.58 (A\ 645)$$

$$\text{Chlorophyll 'b'} = 22.87 (A\ 645) - 4.67 (A\ 663)$$

$$\text{Total Chlorophyll (a + b)} = 8.05 A\ 663 + 20.29 A\ 645$$

2. Flowering parameters

i) Days taken to inflorescence emergence (days)

The number of days required for inflorescence emergence or initiation in each replication was recorded by counting the days from date of planting to date of first flower bud initiation in each plot.

ii) Days required for first flowering (days)

The number of days taken from bud initiation to flower opening in each replication was recorded and expressed in days.

iii) Period of inflorescence emergence to spathe unfurling (days)

The number of days required from inflorescence emergence to unfurling of the spathe was recorded in each replication and treatment and expressed in days.

iv) Flower longevity on the plant (days)

The number of days flower remained fresh on the plant from spathe unfurling till the colour fading of the flower or senescence was recorded and expressed in days.

3. Quality parameters

i) Flower stalk length (cm)

Flower stalk length was measured with the help of one meter scale from the base of the stalk (leaf axil) to the base of the spathe during flowering and the average was expressed in centimeters.

ii) Spadix length (cm)

Length of spadix was measured from the point of its attachment to the spathe to the tip of the spadix with the help of scale and the average length was expressed in centimeters.

iii) Length and breadth of spathe (cm)

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

iv) Anthocyanin content (mg/g)

Anthocyanin were extracted from the spathe an a determined following the method described by Lee and Francis (1972). Weight 1 to 5 gram of sample of anthurium spathe was macerated with the help of mortar and pastel. It was mixed with 20 ml of mixture of 95% ethanol: 1.5 N HCL (Proportion 85:15). Mixture was transferred in beaker and covered with para film and stored overnight. Next day mixture was filtered by whatman filter paper No. 1 and filtrate was collected in flask and final volume was made 30 ml by again filtering macerate (left in filter paper) by addition of 10 ml extracting solvent. From that solution, 10 ml was taken in separate breaker and volume was made upto 20 ml by addition of extracting solvent. Solution was stored in dark for two hours at room temperature and spectrophotometer reading was recorded at 535nm wavelength and anthocyanin pigment was estimated as per the formula given below

Anthocyanin content: (mg/g)

$$= D535 \times \text{Dilution factor} \times 10 / \text{Avg}^{E1\%535}$$

$$= (D535 \times \text{Dilution factor}) / 98.2$$

Where,

D535 = O.D. at 535 nm wave length

Dilution factor = (original extract X dilution amount) extract
taken for dilution

v) Vase life of flower (days)

The flowers of uniform size were selected and harvested after complete unfolding of the spathe. The selected flowers were cut with stalk and each flower was placed in 250 ml conical flask with 150 ml water and kept under room conditions. The stalk end was cut by 1.0 cm at alternate days to prevent clogging. The vase life was expressed in terms of days from the date of harvest till the flowers were found unfit for vase decoration.

4. Yield parameters**i) Number of flowers per plant**

The number of flowers produced from each plant during the experimental period under each treatment was recorded at 2 months intervals upto 24 months period after planting and mean of flowers were calculated and expressed as number of flowers per plant.

3.3 3 To optimize shade level for anthurium**3.3.3.1 Experimental details:**

Treatments	: 3
Replications	: 7
Design	: Randomized Block Design
Variety	: Tropical Red
Number of plants/treatment	: 25
Total plant population	: 525

Pot size	: 20 cm diameter and 18 cm height
Period of experiment	: March, 2019 to March, 2021
Duration of study	: 24 months
Treatment details	: T₁ – 50% shade net T₂ – 75% shade net T₃ – 90% shade net

3.3.3.1a Source of planting material

One month old tissue culture plants of anthurium cv. ‘Tropical red’ were procured from AV Thomas and company, Kerala to conduct the studies on various shade levels under Konkan agro climatic conditions.

3.3.3.2 Details of cultivation practices

3.3.3.2a Preparation of site

Proper shade enhances development of plant like its growth, flowering, quality and yield encourages post-harvest behaviour of anthuriums. Therefore, shade net structure were constructed in the field using shade nets of three different intensity shade levels such as 50, 75 and 90 per cent for this experiment. Total 175 plants were maintained under each shade level *i.e.*, 50, 75 and 90 per cent and in all grand total was 525 plants were maintained.

3.3.3.2b Preparation of media

Media required for the experiment *i.e* sand, cowdung clumps, coconut husk, wood shaving, charcoal, brick pieces was washed with water and then sun dried for sterilization. Small pieces were made of Coconut husk, brick pieces and all the media was dipped in fungicide solution (Bavistin 0.2 %) for 5 minutes before filling the pots.

3.3.3.2c Pot filling and Planting

Pots with uniform size were used for planting. Media was filled $\frac{3}{4}$ the volume of the pots and then they were arranged plants of cv. ‘Tropical Red’ were dipped in 0.1% bavistin and then planted into the pots. Light irrigation was given after planting.

3.3.3.2c Application of fertilizers

Fertilizers were given two weeks after transplanting. Foliar spray of water soluble fertilizer (19:19:19) 2 gm/litre twice in the week and magnesium sulphate (1g/l) and calcium nitrate (1g/l) was given at one month intervals. Micronutrient spray was given at one week intervals @ 1gm / litre.

3.3.3.2d Irrigation

Daily irrigation was given through mist installed in the nozzles were fixed at the top of the plants as overhead in greenhouse. Relative humidity 75-85 per cent level was maintained in the green house and temperature at about 20-28 °C was maintained throughout the cropping period.

3.3.3.2e Shade house management

Proper shade was maintained in the field by using shade nets of three different intensity in shade levels *i.e.*, 50, 75 and 90 per cent in this experiment. Plant requires temperature range between 18 °C and 28 °C. Proper hygienic condition of plants was maintained in the shade. The door of the greenhouse was always kept closed so that relative humidity and temperature were maintained uniformly without external interference.

3.3.3.3 Other cultural operations

3.3.3.3a Weeding

Weeding was done manually depending on the weed population to keep anthurium potted plants free from weeds and reduced competition with the crop.

3.3.3.3b Pruning of leaves

Adequate number of leaves was retained on the plants without any adverse effect on the flower production and quality.

3.3.3.3c Removal of sucker

Anthurium produced suckers at the base of the plant. Suckers were removed by pulling them with hand at early stage of plant growth.

3.3.3.3d Plant protection

Anthuriums are tolerant to diseases and pests. A disease like anthracnose was controlled by spraying 0.1% carbendazim and leaf spot by spraying Diathane M-45 fungicides.

3.3.3.3e Harvesting

Harvesting was done early in the morning (7.00 to 8.00 AM) to retain freshness of flower spikes with the help of secateur and after harvesting spikes were dipped in the bucket containing water. The harvested flower spikes were further used for recording floral observations.

3.3.3.3f Attributes recorded

The observations recorded under broad heads are as follows

1. Vegetative parameters
2. Flowering parameters
3. Quality parameters
4. Yield parameters

1. Vegetative parameters

i) Survival per cent (%)

Total plants survived were counted. Survival per cent was calculated by dividing the remaining number of survived plants with number of originally planted plants and calculated in percentage.

$$\text{Plant survival rate} = \frac{\text{Number of remaining plants}}{\text{Number of plants originally}} \times 100$$

ii) Plant height (cm)

Plant height observation was recorded by measuring plant from base of media level to the leaf tip with the help of wooden meter scale at 4 months intervals for 24 months period after planting of plants and average plant height was worked out.

iii) Number of leaves

The numbers of leaves per plant were counted at the time of recording height of plants at 4 months intervals for 24 months period after planting and average numbers of leaves were worked out.

iv) Leaf area (cm²)

Leaf area was calculated with the help of digital leaf area meter at 4 months intervals for 24 months period after planting where leaf area could be directly obtained. Leaf area of five youngest fully matured leaves was recorded from each plant and average was worked out and expressed in cm².

v) Plant spread (cm)

The plant spread was measured at 4 months interval from planting with the help of wooden meter scale and average was worked out. For the observation of diameter, the maximum plant spread along the East-West and North-South directions was measured.

vi) Length of leaf petiole (cm)

Petiole length was recorded from the point of its emergence to the base of leaf lamina with the help of wooden meter scale at 4 months intervals for 24 months period after planting and average was worked on in centimeters.

vii) Number of suckers per plant

Total number of suckers produced per plant was recorded at 24 month from planting and average was worked out.

viii) Chlorophyll content (mg/g)

Chlorophyll content of leaves was measured by using a Spectronic 20 as described by Starnes and Hadley (1965). Fully matured second terminal green leaf was used for estimation. One gram of the representative sample collected from five plants chosen at random, under each treatment, was used for analysis. Standard procedure was followed for the preparation of sample (Starnes and Hadley, 1965). The OD (A) of an aliquot was measured at wave length

of 645 mm and 663 mm. The contents of chlorophyll 'a', 'b' and 'total' were then estimated using the following relationships. The data were recorded and the average was expressed in mg/g.

$$\text{Chlorophyll 'a'} = 12.72 A_{663} - 2.58 A_{645}$$

$$\text{Chlorophyll 'b'} = 22.87 A_{645} - 4.67 A_{663}$$

$$\text{Total Chlorophyll (a + b)} = 8.05 A_{663} + 20.29 A_{645}$$

2. Flowering parameters

i) Days taken to flower bud initiation (days)

The number of days taken from planting to appearance of flower was recorded and expressed in days.

ii) Days taken to unfolding of spathe (days)

The number of days required from flower bud emergence to opening or unfolding of the spathe was recorded in every plot.

iii) Flower longevity on the plant (days)

The number of days flower remained fresh on the plant from spathe unfurling till the colour fading of the flower or senescence was recorded and expressed in days.

3. Quality parameters

i) Flower stalk length (cm)

Flower stalk length was measured with the help of one meter scale from the base of the stalk (leaf axil) to the base of the spathe during flowering and the average was expressed in centimeters.

ii) Diameter of flower stalk (cm)

The diameter of flower stalk was measured at the basal part of the stalk at flower harvesting stage with the help of Vernier's caliper and the mean was recorded in centimeter.

iii) Length and width of spathe (cm)

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

iv) Spadix length (cm)

Length of spadix was measured from the point of its attachment to the spathe to the tip of the spadix with the help of scale and the average length was expressed in centimeters.

v) Diameter of spadix (cm)

The diameter of spadix was measured at the basal part of the spadix with the help of Vernier's caliper and the mean was recorded in centimeter.

vi) Anthocyanin content (mg/g)

Anthocyanin were extracted from the spathe a determined following the method described by Lee and Francis (1972). Weight 1 to 5 gm of sample of anthurium spathe was macerated with the help of mortar and pastel. It was mixed with 20 ml of mixture of 95% ethanol: 1.5 N HCL (Proportion 85:15). Mixture was transferred in beaker and covered with para film and stored overnight. Next day mixture was filtered by whatman filter paper No. 1 and filtrate was collected in flask and final volume was made 30 ml by again filtering macerate (left in filter paper) by addition of 10 ml extracting solvent. From that solution, 10 ml was taken in separate beaker and volume was made upto 20 ml by addition of extracting solvent. Solution was stored in dark for two hours at room temperature and spectrophotometer reading was recorded at 535nm wavelength and anthocyanin pigment was estimated as per the formula given below

Anthocyanin content: (mg/g)

$$= D_{535} \times \text{Dilution factor} \times 10 / \text{Avg}^{E1\%535}$$

$$= (D_{535} \times \text{Dilution factor}) / 98.2$$

Where,

$$D_{535} = \text{O.D. at 535 nm wave length}$$

Dilution factor = (original extract X dilution amount) extract taken for dilution

4. Yield parameters

i) Number of flowers per plant

The number of flowers produced by each plant during the experimental period under each treatment was recorded and mean number of flowers were worked out and expressed as number of flowers produced per plant.

3.3.4 To study the vase life of anthurium cut flowers by using of various chemicals

3.3.4.1 Experimental details:

Treatments	: 10
Replications	: 3
Design	: Completely Randomized Design
Variety	: Tropical Red
Number of flowers/treatment	: 3
Treatment details	: T₁- Tapwater
	T₂- Tapwater + Bavistin 0.2%
	T₃- Distilled water
	T₄- 8 HQC 200 ppm
	T₅- 8 HQC 400 ppm
	T₆- BA 25 ppm
	T₇- BA 50 ppm
	T₈- Triadimefon 30 ppm
	T₉- AgNo₃ 10 ppm
	T₁₀- AgNo₃ 20 ppm

3.3.4.2 Methodology for vase life studies

Flowers were harvested randomly from each experimental plot. The harvesting of flower stalk was done when fully open and one third of the flower on the spadix opened matured. These selected flower stalks were kept in conical flask containing different holding solutions of preservatives. The bottom ends of spikes were cut about 5 mm every day to prevent clogging of vascular tissues.

3.3.4.2a Observations

i) Initial weight of inflorescence (g)

Initial weight of inflorescence was measured with the help of weighing balance on the first day and the average was expressed in grams.

ii) Final weight of inflorescence (g)

Final weight of inflorescence was measured with the help of weighing balance on the last day of vase life and the average was expressed in grams.

iii) Physiological loss in weight (g)

Physiological loss in weight was measured as difference between the initial weight and the final weight at the time of end of experiment and average was expressed in grams.

iv) Final volume of holding solution (ml)

At the beginning initial volume of solution 150 ml taken in the conical flasks and at the end of experiment final volume of solution was measured and the solution absorbed was worked out and expressed in milliliters.

v) Uptake of vase solution (ml)

At the beginning conical flasks were marked to find out of preservative solution each day the flask were filled with the preservative solution upto the mark till end of the experiment and total quantity of uptake of holding solution by spikes every day was worked out and expressed in milliliters.

vi) Days to spadix necrosis initiation

The number of days required for spadix necrosis of flower was measured from each replication and average was worked out.

vii) Days to spathe blueing initiation

The number of days required for initiation of blueing of spathe was measured from each replication and average was worked out.

viii) Days to gloss loss/fading

The number of days required for gloss loss was measured from each replication and average was worked out.

ix) Vase life of inflorescence (days)

Vase life of inflorescence was measured at the onset of fading the spikes in the holding solution continued up to the date of discard when the spathe showed blueing up to 50 per cent (upper surface).

3.4 Analysis of growing media for physico-chemical properties

Mixed samples of different growing media were used for analysis. The media used was collected from each treatment. The samples were first air dried and then grinded with wooden pastel and mortar and mixed thoroughly. Samples were passed through 2 mm sieve and then used for the determination of different parameters. Following methods were followed for media analysis.

S. No.	Parameters	Method	References
1	pH	Potentiometric	Jackson (1973)
2	EC	Conductometric	Jackson (1973)
3	Moisture (%)	Oven dry basis method	O'Kelly (2004)
4	Water Holding Capacity (%)	Keen- Raczowski method	Piper (1996)
5	Organic carbon	Walkley and Black's rapidtitration method	Jackson (1973)

3.5 Chemical analysis of growing media:-

i. Nitrogen

Treatment wise per cent nitrogen in the growing media was determined by using Alkaline permagnate method (Subbiah and Asija, 1956)

ii. Phosphorous

The treatment wise per cent phosphorous in the growing media was determined by using Klett Summerson colorimeter method using red miltes (Olsen *et al.*, 1954).

iii. Potassium

The treatment wise per cent potassium in the growing media was determined by using Normal ammonium acetate (Hanway and Heidal, 1952) method.

3.6 Economics

Economics for anthurium cultivation was worked out by considering the existing rates of inputs and actual cultivation charges incurred. As per existing market rates of flowers gross income was counted. Then the net profit or loss and cost benefit ratio was worked out. Market value was evaluated on the basis of spathe size and the rates were as below.

3-5 cm spathe - 3 Rs/-

5 -7cm spathe - 5 Rs/-

7-9cm spathe -10 Rs/-

3.7 Statistical analysis

The statistical analysis of the data collected during two years investigation period was done by standard methods of analysis of variance as given by Panse and Sukhatme (1985). The standard error of mean (S.E m) was worked out and the critical difference (C.D.) at 5% level in field conditions and in laboratory (C.D.) at 1% level was calculated, wherever the results were significant. The data and important results have been supported through tables, graphs and plates.

CHAPTER IV

RESULTS AND DISCUSSION

The results obtained during the present studies entitled “Optimization of shade level, media and vase life for cut flower production in anthurium (*Anthurium andreanum* Linn) are presented in this chapter. With reference to the varietal performance vegetative, flowering and yield parameters during two years 2019-20 and 2020-21 are presented here under appropriate heads and discussed with the help of relevant literature available on the topic of the anthurium and other flower crops research.

During the course of investigation following research projects were carried out:

Exp. 1. To study the performance of different anthurium varieties

Exp. 2. To optimize growing media for anthurium cultivation

Exp. 3. To optimize shade level for anthurium cultivation

Exp. 4. To study the vase life of anthurium cut flowers by using of various chemicals

4.1 To study the varietal performance of different anthurium varieties

The different varieties of anthurium viz., - Baby White, Baby Purple, Prince Orange, Princess Amellia, Fancy Red and Queen Black were evaluated at Hi-tech unit, College of Horticulture, Dapoli. The performance of these six varieties with respect to growth, flowering and yield parameters was greatly influenced by the environmental conditions in which they were grown and genetic makeup of those varieties.

4.1.1 Evaluation of variety with respect to vegetative parameters

4.1.1.1 Survival percentage:

The data in respect of survival percentage in anthurium is given in Table 1 and depicted in Fig. 4. The data indicated that the survival percentage (%) in anthurium was significantly influenced by different

varieties. The variety V₅ *i.e.*, Fancy Red recorded significantly maximum survival percentage (96.00 %) which was followed by V₁ *i.e.*, Baby White (94.00%), however, the variety V₆ *i.e.* Queen Black recorded minimum survival percentage (87.00 %).

Table 1: Survival percentage in different varieties of anthurium

Treatments (Varieties)	Survival (%)
V₁- Baby White	94.00
V₂- Baby Purple	93.00
V₃-Prince Orange	90.00
V₄-Princess Amellia	91.50
V₅- Fancy Red	96.00
V₆- Queen Black	87.00
F Test	Sig.
SE(m) ±	0.58
CD at 5%	1.75

The variation in survival percentage (%) was due to inherent capacity of individual variety and their varying response to environment factors like temperature, light and relative humidity under Konkan agroclimatic conditions. Arndt (1991), Leeuwen (1984), Gelder *et al.* (1984), also reported studies on different varieties of anthurium and found variation in their growth pattern.

4.1.1.2 Plant height:

The data with respect to plant height (cm) of anthurium is presented in Table 2 and interpreted through Fig. 5. The data revealed that, the height of anthurium plants was differed significantly among various varieties at all the growth stages *i.e.* 4, 8, 12 and 16 months after planting.

At the stage of 4 months after planting, the variety V₅ *i.e.*, Fancy Red noticed significantly maximum plant height (18.95 cm) which was found statistically at par with the variety V₄ *i.e.* Princess Amellia (17.93 cm), whereas, minimum height of plant was noticed with the variety V₃ *i.e.* Prince Orange (12.62 cm).

At all 4, 8, 12 and 16 months a periodical observation, significantly highest plant height was recorded by the variety V₅ *i.e.* Fancy Red which was statistically significant over all other varieties, whereas, minimum plant height was recorded by the variety V₃ *i.e.* Prince Orange during all periodic plant height observation.

Table 2: Periodical plant height in different varieties of anthurium

Treatments (Varieties)	Plant height (cm)			
	4 MAP	8 MAP	12 MAP	16 MAP
V₁. Baby White	13.44	27.95	31.09	33.50
V₂. Baby Purple	14.04	29.77	32.24	35.03
V₃. Prince Orange	12.62	23.58	27.40	29.05
V₄. Princess Amellia	17.93	33.82	37.99	38.39
V₅. Fancy Red	18.95	35.54	39.80	40.96
V₆. Queen Black	13.28	25.57	29.69	31.87
F Test	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.36	0.58	0.60	0.65
CD at 5%	1.08	1.75	1.82	1.95

The variety V₅ *i.e.* Fancy Red also exhibited significantly maximum plant height (40.96 cm) which was followed by variety V₄ *i.e.*, Princess Amellia (38.39 cm), whereas, minimum height of the plant was noticed with the variety V₃ *i.e.* Prince Orange (29.05 cm) at 16 months after planting.

These results indicate that maximum plant height in Fancy Red variety may be due to its genotypic character and the prevailing environment of Konkan must be suitable for developing maximum vigour of the plant, Similar findings were also reported by Femina *et al.* (2006), Kalirana and Dubey (2009), Nataraj *et al.* (2019) and Chowdhuri *et al.* (2021) in anthurium.

4.1.1.3 Number of leaves:

Number of leaves produced in anthurium plants as cut flower is very important in its growth, development and aesthetics as it adds to its aesthetic and economic value.

The data with respect to total number of leaves produced by

different varieties of anthurium at all the growth stages *i.e.*, 4, 8, 12 and 16 months after planting is presented in Table 3 and illustrated in Fig. 6. The data indicated that number of leaves produced by different varieties of anthurium was found to be significant at 4, 8, 12 and 16 months period after planting.

The variety V₁ *i.e.* Baby White registered significantly maximum number of leaves (4.60) which was statistically at par with the variety V₂ *i.e.*, Baby Purple (4.40), however, the treatment V₆ *i.e.* Queen Black recorded minimum number of leaves (3.90) at 4 months after planting.

Table 3: Number of leaves in different anthurium varieties

Treatments (Varieties)	Number of leaves			
	4 MAP	8 MAP	12 MAP	16MAP
V₁. Baby White	4.60	5.65	9.60	11.85
V₂. Baby Purple	4.40	5.55	9.50	11.50
V₃. Prince Orange	3.95	5.05	7.90	10.95
V₄. Princess Amellia	4.30	5.25	9.00	11.15
V₅. Fancy Red	4.25	4.85	8.70	10.40
V₆. Queen Black	3.90	4.95	8.10	09.45
F Test	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.07	0.09	0.16	0.13
CD at 5%	0.23	0.27	0.50	0.39

At the stage of 8 months after planting, significantly maximum numbers of leaves were counted with the variety V₁ *i.e.* Baby White (5.65) which was statistically at par with treatments V₂ *i.e.* Baby Purple (5.55), whereas, minimum leaves of anthurium per plant were recorded with the variety V₅ *i.e.* Fancy Red (4.85).

Similarly, at the stage of 12 months after planting, significantly maximum number of leaves were noticed in the variety V₁ *i.e.* Baby White (9.60) which was statistically at par with variety V₂ *i.e.* Baby Purple (9.50) and significantly minimum number of leaves of anthurium per plant were recorded with the variety V₇ *i.e.* Queen Black (8.10).

Significantly highest number of leaves (11.85) were recorded by the variety V₁ *i.e.* Baby White which was found to be statistically at par with the variety V₂ *i.e.* Baby Purple (11.50), however, V₆ *i.e.* Queen

Black recorded minimum number of leaves (9.45) at 16 months after planting period.

Variations in leaf production are expected among the cultivars as it attributes to an inherent genetic character. These results are in conformity with the reports of (Srinivasa, 2006), Femina *et al.* (2006), Agasimani *et al.* (2010) and Anand *et al.* (2013) in anthurium.

4.1.1.4 Leaf area (cm²):

The data with respect to varietal response for leaf area (cm²) in anthurium is presented in Table 4 and illustrated in Fig. 7.

At all the stages of 4, 8, and 12 months after planting period, the variety V₅ *i.e.* Fancy Red recorded significantly maximum leaf area which was statistically at par with the variety V₄ *i.e.* Princess Amellia and the Prince Orange variety (V₃) recorded significantly minimum leaf area at all growth periods of observations.

The variety V₅ *i.e.*, Fancy Red exhibited significantly maximum leaf area (105.17 cm²) which was followed by treatment V₄ *i.e.* Princess Amellia (102. 93 cm²), whereas, minimum leaf area of plant was noticed with the treatment V₆ *i.e.* Queen Black (92.19 cm²) at 16 months after planting.

Table 4: Leaf area in different anthurium varieties

Treatments (Varieties)	Leaf area (cm ²)			
	4 MAP	8 MAP	12 MAP	16MAP
V₁. Baby White	28.71	54.27	77.78	98.12
V₂. Baby Purple	27.89	52.88	74.02	95.80
V₃. Prince Orange	25.02	49.53	72.71	94.16
V₄. Princess Amellia	33.92	57.32	79.99	102.93
V₅. Fancy Red	35.81	59.33	81.90	105.17
V₆. Queen Black	25.90	51.19	71.94	92.19
F Test	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.65	0.69	0.75	0.79
CD at 5%	1.95	2.09	2.26	2.38

This might be due to genetic expression of different varieties under environmental factors *i.e.* temperature, RH, and light intensity respond differently for leaf area. The results are in line with the

observation of Valsalakumari *et al.* (1998), Chandrappa (2002), (Srinivasa, 2006), Femina *et al.* (2006) and Agasimani *et al.* (2010) in anthurium crop.

4.1.1.5 Length of leaf petiole:

The data with respect to anthurium leaf petiole length at all the growth stages *i.e.*, 4, 8, 12 and 16 months after planting is presented in Table 5 and illustrated in Fig. 8. The data indicated that length of leaf petiole in anthurium was found significant at 4, 8, 12 and 16 months after planting.

The variety V₅ *i.e.* Fancy Red registered significantly maximum length of leaf petiole (13.17 cm) which was statistically at par with the variety V₁ *i.e.* Baby White (12.77 cm), V₂ *i.e.* Baby Purple (12.46 cm) and V₄ *i.e.* Princess Amellia (12.20 cm), however, the treatment V₆ *i.e.* Queen Black recorded minimum length of leaf petiole (11.90 cm) at 4 months after planting.

At the stage of 8 months after planting, significantly maximum length of leaf petiole was counted of the variety V₅ *i.e.* Fancy Red (16.56 cm) which was statistically at par with treatment V₁ *i.e.* Baby White (15.87 cm), whereas, minimum petiole length of anthurium was recorded by the variety V₆ *i.e.* Queen Black (14.34 cm).

Table 5: Length of leaf petiole in different anthurium varieties

Treatments (Varieties)	Length of leaf petiole (cm)			
	4 MAP	8 MAP	12 MAP	16MAP
V₁- Baby White	12.77	15.87	19.53	20.78
V₂- Baby Purple	12.46	15.27	19.12	20.25
V₃-Prince Orange	11.82	14.57	18.35	19.24
V₄-Princess Amellia	12.20	14.95	18.61	19.75
V₅- Fancy Red	13.17	16.56	20.40	21.72
V₆- Queen Black	11.9	14.34	18.09	18.85
F Test	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.37	0.38	0.44	0.48
CD at 5%	1.12	1.15	1.35	1.45

Similarly, at the stage of 12 months after planting, significantly maximum length of leaf petiole was noticed in the variety V₅ *i.e.* Fancy

Red (20.40 cm) which was statistically at par with variety V₁ *i.e.* Baby White (19.53 cm) and significantly minimum length of leaf petiole of anthurium plant was recorded by the variety V₆ *i.e.* Queen Black (18.09 cm).

The variety V₅ *i.e.* Fancy Red also exhibited significantly maximum length of leaf petiole (21.72 cm) which was followed by variety V₁ *i.e.* Baby White (20.78 cm), whereas, minimum length of leaf petiole of the plant was noticed with the variety V₆ *i.e.* Queen Black (18.85 cm) at 16 months after planting.

Variety Fancy Red exhibited good growth under Konkan agroclimatic conditions which might be due to genetic x environment interaction effect. These results are in agreement with the reports of Nataraj *et al.* (2019).

4.1.1.6 Number of suckers per plant:

The data related to number of suckers per plant in anthurium is given in Table 6 and depicted in Fig. 9. The data indicated that, number of suckers per plant in anthurium was significantly influenced by different varieties.

The variety V₅ *i.e.*, Fancy Red recorded significantly maximum number of suckers per plant (4.40) which was found statistically at par with the treatment V₁ *i.e.*, Baby White (4.20), however, V₆ *i.e.*, Queen Black (2.90) variety recorded minimum number of suckers per plant.

Table 6: Number of suckers produced per plant in different anthurium varieties

Treatments (varieties)	Number of suckers per plant
V₁. Baby White	4.20
V₂. Baby Purple	3.95
V₃. Prince Orange	3.15
V₄. Princess Amellia	3.60
V₅. Fancy Red	4.40
V₆. Queen Black	2.90
F Test	Sig.
SE(m) ±	0.09
CD at 5%	0.27

Production of suckers is highly cultivar dependent. Being genetically controlled character, the suckers production varied among the different cultivars. These results are in line with that of Jawaharlal *et al.* (2001), Agasimani *et al.* (2010), Singh *et al.* (2015), Anand *et al.* (2017) and Chowdhuri *et al.* (2021) in anthurium.

4.1.2 Evaluation of varieties with respect to flowering parameters

4.1.2.1 Days taken for flower bud initiation:

The data with respect to days taken for flower bud initiation (days) in anthurium is presented in Table 7 and depicted in Fig. 10. The data indicated that, days taken for flower bud initiation in anthurium were significantly influenced by different varieties under Konkan climatic conditions.

In this experiment, the variety V₅ *i.e.* Fancy Red recorded significantly minimum days (206.20 days) for flower bud initiation and it was followed by variety V₁ *i.e.* Baby White (210.45 days), whereas, the variety V₆ *i.e.* Queen Black recorded maximum days for flower bud initiation for (224.20 days).

Table 7: Days taken for flower bud initiation, days taken for unfurling of spathe and flower longevity on plant indifferent anthurium varieties

Treatments (Varieties)	Days taken for flower bud initiation (days)	Days taken for unfurling of spathe (days)	Flower longevity		
			1 st year (2019)	2 nd year (2020)	Pooled
V₁. Baby White	210.45	239.20	61.15	62.80	61.97
V₂. Baby Purple	213.80	243.15	59.15	59.16	59.15
V₃. Prince Orange	222.15	250.45	54.70	55.63	55.16
V₄. Princess Amellia	218.50	246.70	56.10	56.76	56.43
V₅. Fancy Red	206.20	234.85	62.80	62.78	62.79
V₆. Queen Black	224.20	252.10	54.00	55.70	54.85
F Test	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.32	0.33	0.28	0.69	0.40
CD at 5%	0.96	0.99	0.84	2.08	1.20

This might be due to the varietal response and few growth parameters like maximum leaf lamina diameter and length of new leaf sheath per plant, which must have contributed in production and accumulation of more photosynthates thereby resulting in early flowering. These results are in line with (Kalirana and Dubey, 2009) in anthurium.

4.1.2.2 Days taken for unfurling of spathe

The data with respect to days taken for unfurling of spathe of anthurium is exhibited in Table 7 and depicted through Fig. 10.

In this experiment, the variety V₅ *i.e.* Fancy Red recorded significantly minimum days (234.85 days) for unfurling of spathe and it was followed by V₁ *i.e.* Baby White (239.20 days) and V₂ *i.e.* Baby Purple (243.15 days), however, the variety V₆ *i.e.* Queen Black recorded maximum days for unfurling of spathe (252.10 days).

This might be due to appropriate climatic conditions during unfurling of spathe. Similar recordings were reported by Nataraj *et al.* (2019) in anthurium.

4.1.2.3 Flower longevity on plants

The data related to flower longevity on plants of different anthurium varieties are given in Table 7 and graphically presented with Fig. 11.

During the present investigation among the six varieties evaluated with respect to flower longevity for two years Fancy Red variety of anthurium was found significantly superior.

In 2019 the present studies revealed that maximum flower longevity (62.80 days) was registered by V₅ *i.e.* Fancy Red variety of anthurium which was at par with V₁ *i.e.* Baby White (61.15 days), whereas, minimum flower longevity (54.00 days) was recorded in V₆ *i.e.* Queen Black.

In 2020 during the course of investigation maximum flower longevity (62.80 days) was registered by variety V₁ *i.e.* Baby White of

anthurium which was at par with V₅ *i.e.* Fancy Red (62.78), whereas minimum days flower longevity was recorded in variety V₃ *i.e.* Prince Orange (55.63 days).

Pooled results showed that maximum flower longevity (62.79 days) was registered by variety V₅ *i.e.* Fancy Red of anthurium which was at par with variety V₁ *i.e.* Baby White (61.97 days) whereas minimum flower longevity (54.85 days) was recorded in V₆ *i.e.* Queen Black (54.85).

This might be due to varietal response of anthurium in optimum conditions and proper nutritional supply through fertigation which increased flower longevity under field conditions.

4.1.3 Evaluation of varieties with respect to quality parameters

4.1.3.1 Flower stalk length (cm):

Peduncle length is an important horticultural parameter that determines the showiness of the cut flower in floral arrangements. The data with respect to flower stalk length (cm) in anthurium under Konkan climatic conditions is given in Table 8 and illustrated in Fig.12. The data indicated that flower stalk length (cm) in anthurium was significantly differed in various anthurium varieties.

During 2019, significantly maximum flower stalk length was registered with the variety V₅ *i.e.* Fancy Red (28.80 cm) which was followed by variety V₁ *i.e.* Baby White (25.90 cm), whereas, the variety V₆ *i.e.* Queen Black recorded minimum flower stalk length (18.30 cm) in anthurium.

In 2020 maximum flower stalk length of anthurium was recorded in variety V₅ *i.e.* Fancy Red (28.48 cm) which was at par with variety V₁ *i.e.*, Baby White (27.21 cm) and minimum flower stalk length was recorded in variety V₆ *i.e.* Queen Black (19.73 cm).

In pooled results flower stalk length of anthurium was registered maximum by variety V₅ *i.e.* Fancy Red (28.65 cm) which was followed by variety V₁ *i.e.* Baby White (26.55 cm) and V₂ *i.e.* Baby Purple (25.11

cm), whereas minimum flower stalk length was recorded in variety V₆ *i.e.* Queen Black (19.03 cm).

This is varietal trait as it is governed by the genetic makeup (Islam *et al.* 2013) in anthurium. These results are in agreement with the reports of (Srinivasa, 2006), Anand *et al.* (2017) and Chowdhuri *et al.* (2021) in anthurium.

4.1.3.2 Spadix length (cm):

The data with respect to spadix length (cm) produced by different varieties of anthurium under Konkan climatic conditions are given in Table 8 and illustrated in Fig.13.

Table 8: Flower stalk length and spadix length in different anthurium varieties

Treatments (Varieties)	Flower stalk length (cm)			Spadix length (cm)		
	1 st year (2019)	2 nd year (2020)	Pooled mean	1 st year (2019)	2 nd year (2020)	Pooled mean
V₁. Baby White	25.90	27.21	26.55	4.08	4.44	4.26
V₂. Baby Purple	24.80	25.41	25.11	3.95	4.32	4.14
V₃. Prince Orange	20.00	20.58	20.31	3.47	3.72	3.60
V₄. Princess Amellia	22.10	22.89	22.49	3.67	4.10	3.88
V₅. Fancy Red	28.80	28.48	28.65	4.27	4.50	4.38
V₆. Queen Black	18.30	19.73	19.03	3.35	3.80	3.57
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.22	0.49	0.26	0.02	0.12	0.06
CD at 5%	0.67	1.49	0.78	0.06	0.38	0.20

During course investigation in the year 2019 among the six varieties evaluated for two years significantly maximum spadix length was registered by the variety V₅ *i.e.* Fancy Red (4.27 cm) which was superior over all other varieties and it was followed by variety V₁ *i.e.* Baby White (4.08 cm) and variety V₂ *i.e.* Baby Purple (3.95 cm), whereas, the variety V₆ *i.e.* Queen Black recorded minimum spadix length (3.35 cm) in anthurium.

During the course of investigation (2020) maximum spadix length (4.50 cm) was recorded by variety V₅ *i.e.* Fancy Red of anthurium which was at par with variety V₁ *i.e.* Baby White (4.44 cm) and variety V₂ *i.e.* Baby Purple (4.32 cm) whereas, minimum spadix length (3.72 cm) was observed in variety V₃ *i.e.* Prince Orange.

In pooled results maximum spadix length (4.38 cm) was registered by variety V₅ *i.e.* Fancy Red of anthurium which was at par with variety V₁ *i.e.*, Baby White (4.26 cm) whereas minimum spadix length (3.57 cm) was recorded by V₆ *i.e.* Queen Black.

Variations in spadix length might be due to genetic characters of all the varieties (Chowdhuri *et al.* 2021). These results are in agreement with the reports of Shetye (2007), Agasimani *et al.* (2010), Anand *et al.* (2017) and Nataraj *et al.* (2019) in anthurium.

4.1.3.3 Length of spathe (cm):

The data pertaining to length of spathe is presented in Table 9 and depicted in Fig. 14.

The length of spathe was found to be significantly superior (6.05 cm) in variety V₅ *i.e.*, Fancy Red which was followed by variety V₁ *i.e.*, Baby White (5.60 cm) and variety V₄ *i.e.*, Princess Amellia (5.21 cm), whereas, minimum length of spathe was recorded in variety V₆ *i.e.*, Queen Black (4.18 cm) during 2019.

During 2020, variety V₅ *i.e.*, Fancy Red (6.09 cm) recorded maximum length of spathe which was followed by variety V₁ *i.e.*, Baby White (5.71 cm), variety V₄ *i.e.*, Princess Amellia (5.41 cm) and minimum length of spathe was recorded in V₆ *i.e.*, Queen Black (4.25 cm).

In the pooled results, maximum length of spathe (6.07 cm) was observed in variety V₅ *i.e.*, Fancy Red which was followed by V₁ *i.e.*, Baby White (5.66 cm) and variety V₄ *i.e.*, Princess Amellia (5.31 cm). The minimum length of spathe (4.21 cm) of anthurium was found in variety V₆ *i.e.*, Queen Black.

Varietal response to different environmental factors like temperature, relative humidity might have influenced the spathe length so also genetic variation within cultivars might have resulted in differences. These results are in line with those of Talia *et al.* (2003), Agasimani *et al.* (2010), Anand *et al.* (2013), Anand *et al.* (2017), Kurniati *et al.* (2019) and Chowdhuri *et al.* (2021) in anthurium.

Table 9: Length and breadth of spathe in different anthurium varieties

Treatments (Varieties)	Length of spathe (cm)			Breadth of spathe(cm)		
	1 st year (2019)	2 nd year (2020)	Pooled	1 st year (2019)	2 nd year (2020)	Pooled
V₁. Baby White	5.60	5.71	5.66	4.77	5.02	4.89
V₂. Baby Purple	4.59	4.62	4.61	4.55	4.70	4.63
V₃. Prince Orange	4.38	4.78	4.58	4.22	4.18	4.20
V₄. Princess Amellia	5.21	5.41	5.31	4.40	4.49	4.44
V₅. Fancy Red	6.05	6.09	6.07	4.98	5.02	5.00
V₆. Queen Black	4.18	4.25	4.21	3.99	4.07	4.03
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.02	0.10	0.05	0.02	0.07	0.03
CD at 5%	0.07	0.30	0.17	0.06	0.21	0.11

4.1.3.4 Breadth of spathe (cm)

The data with respect to breadth of spathe (cm) recorded by different varieties of anthurium under Konkan climatic condition is given in Table 9 and depicted in Fig. 14.

During the year 2019 of the investigation significantly maximum breadth of spathe (4.98 cm) was recorded in variety V₅ *i.e.*, Fancy Red and it was followed by variety V₁ *i.e.*, Baby White (4.77 cm) and variety V₂ *i.e.*, Baby Purple (4.55 cm). Breadth of spathe was recorded minimum in variety V₆ *i.e.*, Queen Black (3.99 cm).

During the year 2020 maximum breadth of spathe of anthurium was recorded in variety V₅ *i.e.*, Fancy Red (5.02 cm) and in V₁ *i.e.*, Baby White (5.02 cm) which was followed by V₂ *i.e.*, Baby Purple (4.70

cm), however, minimum breadth of spathe was recorded in V₆ *i.e.*, Queen Black (4.07).

In pooled results analysis breadth of spathe was registered maximum by variety V₅ *i.e.*, Fancy Red (5.00 cm) of anthurium which was at par with variety V₁ *i.e.*, Baby White (4.89 cm), whereas minimum breadth of spathe was recorded in variety V₆ *i.e.*, Queen Black (4.03 cm).

The modest temperature of 15°C to 30°C maximum and relative humidity of 60 - 70% was found to be ideal for the growth, which might have influenced the spathe breadth and varied among cultivars. These results are in close conformity with the earlier reports of Rajeevan *et al.* (2007), Singh *et al.* (2015) and Nataraj *et al.* (2019) in anthurium.

4.1.3.5 Vase life of flower (days):

The data was recorded to observe the performance of varieties in vase which is given in Table 10.

Table 10: Vase life of flower and angle of spadix to spathe in different anthurium varieties

Treatments (varieties)	Vase life of flower (days)			Angle of spadix to spathe (°)		
	1 st year (2019)	2 nd year (2020)	Pooled	1 st year (2019)	2 nd year (2020)	Pooled
V₁- Baby White	13.90	14.52	14.21	31.00	31.35	31.17
V₂- Baby Purple	13.50	14.05	13.80	28.53	29.19	28.86
V₃-Prince Orange	13.00	13.35	13.17	35.20	36.05	35.62
V₄-Princess Amellia	13.20	13.55	13.37	36.02	35.57	35.80
V₅- Fancy Red	14.20	14.32	14.28	38.93	38.10	38.51
V₆- Queen Black	11.70	12.17	11.96	32.95	32.83	32.89
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.14	0.13	0.12	0.31	0.72	0.42
CD at 5%	0.42	0.40	0.38	0.95	2.17	1.27

The present studies revealed that during the year 2019 maximum vase life of flower (14.20 days) was registered by V₅ *i.e.*, Fancy Red variety of anthurium which was at par with V₁ *i.e.*, Baby White (13.90 days), whereas, minimum flower longevity (11.70 days) was recorded in V₆ *i.e.*, Queen Black.

During the year 2020 of investigation maximum vase life of flower (14.52 days) was registered by variety V₁ *i.e.*, Baby White of anthurium which was at par with V₅ *i.e.*, Fancy Red (14.32 days), whereas minimum vase life of flower was recorded in variety V₆ *i.e.*, Queen Black (12.17 days)

Pooled results showed that maximum vase life of flower (14.28 days) was registered by variety V₅ *i.e.*, Fancy Red of anthurium which was at par with variety V₁ *i.e.*, Baby White (14.21 days) whereas minimum vase life of flowers was recorded in V₆ *i.e.*, Queen Black (11.96 days).

Vase life of flower seems to be an inherent capacity of the cultivar and sometimes influenced by the size of flowers. These results are in line with those of Shriram *et al.* (2008), Islam *et al.* (2013), Roni *et al.* (2016), Anand *et al.* (2017), Tejaswini *et al.* (2018) and Nataraj *et al.* (2019) in anthurium cut flowers.

4.1.3.6 Angle of spadix to spathe (°):

The data pertaining to angle of spadix to spathe are presented in Table 10. The angle of spadix to spathe was found to be significantly superior (38.93°) in variety V₅ *i.e.*, Fancy Red which was followed by variety V₄ *i.e.*, Princess Amellia (36.02°) and variety V₃ *i.e.*, Prince Orange (35.20°), whereas, minimum spadix to spathe angle was recorded in variety V₂ *i.e.*, Baby Purple (28.53°) during 2019.

During the year 2020, variety V₅ *i.e.*, Fancy Red (38.10°) recorded maximum angle of spadix to spathe which was followed by variety V₃ *i.e.*, Prince Orange (36.05°) and variety V₄ *i.e.*, Princess

Amellia (35.57°). The minimum angle of spadix to spathe was recorded in V₂ *i.e.*, Baby Purple (29.19°).

In the pooled results, maximum angle of spadix to spathe (38.51°) was observed in variety V₅ *i.e.*, Fancy Red which was followed by V₄ *i.e.*, Princess Amellia (35.80°) and variety V₃ *i.e.*, Prince Orange (35.62°). The minimum angle of spadix to spathe (28.86°) of anthurium was recorded in variety V₂ *i.e.*, Baby Purple.

Variation in angle of spadix to spathe is due to varietal trait and it is governed by the genetic makeup of particular variety (Rajeevan *et al.* 2007) in anthurium. Similar results were also reported by Femina *et al.* (2006), Islam *et al.* (2013), Tejaswini *et al.* (2018) and Nataraj *et al.* (2019) in anthurium.

4.1.4 Evaluation of varieties with respect to yield parameters

4.1.4.1 Number of flower spikes per plant:

The data with respect to number of flower spikes produced per plant in anthurium under Konkan climatic conditions at all the growth stages *i.e.*, 8, 10, 12, 14 and 16 months after planting is presented in Table 11 and illustrated in Fig. 15. The data indicated that, number of flower spikes produced per plant in anthurium was found to be significant at 8, 10, 12, 14 and 16 months after planting.

Table 11: Number of flowers produced per plant at bimonth interval in different anthurium varieties

Treatments (Varieties)	Number of flowers produced per plant					Mean
	8 MAP	10 MAP	12 MAP	14 MAP	16 MAP	
V₁. Baby White	1.65	2.80	3.65	4.65	5.30	3.61
V₂. Baby Purple	1.55	2.60	3.40	3.85	4.35	3.15
V₃. Prince Orange	1.35	2.25	2.65	2.90	3.50	2.53
V₄. Princess Amellia	1.60	2.15	2.40	2.70	3.30	2.43
V₅. Fancy Red	1.40	2.50	3.20	3.75	4.15	3.00
V₆. Queen Black	1.20	2.10	2.40	3.10	3.42	2.44
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	
SE(m) ±	0.08	0.10	0.10	0.16	0.12	
CD at 5%	0.24	0.30	0.30	0.48	0.36	

The variety V₁ *i.e.*, Baby White registered significantly maximum number of flower spikes per plant (1.65 flowers) which was statistically at par with the variety V₄ *i.e.*, Princess Amellia (1.60 flowers) and V₂ *i.e.*, Baby Purple (1.55 flowers), however, the variety V₆ *i.e.*, Queen Black recorded minimum number of flowers (1.20 flowers) at 4 months after planting.

At the stage of 10 months after planting, significantly maximum number of flower spikes per plant were counted with the variety V₁ *i.e.*, Baby White (2.80 flowers) which was statistically at par with variety V₂ *i.e.*, Baby Purple (2.60 flowers) and V₅ *i.e.*, Fancy Red (2.50 flowers) whereas, minimum flower spikes of anthurium per plant were recorded with the variety V₆ *i.e.*, Queen Black (2.10 flowers).

Similarly, at the stage of 12 months after planting, significantly maximum number of flower spikes per plant were noticed in the variety V₁ *i.e.*, Baby White (3.65 flowers) which was statistically at par with variety V₂ *i.e.*, Baby Purple (3.40 flowers) and significantly minimum number of flower spikes per plant in anthurium plant were recorded with the variety V₆ *i.e.*, Queen Black and V₄ *i.e.*, Princess Amellia (2.40 flowers).

The number of flower spikes produced per plant at the stage of 14 months was found to be significantly superior (4.65 flowers) in variety V₁ *i.e.*, Baby White which was followed by variety V₂ *i.e.*, Baby Purple (3.85) and variety V₅ *i.e.*, Fancy Red (3.75 flowers), whereas, minimum number of flower spikes per plant were recorded in variety V₄ *i.e.*, Princess Amellia (2.70 flowers).

Significantly highest number of flower spikes per plant (5.30 flowers) at 16 months stage was counted in the variety V₁ *i.e.*, Baby White which was followed by variety V₂ *i.e.*, Baby Purple (4.35 flowers) and V₅ *i.e.*, Fancy Red (4.15 flowers), however, V₄ *i.e.*, Princess Amellia produced minimum number of flower spikes (3.30 flowers) at 16 months after planting.

The number of spikes per plant is genetically controlled factor and also influenced by environment (Agasimani *et al.* 2010) in anthurium. Similar results were noticed in respect to flower production by Rajeevan *et al.* (2007), Shiva and Nair (2008) and Anand *et al.* (2017) in anthurium.

4.1.5 Evaluation of varieties with respect to economic parameters

4.1.5.1 Gross and net monetary returns

The data with respect to gross and net monetary returns in anthurium (Rs) produced by different varieties is presented in Table 12. The data indicated that, the varietal differences were significant in respect of gross and net monetary returns.

Table 12: Economics of anthurium varieties cultivation (100sq.m)

Treatments	Cost of cultivation (Rs)	Income (Rs)			Pot plant (Rs)	Gross return (Rs)	Net return (Rs)	B:C ratio
		Suckers (Rs)	Flowers (Rs)					
			A grade	B grade				
V ₁ - Baby White	47,766	150150	14109.40	4252.50	105000	273512	190746	3.30
V ₂ - Baby Purple	47,766	134794	11550.00	3963.75	105000	255308	172542	3.08
V ₃ - Prince Orange	47,766	107494	18900.00	5468.75	105000	236863	154097	2.86
V ₄ - Princess Amellia	47,766	122850	16800.00	5381.25	105000	250031	167265	3.02
V ₅ - Fancy Red	47,766	143325	21918.80	6212.50	105000	276456	193690	3.34
V ₆ - Queen Black	47,766	98962.5	8662.50	2992.50	105000	215618	132852	2.60
F Test		Sig.	Sig.	Sig.		Sig.	Sig.	
SE(m) ±		3075.99	269.57	126.68		3020.32	3020.32	0.03
CD at 5%		9230.07	810.40	381.77		9102.31	9102.31	0.10

Market rate: A grade flower

Baby White, Baby Purple, Queen Black - Rs. 5

Prince Orange, Princess Amellia, Fancy Red – Rs. 10

B grade flower

Baby White, Baby Purple, Queen Black - Rs. 3

Prince Orange, Princess Amellia, Fancy Red – Rs. 5

Suckers- Rs- 65

Pot plant – Rs. 200

The gross and net monetary returns were significantly maximum with the variety V₅ *i.e.*, Fancy Red (Rs. 276456.00 and Rs. 193690.00, respectively) which was followed by variety V₁ *i.e.*, Baby White (Rs. 273512.00 and 190746.00 respectively) and V₂ *i.e.*, Baby Purple (Rs. 255308.00 and, 172542.00 respectively). Whereas, the gross monetary and net monetary returns were found to be significantly minimum with the variety V₆ *i.e.*, Queen Black (Rs 215618.00 and 132852.00 respectively).

4.1.5.2 Benefit: Cost ratio

The data regarding benefit: cost ratio as influenced by different varieties of anthurium under Konkan climatic conditions is presented in Table 12 and Fig. 16.

The maximum benefit: cost ratio was obtained with the variety V₅ *i.e.*, Fancy Red (3.34) followed by V₁ *i.e.*, Baby White (3.30) and T₂ *i.e.*, Baby Purple (3.08). whereas, minimum benefit: cost ratio was recorded with the variety V₆ *i.e.*, Queen Black (2.60).

These differences may be attributed to yield potential and quality of flowers of individual genotypes. Similar results were also reported by Agasimani *et al.* (2011) and Nataraj *et al.* (2019).

4.2 To optimize growing media for anthurium cultivation

The various media combination treatments of anthurium *viz.*, - T₁ -Coconut husk + charcoal (3:1), T₂ - Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1), T₃ - Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1), T₄ - Cocopeat + wood shavings + FYM+ brick pieces + charcoal (2:1:1:1:1), T₅ - Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1:1), T₆ - Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1) and T₇ -Sand + cowdung clumps + coconut husk + wood shaving + charcoal + earthen crocks + brick pieces + Cocopeat (2:1:2:1:0.5:0.5:1:1) were evaluated at Hi-tech unit, College of Horticulture, Dapoli. The effect of these seven media combination

treatments with respect to growth, flowering and yield parameters was studied. The results are presented under following heads.

4.2.1 Evaluation of growing media with respect to vegetative parameters

4.2.1.1 Survival percentage:

The data with respect to survival percentage (%) in anthurium as influenced by different media is presented in Table 13 and depicted through Fig. 17. The data indicated that the treatment differences were significant in respect of survival percentage in anthurium due to different treatment combinations of media.

Table 13: Effect of growing media on survival percentage of anthurium cv. Tropical Red

Treatments	Survival (%)
T₁	92.00
T₂	95.33
T₃	93.33
T₄	89.33
T₅	94.67
T₆	91.33
T₇	90.00
F Test	Sig.
SE(m) ±	0.83
CD at 5%	2.49

T₁- Coconut husk + charcoal (3:1)

T₂- Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)

T₃- Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1)

T₄- Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1)

T₅- Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1)

T₆- Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1)

T₇- Sand + cowdung clumps + coconut husk + wood shaving + charcoal+ earthen crocks + brick pieces + cocopeat (2:1:2:1:0.5:0.5:1:1)

The treatment T₂ i.e., Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) recorded significantly maximum survival

percentage (95.33 %) which was found to be at par with the treatments T₅ i.e., Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (94.67%) and T₃ i.e., cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (93.33%), whereas, the treatment T₄ i.e., Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum survival percentage (89.33 %).

The potting material used in the potting medium supported plantlets and provided nutrients and water to roots of plantlets. Coconut husk is suitable to improve water holding capacity of the substrate and nutrient contents at the initial stage. Brick pieces provide good drainage, aeration and mechanical support to plantlets. Charcoal is also useful to provide aeration, tolerance to fungal growth and permeability to the potting medium (Lakshanthi and Seran 2019) in *Dendrobium* orchids. Similar results were also reported by Selvaraj and Bharathi (2018) in anthurium and orchids, Thokchom and Maitra (2017) in anthurium, Sabareeswaran *et al.* (2018) in *Dendrobium* orchids.

4.2.1.2 Plant height (cm):

The data with respect to plant height (cm) in anthurium is exhibited in Table 14 and depicted through Fig. 18. The data revealed that, the height of anthurium plant was influenced significantly by various treatments of media combinations at all the growth stages i.e., 4, 8, 12, 16, 20 and 24 months after planting.

At the stage of 4 months after planting, the treatment T₂ i.e., Sand + FYM+ coconut husk + brick pieces + charcoal (1:1:1:1:1) noticed significantly maximum plant height (13.47 cm) which was found statistically at par with all the treatments except T₇ whereas, minimum height of plant was noticed with the treatment T₄ i.e., Cocopeat + wood shavings +FYM+ brick pieces + charcoal (2:1:1:1:1) (12.77 cm).

At 8 months after planting, significantly highest plant height was noticed with the treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) (23.36 cm) which was statistically at par with T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1) (23.26 cm), T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (22.65 cm), whereas, minimum plant height was recorded in the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (19.90 cm).

Table 14: Effect of growing media on plant height of anthurium cv. Tropical Red

Treatments	Plant height (cm)					
	4 MAP	8 MAP	12 MAP	16 MAP	20 MAP	24 MAP
T₁	13.15	21.73	25.66	29.18	33.09	33.17
T₂	13.47	23.36	28.36	33.19	39.05	40.99
T₃	13.29	22.65	27.41	31.07	36.19	37.86
T₄	12.77	19.90	24.70	26.13	29.23	31.13
T₅	13.35	23.26	28.03	32.46	38.13	38.41
T₆	13.17	22.19	26.75	30.95	35.04	35.53
T₇	12.95	21.19	25.17	27.43	31.29	32.23
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.15	0.27	0.39	0.43	0.49	0.56
CD at 5%	0.45	0.84	1.19	1.34	1.51	1.71

T₁- Coconut husk + charcoal (3:1)

T₂- Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)

T₃- Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1)

T₄- Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1)

T₅- Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1)

T₆- Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1)

T₇- Sand + cowdung clumps + coconut husk + wood shaving + charcoal+ earthen crocks + brick pieces + cocopeat (2:1:2:1:0.5:0.5:1:1)

At 12 months after planting, the treatment T₂ (Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) exhibited

significantly maximum plant height (28.36 cm) which was at par with T₅ and T₃ (28.03 and 27.41 cm, respectively) and minimum height of plant was recorded by the treatment *i.e.*, T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (24.70 cm).

At 16 months after planting the treatment T₂ *i.e.*, sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) exhibited significantly maximum plant height (33.19 cm) which was statistically at par with the treatment T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (32.46 cm), whereas, minimum height of the plant was recorded by the treatment T₄ *i.e.*, cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (26.13 cm).

At 20 months after planting, maximum plant height was noticed by the treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) (39.05 cm) which was statistically at par with T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (38.13 cm), whereas, minimum plant height (29.23 cm) was recorded by the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1).

At the stage of 24 months after planting, the treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) recorded significantly maximum plant height (40.99 cm) which was followed by treatment T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (38.41 cm) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (37.86 cm), whereas, minimum height of plant was recorded by the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (31.13 cm).

Anthurium is epiphytic in nature, optimum water holding capacity, better drainage and aeration in growing media is required for better growth which provides congenial conditions for the roots to anchor and further plant establishment and growth (Kapane *et al.*

2015). Similar findings were reported by Gowda *et al.* (2005), Basheer and Thekkayam (2012), in anthurium and Arumugam and Jawaharlal (2004) in *Dendrobium* orchid. However, media containing cocopeat seemed to hold extra moisture which has adverse effect on growth of anthurium plants.

4.2.1.3 Number of leaves:

The data with respect of total number of leaves produced by plants anthurium as influenced by various media at all the growth stages *i.e.*, 4, 8, 12, 16, 20 and 24 months after planting is presented in Table 15 and illustrated in Fig.19. The data indicated that the effect of various media on number of leaves produced by anthurium plants was found significant at all growth stages period after planting.

At 4 months after planting, the treatment T₂ (Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)) registered significantly maximum number of leaves (5.20) which was statistically at par with the treatments T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (4.80), however, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum number of leaves (4.33)

At the stage of 8 months after planting, significantly maximum numbers of leaves were counted with the treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) (7.13) which was statistically at par with treatments T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (6.70), T₆ *i.e.*, Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1) (6.67), T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (6.73), whereas, minimum number of leaves on anthurium plants were recorded by the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (5.53).

Similarly, at the stage of 12 months after planting, significantly maximum numbers of leaves were noticed in the treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)

(8.07) which was statistically at par with treatments T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (7.67) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (7.40) and significantly minimum number of leaves on anthurium plants were recorded by the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (5.87).

Table 15: Effect of growing media on number of leaves per plant of anthurium cv. Tropical Red

Treatments	Number of leaves per plant					
	4 MAP	8 MAP	12 MAP	16 MAP	20 MAP	24 MAP
T₁	4.53	6.33	6.93	7.73	8.20	8.60
T₂	5.20	7.13	8.07	8.60	9.00	9.80
T₃	4.67	6.73	7.40	8.27	8.73	9.00
T₄	4.33	5.53	5.87	6.20	6.87	7.13
T₅	4.80	6.70	7.67	8.40	8.80	9.13
T₆	4.60	6.67	7.13	7.87	8.53	8.80
T₇	4.40	5.93	6.73	7.47	7.67	8.53
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.14	0.25	0.29	0.31	0.35	0.40
CD at 5%	0.42	0.76	0.89	0.95	1.07	1.22

T₁- Coconut husk + charcoal (3:1)

T₂- Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)

T₃- Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1)

T₄- Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1)

T₅- Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1)

T₆- Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1)

T₇- Sand + cowdung clumps + coconut husk + wood shaving + charcoal+ earthen crocks + brick pieces + cocopeat (2:1:2:1:0.5:0.5:1:1)

At 16 months after planting significantly highest number of leaves (8.60) was recorded by the treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was found

statistically at par with the treatments T₅ *i.e.*, Brick pieces + wood shavings + sand+ FYM+ coconut husk+ charcoal (1:1:1:1:1:1) (8.40), T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (8.27), T₆ *i.e.*, Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1) (7.87) and T₁ *i.e.*, Coconut husk + charcoal (3:1) (7.73), however, T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum number of leaves (6.20).

At 20 months stage significantly maximum number of leaves (9.00) in anthurium was recorded by the treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) and all other treatments were at par except T₄. However, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum number of leaves (6.87) in anthurium.

At the stage of 24 months, treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) recorded significantly maximum number of leaves (9.80) and it was found statistically at par with rest of the treatments except T₄ whereas, significantly minimum number of leaves was recorded by T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1)(7.13 cm).

This can be attributed to the fact that the coconut husk as growing medium improves aeration and maintains moisture level in root zone as desired by anthurium whereas charcoal and brick pieces helps in absorption of dissolvable salts and other impurities that could damage the root systems of the plant that allows free air movement, retains moisture and nutrients for growth of plants and delays senescence of the leaves present on the plant when used in combination with other growing media (Santiago and Santiago, 1989). Similar results were recorded by Tatte *et al.* (2019) in anthurium, Sabareeswaran *et al.* (2018) and Lakshanthi and Seran (2019) in *Dendrobium* orchids.

4.2.1.4 Length of leaf (cm):

The data with respect to effect of various media on length of leaf (cm) in anthurium is presented in Table 16 and depicted in Fig. 20. The data indicated that the length of leaf (cm) in anthurium was influenced significantly due to different treatment combinations of media.

At the stage of 4 months, treatment T₂ (Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)) recorded significantly maximum length of leaf (5.61cm) which was statistically at par with the treatment T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1) (5.37cm) and the T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) treatment (T₄) recorded significantly minimum length of leaf (4.51 cm).

At 8 months stage treatment T₂ *i.e.*, (Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)) recorded significantly maximum length of leaf in anthurium (8.47 cm) and it was statistically at par with the treatments T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1) (7.97 cm), whereas, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum length of leaf (5.95 cm).

At 12 months stage after planting significantly maximum length of leaf was registered by the treatment T₂ *i.e.*, (Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)) (10.46 cm) and it was found statistically at par with the treatments T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1) (9.94 cm) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (9.76 cm), whereas, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum length of leaf (7.55 cm).

At 16 months after planting, treatment T₂ *i.e.*, (Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)) recorded

significantly maximum length of leaf (12.82 cm) which was found statistically at par with the treatment T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk+ charcoal (1:1:1:1:1:1) (12.10 cm) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (11.68 cm), however, minimum length of leaf (8.74 cm) was recorded by with treatment (T₄).

Table 16: Effect of growing media on length of anthurium leaf cv. Tropical Red

Treatments	Length of leaf (cm)					
	4 MAP	8 MAP	12 MAP	16 MAP	20 MAP	24 MAP
T₁	4.72	6.93	9.46	10.97	12.65	13.76
T₂	5.61	8.47	10.46	12.82	14.42	15.00
T₃	4.83	7.76	9.76	11.68	13.51	14.69
T₄	4.51	5.95	7.55	8.74	10.80	12.81
T₅	5.37	7.97	9.94	12.10	13.85	14.93
T₆	4.75	7.72	9.67	11.53	13.17	13.91
T₇	4.60	6.74	9.39	9.92	12.26	13.43
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.15	0.20	0.25	0.39	0.39	0.43
CD at 5%	0.47	0.63	0.76	1.19	1.22	1.31

T₁- Coconut husk + charcoal (3:1)

T₂- Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)

T₃- Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1)

T₄- Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1)

T₅- Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1)

T₆- Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1)

T₇- Sand + cowdung clumps + coconut husk + wood shaving + charcoal+ earthen crocks + brick pieces + cocopeat (2:1:2:1:0.5:0.5:1:1)

At 20 months stage the treatment T₂ *i.e.*, (Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) recorded significantly maximum length of leaf (14.42 cm) which was at par with the treatments T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM +

coconut husk + charcoal (1:1:1:1:1:1) (13.85 cm) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (13.51 cm) whereas, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum length of leaf (10.80 cm).

At 24 months after planting, treatment T₂ *i.e.*, Sand + FYM+ coconut husk + brick pieces + charcoal (1:1:1:1:1) recorded significantly maximum leaf length in anthurium (15.00 cm) and it was statistically at par with the treatments T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (14.93 cm), T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (14.69 cm), T₆- Saw dust+ wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1) (13.91 cm) and T₁- Coconut husk + charcoal (3:1) (13.76 cm), however, treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum length of leaf (12.81 cm).

For optimal growth of plants, media must retain enough water and air which mainly depends on the physical properties of medium. Most of the light weight, soilless media are combinations of two or more components formulated to achieve desirable physical and chemical properties which result in optimum vegetative growth of plants (Muraleedharan and Karuppaiah 2015) in anthurium. Similar results were reported by Dewayne *et al.* (2003) in ornamental plants and Tatte *et al.* (2018) in anthurium.

4.2.1.5 Breadth of leaf (cm):

The data with respect to breadth of leaf (cm) in anthurium as influenced by various media at all the growth stages *i.e.*, 4, 8, 12, 16, 20 and 24 months after planting is presented in Table 17 and illustrated in Fig. 20. The data indicated that the effect of various media on breadth of leaf (cm) in anthurium was found significant at 4, 8, 12, 16, 20 and 24 months after planting.

At 4 months after planting the treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) registered significantly maximum breadth of leaf (3.03 cm) which was statistically at par with the treatments T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1) (2.56 cm), however, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum breadth of leaf (2.05 cm).

At 8 months after planting, significantly maximum breadth of leaf was recorded by the treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) (4.29 cm) which was followed by T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1) (3.36 cm) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (3.16 cm), whereas, minimum breadth of leaf was recorded with the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (2.63 cm).

At 12 months after planting, the treatment T₂ (Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) exhibited significantly maximum breadth of leaf (6.51 cm) which was significantly at par with T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1) (5.65 cm) and minimum breadth of leaf was recorded with the Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) treatment *i.e.*, T₄ (4.11 cm).

At 16 months after planting, the treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) exhibited significantly maximum breadth of leaf (8.07 cm) which was found statistically at par with the treatment T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1) (7.07 cm) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (6.98 cm), whereas, minimum height of the plant was noticed

with the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (5.91 cm).

Table 17: Effect of growing media on breadth of anthurium leaf cv. Tropical Red

Treatments No.	Breadth of leaf (cm)					
	4 MAP	8 MAP	12 MAP	16 MAP	20 MAP	24 MAP
T₁	2.20	2.90	4.31	6.46	7.71	9.10
T₂	3.03	4.29	6.51	8.07	9.07	9.65
T₃	2.33	3.16	4.82	6.98	8.69	9.40
T₄	2.05	2.63	4.11	5.91	6.86	7.89
T₅	2.56	3.36	5.65	7.07	8.81	9.43
T₆	2.32	3.05	4.59	6.80	7.86	9.30
T₇	2.20	2.81	4.23	6.31	7.62	8.85
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.21	0.28	0.33	0.37	0.40	0.45
CD at 5%	0.65	0.86	1.01	1.13	1.22	1.38

T₁- Coconut husk + charcoal (3:1)

T₂- Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)

T₃- Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1)

T₄- Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1)

T₅- Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1)

T₆- Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1)

T₇- Sand + cowdung clumps + coconut husk + wood shaving + charcoal+ earthen crocks + brick pieces + cocopeat (2:1:2:1:0.5:0.5:1:1)

At 20 months stage treatment T₂ *i.e.*, (Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) recorded significantly maximum breadth of leaf (9.07 cm) which was at par with the treatments T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (8.81 cm) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (8.69 cm) and T₆- Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1)(7.86 cm) whereas, the treatment T₄ *i.e.*, Cocopeat + wood

shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum breadth of leaf (6.86 cm).

At 24 months after planting, treatment T₂ *i.e.*, (Sand + FYM+ coconut husk + brick pieces + charcoal (1:1:1:1:1) recorded significantly maximum in anthurium (9.65 cm) and it was statistically at par with the treatments T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (9.43 cm), T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (9.40 cm), T₆- Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1) (9.30 cm), T₁- Coconut husk + charcoal (3:1) (9.10 cm) and T₇ *i.e.*, Sand + cowdung clumps + coconut husk + wood shaving + charcoal + earthen crocks + brick pieces + cocopeat (2:1:2:1:0.5:0.5:1:1) (8.85 cm), however, treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum breadth of leaf (7.89 cm).

The physical characteristics of media with its aeration and water holding capacity are probably the most important factors which favour plant growth while, among the chemical characteristics nutritional status and salinity level have crucial role on plant growth and development (Dewayne *et al.* 2003) in ornamental plants. Present results are in agreement with the results of Tatte *et al.* (2018) in anthurium and Sabareeswaran *et al.* (2018) in Dendrobium orchids.

4.2.1.6 Leaf area (cm²):

The data with respect of effect to various media on leaf area (cm²) in anthurium is presented in Table 18 and furnished in Fig. 21. The data indicated that the leaf area (cm²) in anthurium was influenced significantly due to different treatments of media.

At 4 months after planting, treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) recorded significantly maximum leaf area (37.01 cm²) which was statistically at par with the treatment T₅ *i.e.*, Brick pieces + wood shavings + Sand +

FYM + coconut husk + charcoal (1:1:1:1:1:1) (36.80 cm²) and the treatment Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (T₄) recorded significantly minimum leaf area (27.23 cm²).

At 8 months after planting significantly maximum leaf area (56.87 cm²) was noticed with the treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) and it was found to be at par with the treatments T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (55.92 cm²), whereas, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum leaf area (44.60 cm²) in anthurium.

At 12 months after planting, the treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) at 12 months after recorded significantly maximum leaf area in anthurium (95.97 cm²) whereas, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum leaf area (79.29 cm²).

At 16 months after planting, treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) recorded significantly maximum leaf area in anthurium (125.29 cm²), however, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum leaf area (109.11 cm²).

At 20 months after planting significantly the maximum leaf area was measured with the treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) (151.77 cm²), whereas, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum leaf area (135.13 cm²).

At 24 months after planting, the treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) recorded significantly maximum leaf area (176.33 cm²), whereas, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum leaf area (160.21 cm²).

Table 18: Effect of growing media on leaf area of anthurium cv. Tropical Red

Treatments	Leaf area (cm ²)					
	4 MAP	8 MAP	12 MAP	16 MAP	20 MAP	24 MAP
T₁	29.24	48.29	84.93	112.73	141.63	165.87
T₂	37.01	56.87	95.97	125.29	151.77	176.33
T₃	33.35	53.79	90.14	118.39	147.37	170.83
T₄	27.23	44.60	79.29	109.11	135.13	160.21
T₅	36.80	55.92	93.06	122.40	149.43	172.33
T₆	32.24	50.63	87.47	115.10	144.57	168.01
T₇	30.36	46.00	82.63	110.66	138.13	162.70
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.28	0.35	0.36	0.45	0.49	0.38
CD at 5%	0.86	1.07	1.10	1.37	1.49	1.16

T₁- Coconut husk + charcoal (3:1)

T₂- Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)

T₃- Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1)

T₄- Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1)

T₅- Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1)

T₆- Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1)

T₇- Sand + cowdung clumps + coconut husk + wood shaving + charcoal+ earthen crocks + brick pieces + cocopeat (2:1:2:1:0.5:0.5:1:1)

Significant increase in leaf area can be attributed to favorable physico-chemical properties like low bulk density, high porosity and lower pH value of media that supported proper growth of plants. Coconut husk, brick pieces and sand helped in proper drainage, whereas charcoal helped to improve the Cation Exchange Capacity and porosity of a substrate, which provided favourable growing conditions for root development and more number of leaves per plant that facilitated well establishment of plant growth. These results are in line with those of (Jackson, 1973), Gowda and Ramakrishna (2009)

Kapane *et al.* (2015) and Tatte *et al.* (2019) in anthurium, Sabareeswaran *et al.* (2018) in orchids.

4.2.1.7 Number of suckers per plant:

The data with respect to number of suckers per plant in anthurium as influenced by various media is presented in Table 19 and depicted in Fig. 22. The data shows that the effect of various media on number of suckers per plant in anthurium was found significant.

Table 19: Effect of growing media on number of suckers per plant of anthurium cv. Tropical Red

Treatments	Number of suckers per plant
T₁	3.00
T₂	3.87
T₃	3.60
T₄	2.60
T₅	3.73
T₆	3.20
T₇	2.80
F Test	Sig.
SE(m) ±	0.14
CD at 5%	0.42

T₁- Coconut husk + charcoal (3:1)

T₂- Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)

T₃- Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1)

T₄- Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1)

T₅- Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1)

T₆- Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1)

T₇- Sand + cowdung clumps + coconut husk + wood shaving + charcoal+ earthen crocks + brick pieces + cocopeat (2:1:2:1:0.5:0.5:1:1)

The treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) recorded significantly maximum number of suckers per plant (3.87) which was found statistically at par with the treatment T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1) (3.73) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (3.60), however, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum number of suckers per plant (2.60).

This might be due to media which provided sufficient anchorage or support to the plant, served as reservoir for optimum moisture and aeration which allowed gaseous exchange between the roots and atmosphere outside the root substrate which resulted in growth and development of plants. The results are in line with those of Jawaharlal *et al.* (2001), Dhananjaya and Sulladmath (2003), Muraleedharan and Karuppaiah (2015), Kapane *et al.* (2015) and Tatte *et al.* (2018) in anthurium.

4.2.1.8 Chlorophyll a (mg/g)

The data with respect to chlorophyll a (mg/g) of anthurium as influenced by various media is presented in Table 20. The data indicated that, in chlorophyll a (mg/g) was significantly influenced by different treatments of media.

The present studies revealed that in 2019, maximum chlorophyll a (2.18 mg/g) was registered by treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was followed by T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1) (2.12 mg/g) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (2.06 mg/g), however, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum chlorophyll a (1.85 mg/g).

Table 20: Effect of growing media on chlorophyll a and b (mg/g) in anthurium cv. Tropical Red

Treatments	Chlorophyll a (mg/g)			Chlorophyll b (mg/g)		
	1 st year (2019)	2 nd year (2020)	Pooled	1 st year (2019)	2 nd year (2020)	Pooled
T₁	1.95	1.96	1.95	1.21	1.20	1.21
T₂	2.18	2.14	2.16	1.34	1.32	1.33
T₃	2.06	2.03	2.05	1.29	1.28	1.29
T₄	1.85	1.89	1.87	1.14	1.17	1.15
T₅	2.12	2.08	2.10	1.32	1.30	1.31
T₆	2.01	1.99	2.00	1.24	1.23	1.24
T₇	1.90	1.92	1.91	1.18	1.21	1.19
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.01	0.03	0.02	0.01	0.02	0.01
CD at 5%	0.04	0.10	0.05	0.03	0.05	0.04

T₁- Coconut husk + charcoal (3:1)

T₂- Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)

T₃- Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1)

T₄- Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1)

T₅- Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1)

T₆- Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1)

T₇- Sand + cowdung clumps + coconut husk + wood shaving + charcoal+ earthen crocks + brick pieces + cocopeat (2:1:2:1:0.5:0.5:1:1)

In 2020, during the course of investigation maximum Chlorophyll a (2.14 mg/g) was registered by treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was significantly at par with T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (2.08 mg/g), while minimum Chlorophyll a (1.89 mg/g) was observed in T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1).

Pooled results show that maximum chlorophyll a (2.16 mg/g) was registered by T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces +

charcoal (1:1:1:1:1) which was followed by T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1) (2.10 mg/g) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (2.05 mg/g), whereas, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum chlorophyll a (1.87 mg/g).

4.2.1.9 Chlorophyll b (mg/g)

The data with respect to Chlorophyll b (mg/g) in anthurium as influenced by various media is presented in Table 20.

In 2019, maximum Chlorophyll b (1.34 mg/g) was recorded by treatment T₂ *i.e.*, sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was found to be at par with T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1) (1.32 mg/g), however, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum chlorophyll b (1.14 mg/g).

In 2020, during the course of investigation maximum chlorophyll b (1.32 mg/g) was registered by treatment T₂ *i.e.*, sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was significantly at par with T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1) (1.30 mg/g) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (1.28 mg/g), while minimum chlorophyll b (1.17 mg/g) was observed in T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1).

Pooled results showed that maximum chlorophyll b (1.33 mg/g) was registered by T₂ *i.e.*, (Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was at par with T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1) (1.31 mg/g) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (1.29 mg/g), whereas, the treatment T₄ *i.e.*, Cocopeat + wood

shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum chlorophyll a (1.15 mg/g).

4.2.1.10 Total Chlorophyll (mg/g)

The data in respect of total chlorophyll (mg/g) in anthurium as influenced by various media is presented in Table 21.

The present studies revealed that in 2019, maximum total chlorophyll (3.52 mg/g) was recorded by treatment T₂ *i.e.*, (Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was followed by T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (3.44 mg/g) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (3.35 mg/g), however, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum total chlorophyll (2.99 mg/g).

In 2020, during the course of investigation maximum total chlorophyll (3.46 mg/g) was registered by treatment T₂ *i.e.*, (Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was significantly at par with T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (3.38 mg/g), while minimum total chlorophyll (3.06 mg/g) was observed in T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1).

Pooled results showed that at maximum total chlorophyll (3.49 mg/g) was registered by T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was followed by T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (3.41 mg/g) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (3.33 mg/g), whereas, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum total chlorophyll (3.03 mg/g).

This might be due to magnesium which is essential for chlorophyll synthesis is present in coconut husk resulted in increase

of chlorophyll content (Sanghamitra *et al.* 2019^a in orchids). These results are in agreement with the reports of Tatte *et al.* (2018) and Kapane *et al.* (2015) in anthurium, De *et al.* (2018) in cymbidium orchids and Sabareeswaran *et al.* (2018) in orchids and.

Table 21: Effect of growing media on total chlorophyll in anthurium cv. Tropical Red

Treatments	Total Chlorophyll (mg/g)		
	1 st year (2019)	2 nd year (2020)	Pooled
T₁	3.15	3.16	3.16
T₂	3.52	3.46	3.49
T₃	3.35	3.31	3.33
T₄	2.99	3.06	3.03
T₅	3.44	3.38	3.41
T₆	3.25	3.22	3.24
T₇	3.08	3.13	3.10
F Test	Sig.	Sig.	Sig.
SE(m) ±	0.01	0.04	0.02
CD at 5%	0.04	0.13	0.06

T₁- Coconut husk + charcoal (3:1)

T₂- Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)

T₃- Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1)

T₄- Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1)

T₅- Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1)

T₆- Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1)

T₇- Sand + cowdung clumps + coconut husk + wood shaving + charcoal+ earthen crocks + brick pieces + cocopeat (2:1:2:1:0.5:0.5:1:1)

4.2.2 Evaluation of growing media with respect to flowering parameters

4.2.2.1 Days taken for inflorescence emergence in anthurium plants

The data with respect to days taken for inflorescence emergence (days) in anthurium as affected by various media is furnished in Table 22.

In this experiment, the minimum days taken for inflorescence emergence was observed in treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) (224.20 days) which was followed by treatment T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1) (235.13 days) and treatment T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (245.00 days), however, maximum days taken for inflorescence emergence was recorded in T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (279.80 days).

It might be due to the media which provides good porosity and drainage which is necessary for root development that developed favorable microclimate for early flower induction (Kapane *et al.* 2015). Similar results were recorded by Cuquel *et al.* (2012) in anthurium, Chavada *et al.* (2017) in rose, Arumugam and Jawaharlal (2004) and Muraleedharan and Karuppaiah (2015) in anthurium.

4.2.2.2 Days required for first flowering:

The data with respect to days required for first flowering in anthurium as influenced by various media is exhibited in Table 22.

In this experiment, the treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) recorded minimum days (248.80 days) for first flowering and it was followed by T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1) (261.87 days) and treatment T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (272.80 days), whereas, maximum days taken for inflorescence emergence were recorded in T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (310.53 days).

Table 22: Effect of growing media on days taken for inflorescence emergence and days required for first flowering of anthurium cv. Tropical Red

Treatments	Days taken for inflorescence emergence in anthurium plants	Days required for first flowering
T₁	267.40	296.80
T₂	224.20	248.80
T₃	245.00	272.80
T₄	279.80	310.53
T₅	235.13	261.87
T₆	254.50	283.40
T₇	273.07	302.67
F Test	Sig.	Sig.
SE(m) ±	1.12	1.01
CD at 5%	3.44	3.10

T₁- Coconut husk + charcoal (3:1)

T₂- Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)

T₃- Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1)

T₄- Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1)

T₅- Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1)

T₆- Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1)

T₇- Sand + cowdung clumps + coconut husk + wood shaving + charcoal+ earthen crocks + brick pieces + cocopeat (2:1:2:1:0.5:0.5:1:1)

The early flowering was probably due to increased availability of nutrients during the vegetative (juvenile) phase, which increased photosynthesis and respiration with enhanced carbon-di-oxide fixation, thereby induced early flowering (Basheer and Thekkayam 2012). Similar results were recorded by Kapne et al. (2015), Tatte *et al.* (2018) in anthurium.

4.2.2.3 Period of inflorescence emergence to spathe unfurling (days):

The data with respect to period of inflorescence emergence to spathe unfurling in anthurium as influenced by various media is

presented in Table 23. The data indicated that period of inflorescence emergence to spathe unfurling in anthurium was significantly influenced by different treatments of various media.

During 2019, studies revealed that minimum period of inflorescence emergence to spathe unfurling was recorded in treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) (19.67 days) and it was followed by T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1) (21.07 days) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (21.40 days), while, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded maximum period of inflorescence emergence to spathe unfurling (24.07 days) in anthurium.

During 2020, T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) recorded minimum period (19.53 days) of inflorescence emergence to spathe unfurling and it was found at par with T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1) (21.60 days). Treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded maximum of period of inflorescence emergence to spathe unfurling (25.40 days) in anthurium.

Pooled data showed that significantly minimum (19.60 days) period of inflorescence emergence to spathe unfurling was noticed with the treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) and it was found to be at par with the treatment T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1) (21.50 days), whereas, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded maximum period of inflorescence emergence to spathe unfurling (24.73 days) in anthurium.

Table 23: Effect of growing media on period of inflorescence emergence to spathe unfurling and flower longevity on plant of anthurium cv. Tropical Red

Treatments	Period of inflorescence emergence to spathe unfurling (days)			Flower longevity on the plant (days)		
	1 st year (2019)	2 nd year (2020)	Pooled	1 st year (2019)	2 nd year (2020)	Pooled
T₁	22.60	23.86	23.11	56.33	57.23	56.95
T₂	19.67	19.53	19.60	65.40	64.33	64.86
T₃	21.40	23.26	22.38	60.67	61.06	61.86
T₄	24.07	25.40	24.73	54.27	55.20	55.14
T₅	21.07	21.60	21.50	62.53	63.06	61.95
T₆	22.13	23.70	22.93	59.60	57.57	57.4
T₇	23.13	24.10	23.50	54.83	56.56	56.03
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.43	0.88	0.51	0.68	1.29	0.92
CD at 5%	1.31	2.71	1.57	2.06	3.99	2.82

T₁- Coconut husk + charcoal (3:1)

T₂- Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)

T₃- Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1)

T₄- Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1)

T₅- Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1)

T₆- Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1)

T₇- Sand + cowdung clumps + coconut husk + wood shaving + charcoal+ earthen crocks + brick pieces + cocopeat (2:1:2:1:0.5:0.5:1:1)

This might be due to the media which provides proper aeration and drainage which is necessary for plant development which developed favorable microclimate for inflorescence emergence and early spathe unfurling (Singh *et al.* 2011). Results are in close conformity with the findings of Tatte *et al.* (2018) in anthurium.

4.2.2.4 Flower longevity on the plant (days):

The data with respect to effect of various media on flower longevity on the plant (days) in anthurium is presented in Table 23.

In 2019, maximum flower longevity on the plant (65.40 days) was recorded by treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was found to be at par with T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1) (62.53 days), however, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum flower longevity on the plant (54.27 days).

In 2020, during the course of investigation maximum flower longevity on the plant (64.33 days) was recorded by treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was significantly at par with T₅ *i.e.*, Brick pieces + wood shavings + sand+ FYM + coconut husk + charcoal (1:1:1:1:1) (63.06 days) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (61.06 days), while minimum flower longevity on the plant (55.20 days) was observed in T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1).

Pooled results indicated that maximum flower longevity on the plant (64.86 days) was registered by T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was followed by T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1) (61.95 days) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (61.86 days), whereas, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum flower longevity on the plant (55.14 days).

This might be due to the fact that organic substrates of media contain optimum level of essential nutrients that produce quality flowers giving superior longevity of inflorescences on plant (Singh *et al.*

2011). These findings are in line with the findings of Singh et al. (2009), Gupta and Saravanan (2017), Kapane *et al.* (2015) in anthurium and Sanghamitra *et al.* (2019) in orchids.

4.2.3 Evaluation of growing media with respect to quality parameters

4.2.3.1 Flower stalk length (cm):

The data with respect to flower stalk length was recorded and presented in Table 24 and graphically depicted in Fig. 23. During the period of investigation which was conducted for two years the effect of various media on flower stalk length of Tropical Red variety of anthurium was found significant.

During 2019, studies revealed that maximum flower stalk length (27.40 cm) was registered in treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1), which, it was at par with T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1) (25.80 cm). The treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum flower stalk length on the plant (15.80 cm).

During the course of investigation in 2020, maximum flower stalk length (27.46 cm) was recorded in treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was at par with T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1) (26.53 cm) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (24.26 cm), whereas, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum flower stalk length (17.26 cm).

In pooled analysis, maximum flower stalk length (27.43 cm) was registered by T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was at par with treatment T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal

(1:1:1:1:1:1) (26.16 cm). Minimum flower stalk length was recorded in treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (16.53 cm).

A good number of leaves coupled with active conductive root environment which might have led to proper nutrient uptake in the organic substrates which might have resulted in greater accumulation of food material leading to increase in length of flower stalk. These results are in conformity with the reports of Nakasone and Kamemoto (1962), Gowda *et al.* (2005), Kalirana and Dubey (2008), Kapane *et al.* (2015), Singh *et al.* (2011) and Tatte *et al.* (2018) in anthurium.

4.2.3.2 Spadix length (cm):

The data recorded on spadix length (cm) is given in Table 24. The data indicated that spadix length (cm) of anthurium was significantly influenced by different treatments of various media.

In 2019, maximum spadix length (4.60 cm) was recorded in treatment T₂ *i.e.*, Sand + FYM+ coconut husk + brick pieces + charcoal (1:1:1:1:1), which, it was at par with T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1) (4.45 cm). The treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum flower stalk length on the plant (3.28 cm).

During 2020, maximum spadix length (4.50 cm) was recorded in treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was at par with T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1) (4.48 cm) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (4.30 cm), whereas, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum spadix length (3.38 cm).

Table 24: Effect of growing media on flower stalk length and spadix length of anthurium cv. Tropical Red

Treatments	Flower stalk length (cm)			Spadix length (cm)		
	1 st year (2019)	2 nd year (2020)	Pooled	1 st year (2019)	2 nd year (2020)	Pooled
T₁	18.47	20.34	19.40	3.77	3.94	3.86
T₂	27.40	27.46	27.33	4.60	4.50	4.55
T₃	23.40	24.26	23.83	4.17	4.30	4.23
T₄	15.80	17.26	16.53	3.28	3.38	3.33
T₅	25.80	26.53	26.16	4.45	4.48	4.46
T₆	20.73	21.60	21.16	3.95	4.08	4.01
T₇	16.80	18.80	17.80	3.55	3.72	3.64
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.62	1.19	0.87	0.06	0.13	0.09
CD at 5%	1.88	3.66	2.67	0.20	0.40	0.28

T₁- Coconut husk + charcoal (3:1)

T₂- Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)

T₃- Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1)

T₄- Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1)

T₅- Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1)

T₆- Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1)

T₇- Sand + cowdung clumps + coconut husk + wood shaving + charcoal+ earthen crocks + brick pieces + cocopeat (2:1:2:1:0.5:0.5:1:1)

Pooled results showed that maximum spadix length (4.55 cm) was registered by T₂ i.e., Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was at par with treatment T₅ i.e., Brick pieces + wood shavings + sand+ FYM + coconut husk + charcoal (1:1:1:1:1:1) (4.46 cm), while, spadix length was recorded minimum in treatment T₄ i.e., Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (3.33 cm).

Spadix length was greatly influenced by growing media which might be due to higher porosity, adequate nutrient availability must

have helped to express the genetic potential of anthurium variety Tropical Red. These results are in agreement with the reports of Singh *et al.* (2011) and Tatte *et al.* (2018) in anthurium.

4.2.3.3 Length of spathe (cm):

The data recorded on length of spathe in anthurium as influenced by various media is presented in Table 25. The data indicated that length of spathe in anthurium was significantly influenced by different treatments of various media.

During 2019, studies revealed that maximum length of spathe was recorded in treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) (7.13 cm) which was statistically at par with T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1) (6.95 cm), whereas, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum length of spathe (5.52 cm) in anthurium.

In 2020, T₂ *i.e.*, (Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) recorded maximum length of spathe (7.05 cm) and it was found to be at par with T₅ *i.e.*, Brick pieces + wood shavings + Sand+ FYM + coconut husk + charcoal (1:1:1:1:1) (6.85 cm), whereas, treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded maximum length of spathe (5.93 cm) in anthurium.

Pooled data showed that significantly maximum (7.09 cm) length of spathe was recorded in treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) and it was par with the treatment T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk+ charcoal (1:1:1:1:1) (6.90 cm), whereas, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum length of spathe (5.72 cm) in anthurium.

Table 25: Effect of growing media on length of spathe and breadth of spathe of anthurium cv. Tropical Red

Treatments	Length of spathe (cm)			Breadth of spathe (cm)		
	1 st year (2019)	2 nd year (2020)	Pooled	1 st year (2019)	2 nd year (2020)	Pooled
T₁	6.15	6.52	6.34	4.87	5.05	4.96
T₂	7.13	7.05	7.09	6.11	6.23	6.17
T₃	6.55	6.68	6.61	5.54	5.69	5.61
T₄	5.52	5.93	5.72	4.31	4.71	4.51
T₅	6.95	6.85	6.90	5.24	5.95	5.89
T₆	6.45	6.55	6.50	5.16	5.40	5.28
T₇	5.87	6.04	5.95	4.53	4.85	4.69
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.07	0.11	0.07	0.07	0.12	0.09
CD at 5%	0.22	0.34	0.22	0.21	0.38	0.28

T₁- Coconut husk + charcoal (3:1)

T₂- Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)

T₃- Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1)

T₄- Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1)

T₅- Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1)

T₆- Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1)

T₇- Sand + cowdung clumps + coconut husk + wood shaving + charcoal+ earthen crocks + brick pieces + cocopeat (2:1:2:1:0.5:0.5:1:1)

The increase in size of spathe might be due to cumulative effect of all the growth parameters observed throughout the growing period. Increased size of spathe in different growing medium as resulted by higher porosity, adequate nutrient availability in these medium. Similar results were recorded by Dabral et al. (2019) in Calla lily, Higaki and Imamura (1985) in *Eucalyptus robusta*, Singh et al. (2011), Kapane et al. (2015) and Tatte et al. (2018) in anthurium.

4.2.3.4 Breadth of spathe (cm):

The data with respect to breadth of spathe in anthurium as influenced by various media is presented in Table 25.

Data indicated that during 2019, maximum breadth of spathe (6.11 cm) was registered by treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was followed by T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1:1) (5.54 cm) and T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (5.24 cm), whereas, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum breadth of spathe (4.31 cm).

In 2020, maximum breadth of spathe (6.23 cm) was registered by treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was significantly at par with T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (5.95 cm), while minimum breadth of spathe (4.71 cm) was recorded in T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1).

Pooled results showed that maximum breadth of spathe (6.17 cm) was registered by treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was at par with T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (5.89 cm). The treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum breadth of spathe (4.51 cm).

This might be due to different combination of media which consistently favored the better growth and physiological development of plant characters which may ultimately result in the good flowering characters such as spadix breadth. These findings are in line with those of Kapane *et al.* (2015) and Tatte *et al.* (2018) in anthurium.

4.2.3.5 Anthocyanin content (mg/g):

The data on effect of various media on anthocyanin content (mg/g) in anthurium is presented in Table 26.

In 2019, maximum anthocyanin content (0.70 mg/g) was recorded by treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was found to be at par with T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1) (0.67 mg/g), whereas, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum anthocyanin content (0.56 mg/g).

In 2020, during the course of investigation maximum anthocyanin content (0.67 mg/g) was recorded by treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was significantly at par with treatment T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1) (0.65 mg/g), T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (0.64 mg/g) and T₆ *i.e.*, Dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1) (0.63 mg/g), whereas, minimum anthocyanin content (0.55 mg/g) was observed in T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1).

Pooled results indicated that maximum anthocyanin content (0.68 mg/g) was registered by T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which at par with T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1) (0.66 mg/g), whereas, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum anthocyanin (0.55 mg/g) content.

Results are in line with the findings of Kapane *et al.* (2015) in anthurium.

Table 26: Effect of growing media on anthocyanin content and vase life of anthurium flower on plant cv. Tropical Red

Treatments	Anthocyanin content mg/g			Vase life of flower (days)		
	1 st year (2019)	2 nd year (2020)	Pooled	1 st year (2019)	2 nd year (2020)	Pooled
T₁	0.60	0.58	0.59	12.17	12.58	12.37
T₂	0.70	0.67	0.68	14.70	14.81	14.76
T₃	0.62	0.64	0.63	13.69	14.05	13.87
T₄	0.56	0.55	0.55	11.11	11.69	11.40
T₅	0.67	0.65	0.66	14.13	14.15	14.09
T₆	0.61	0.63	0.62	13.59	13.81	13.75
T₇	0.57	0.56	0.56	11.63	11.93	11.78
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.01	0.02	0.01	0.24	0.13	0.12
CD at 5%	0.03	0.06	0.04	0.74	0.40	0.38

T₁- Coconut husk + charcoal (3:1)

T₂- Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)

T₃- Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1)

T₄- Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1)

T₅- Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1)

T₆- Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1)

T₇- Sand + cowdung clumps + coconut husk + wood shaving + charcoal+ earthen crocks + brick pieces + cocopeat (2:1:2:1:0.5:0.5:1:1)

4.2.3.6 Vase life of flower (days):

The data with respect to vase life of flower was recorded and presented in Table 26. During the period of investigation which was conducted for two years the effect of various media on vase life of flower of Tropical Red variety of anthurium was found significant.

During 2019 studies revealed that maximum vase life of flower (14.70 days) was registered by the treatment T₂ i.e., Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) and it was found to

be at par with T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk+ charcoal (1:1:1:1:1:1) (14.13 days) whereas, the treatment T₄ *i.e.*, Cocopeat + wood shavings +FYM+ brick pieces + charcoal (2:1:1:1:1) recorded minimum vase life of flower (11.11 days).

During the course of investigation in 2020, maximum vase life of flower (14.81 days) was recorded in treatment T₂ *i.e.*, (Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was followed by T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk+ charcoal (1:1:1:1:1:1) (14.15 days) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (14.05 days), whereas, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum vase life of flower (11.69 days).

In pooled analysis maximum vase life of flower (14.76 days) was registered by T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was followed by treatment T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (14.09 days) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (13.87 days), whereas, minimum vase life of flower was recorded in treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (11.40 days).

This might be due to the ability of media combination for superior growth throughout the experimental period which provided the best quality flowers and increase in internal carbohydrate content of the flowers which enhanced the vase life. These findings are in line with those reported by Sanghamitra *et al.* (2019) in *Dendrobium* orchid and Singh *et al.* (2011) in anthurium.

4.2.4 Evaluation of growing media with respect to yield parameters

4.2.4.1 Number of flower spikes per plant:

The data with respect of number of flower spikes per plant in anthurium as influenced by various media at 8, 10, 12, 14, 16, 18, 20

and 24 months period after planting is presented in Table 27 and illustrated in Fig. 24. The data indicated that the effect of various media on number of flower spikes produced per plant in anthurium was found significant at all the growth period of 8, 10, 12, 14, 16, 18, 20 and 24 months after planting.

The treatment T₂ (Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) registered significantly maximum number of flowers per plant (1.53 flowers) which was statistically at par with the treatments T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (1.27 flowers), whereas, the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum number of flowers per plants (0.40 flowers) at 8 months after planting.

At 10 months after planting, significantly maximum number of flowers per plant was noticed with the treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) (2.00 flowers) which was followed by T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (1.67 flowers) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (1.47 flowers), whereas, minimum number of flowers per plant was recorded with the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (0.73 flowers).

Similarly, the treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) exhibited significantly maximum number of flowers per plant (2.73 flowers) which was followed by T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (2.40 flowers) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (2.13 flowers) minimum number of flowers per plant was recorded with the Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) treatment *i.e.*, T₄ (1.13 flowers) at 12 months after planting.

The treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) exhibited significantly maximum number of flowers per plant (3.20 flowers) which was found statistically at par with the treatment T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (2.73 flowers) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (2.53 flowers), whereas, minimum number of flowers per plant was noticed with the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (1.27 flowers) at 14 months after planting.

At the stage of 16 months after planting, the treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) noticed significantly maximum number of flowers per plant (3.33 flowers) which was found statistically at par with the treatment T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (3.00 flowers) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (2.67 flowers) and T₆ *i.e.*, Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1) (2.53 flowers) and T₁ *i.e.*, Coconut husk + charcoal (3:1) (2.33 flowers) whereas, minimum number of flowers per plant was noticed with the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (1.53 flowers).

At 18 months after planting, significantly maximum number of flowers per plant was noticed with the treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) (3.47 flowers) which was statistically at par with T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (3.20 flowers) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (3.13 flowers), whereas, minimum number of flowers per plant was recorded with the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (1.73 flowers).

Table 27: Effect of growing media on number of flowers per plant of anthurium cv. Tropical Red at bimonth intervals

Treatments	Number of flowers per plant									Mean
	8 MAP	10 MAP	12 MAP	14 MAP	16 MAP	18 MAP	20 MAP	22 MAP	24 MAP	
T₁	0.67	0.93	1.73	2.07	2.33	2.53	2.73	3.13	3.40	2.17
T₂	1.53	2.00	2.73	3.20	3.33	3.47	3.60	3.93	4.40	3.13
T₃	1.00	1.47	2.13	2.53	2.67	3.13	3.20	3.60	3.87	2.62
T₄	0.40	0.73	1.13	1.27	1.53	1.73	2.00	2.40	2.73	1.54
T₅	1.27	1.67	2.40	2.73	3.00	3.20	3.40	3.80	4.07	2.83
T₆	0.87	1.13	2.33	2.43	2.53	2.73	3.00	3.40	3.60	2.44
T₇	0.47	0.87	1.40	1.73	2.00	2.13	2.30	2.80	3.00	1.85
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	
SE(m) ±	0.08	0.08	0.07	0.22	0.23	0.22	0.09	0.23	0.10	
CD at 5%	0.26	0.25	0.23	0.68	0.71	0.68	0.29	0.71	0.32	

T₁- Coconut husk + charcoal (3:1)

T₂- Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)

T₃- Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1)

T₄- Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1)

T₅- Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1)

T₆- Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1)

T₇- Sand + cowdung clumps + coconut husk + wood shaving + charcoal+ earthen crocks + brick pieces + cocopeat (2:1:2:1:0.5:0.5:1:1)

Similarly, the treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) exhibited significantly maximum number of flowers per plant (3.60 flowers) which was followed by T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (3.40 flowers) and minimum number of flowers per plant was recorded with the Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) treatment *i.e.*, T₄ (2.00 flowers) at 20 months after planting.

At 22 months after planting, treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) recorded maximum

number of flowers per plant (3.93 flowers) which was found statistically at par with the treatment T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (3.80 flowers), T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (3.60 flowers) and T₆ *i.e.*, Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1) (3.40 flowers) whereas, minimum number of flowers per plant was noticed with the treatment T₄ *i.e.*, Cocopeat + wood shavings +FYM+ brick pieces + charcoal (2:1:1:1:1) (2.40 flowers).

At 24 months after planting, treatment T₂ *i.e.*, Sand + FYM+ coconut husk + brick pieces + charcoal (1:1:1:1:1) recorded significantly maximum number of flowers per plant in anthurium (4.40 flowers) and it was followed by treatment T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (4.07 flowers) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (3.87 flowers), whereas, treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) recorded minimum number of flowers per plant (2.73 flowers).

This might be due to good physico-chemical properties like physical characteristics *i.e.*, higher porosity, aeration, water holding and adequate nutrient availability and chemical characteristics of the growing medium *i.e.*, exert substantial effect on growth of plants which enhanced plant growth, flowering, quality and yield (Sanghamitra *et al.* 2019^a in *Dendrobium* orchids). Results are in agreement with Gupta and Dilita (2015), Bagci *et al.* (2011) in *Primula*, Barman *et al.* (2008) in *Cymbidium*, Kapane *et al.* (2015) and Tatte *et al.* (2018) in anthurium.

4.2.4.2 Economics:

The data in respect of gross and net monetary returns in anthurium (Rs.) of different media is presented in Table 28 and Fig. 25. The data indicated that the media differences were significant in respect of gross and net monetary returns.

The gross and net monetary returns were significantly maximum with the treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) (Rs. 264116.67 and 207366.67, respectively) which followed by treatment T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (Rs. 254741.67 and 197850.67, respectively) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (Rs. 246458.33- and 187829.33, respectively). The gross monetary and net monetary returns were found to be significantly minimum with the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (Rs. 203641.67 and 143658.67, respectively).

4.2.4.3 Benefit: Cost ratio

The data regarding benefit: cost ratio as influenced by different media in anthurium is presented in Table 28 and Fig. 25.

The maximum benefit: cost ratio was obtained with the treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) (4.65) which was at par with treatment T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (4.48) and followed by treatment T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (4.20). whereas, minimum benefit: cost ratio was recorded with the treatment T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (3.70).

The higher benefit cost ratio was because of the maximum production of suckers per plant and maximum net profit compared to all the other treatment combinations.

Table 28: Economics for cultivation of anthurium in different media (100 sq.m)

Treatment	Cost of cultivation (Rs)	Income (Rs)			Pot plant (Rs)	Gross return (Rs)	Net return (Rs)	B:C ratio
		Suckers (Rs)	Flowers (Rs)					
			A grade	B grade				
T ₁	56818	104650	14116.67	2916.67	105000	226683.33	169865.33	3.99
T ₂	56750	134225	19408.33	5483.33	105000	264116.67	207366.67	4.65
T ₃	58629	120575	16683.33	4200.00	105000	246458.33	187829.33	4.20
T ₄	59983	86450	10208.33	1983.33	105000	203641.67	143658.67	3.39
T ₅	56891	127400	17675.00	4666.67	105000	254741.67	197850.67	4.48
T ₆	57233	109200	15183.33	3616.67	105000	233000.00	175767.00	4.07
T ₇	58172	95550	12308.33	2391.67	105000	215250.00	157078.00	3.70
F Test		Sig.	Sig.	Sig.		Sig.	Sig.	
SE (m) ±		4241.63	514.35	122.43		4358.39	4358.39	0.07
CD at 5%		12726.89	1545.05	369.24		13174.17	13174.17	0.23

Market rate: A grade flower:- Rs. 10 B grade flower:- Rs.5

Suckers- Rs. 65

Pot plant – Rs. 200

T₁- Coconut husk + charcoal (3:1)

T₂- Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)

T₃- Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1)

T₄- Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1)

T₅- Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1)

T₆- Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1)

T₇- Sand + cowdung clumps + coconut husk + wood shaving + charcoal+ earthen crocks + brick pieces + cocopeat (2:1:2:1:0.5:0.5:1:1)

4.3 To optimize shade level for anthurium

Different shade levels for anthurium cultivation viz., 50%, 75% and 90% shade levels were evaluated at Hi-Tech Unit, College of Horticulture, Dapoli which greatly influenced the growth, flowering and yield of anthurium under the environmental conditions of Konkan region.

4.3.1 Evaluation of shade level with respect to vegetative parameters

4.3.1.1 Survival percentage:

The data with respect to survival percentage (%) in anthurium as influenced by different shade levels is presented in Table 29. The data indicated that the treatment differences were significant in respect of survival percentage of anthurium.

Table 29: Effect of shade levels on survival percentage of anthurium cv. Tropical Red

Treatments	Survival (%)
T₁- 50% shade level	89.63
T₂- 75% shade level	92.57
T₃- 90% shade level	95.63
F Test	Sig.
SE(m) ±	0.60
CD at 5%	1.82

The treatment T₃ i.e., 90% shade level recorded significantly maximum survival percentage (95.63%) which was followed by treatment T₂ i.e., 75% shade level (92.57%), whereas, the treatment T₁ i.e., 50% shade level recorded minimum survival percentage (89.63 %).

This might be due to the fact that anthurium performs better with decrease in light intensity during initial 6 months period of growth under 90% shade level. Similar results were reported by Mayoli *et al.* (2009) under 80% shade level in *Ranunculus* cut flower.

4.3.1.2 Plant height:

The data with respect to plant height (cm) in anthurium is exhibited in Table 30 and illustrated through Fig. 26. The data revealed that the height of anthurium plant was influenced significantly by various shade levels at all the growth stages i.e., 4, 8, 12, 16, 20 and 24 months after planting.

At the stage of 4 months after planting, the treatment T₂ i.e., 75% shade level recorded maximum plant height (13.56 cm) which

was followed by treatment T₃ *i.e.*, 90% shade level (11.53 cm), whereas, minimum height of plant was noticed with the treatment T₃ *i.e.*, 50% shade level (9.41 cm).

Table 30: Effect of shade levels on plant height of anthurium cv. Tropical Red

Treatments	Plant height (cm)					
	4 MAP	8 MAP	12 MAP	16 MAP	20 MAP	24 MAP
T₁- 50% shade level	9.41	18.49	23.24	30.01	33.64	36.34
T₂- 75% shade level	13.56	24.03	28.14	34.09	38.89	41.11
T₃- 90% shade level	11.53	21.27	26.47	32.26	35.29	38.43
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.08	0.20	0.15	0.21	0.36	0.59
CD at 5%	0.25	0.60	0.45	0.64	1.10	1.79

At 8 months after planting maximum plant height was recorded by the treatment T₂ *i.e.*, 75% shade level (24.03 cm) which was followed by treatment T₃ *i.e.*, 90% shade level (21.27 cm), whereas, minimum plant height was recorded with the treatment T₁ *i.e.*, 50% shade level (18.49 cm). Similarly, the treatment T₂ *i.e.*, 75% shade level recorded significantly maximum plant height (28.14 cm) which was followed by treatment T₃ *i.e.*, 90% shade level (26.47 cm) and minimum height of plant was recorded by the treatment *i.e.*, T₁ (50% shade level) (23.24 cm) at 12 months after planting.

At 16 months after planting, the treatment T₂ *i.e.*, 75% shade level exhibited significantly maximum plant height (34.09 cm) which was followed by T₃ *i.e.*, 90% shade level (32.26 cm), however, minimum height of the plant was recorded with the treatment T₃ *i.e.*, 50% shade level (30.01 cm).

At 20 months after planting, maximum plant height was recorded by the treatment T₂ *i.e.*, 75% shade level (38.89 cm) which was followed by T₃ *i.e.*, 90% shade level (35.29 cm), whereas, minimum plant height was recorded by the treatment T₁ *i.e.*, 50% shade level (33.64 cm).

At the stage of 24 months after planting, the treatment T₂ *i.e.*, 75% shade level recorded significantly maximum plant height (41.11 cm) which was followed by treatment T₃ *i.e.*, 90% shade level (38.43 cm), whereas, minimum height of plant was recorded by the treatment T₁ *i.e.*, 50% shade level (36.34 cm).

The present findings indicate that for better growth anthurium need 25% light which is optimum for better growth that is important for maximum photosynthesis and higher hormonal production just below the apical meristem zone this might have increased the plant height by cell elongation (Dev *et al.* 2018) in cactus under 75% shade level. Results are in agreement with those of Sudhakar and Rameshkumar (2012) in heliconium (75% shade level), Youssef and Mady (2013) in *Aspidistra elatior* Blume plant (73% shade level), Hlatshwayo and Wahome (2010) in carnation (75% shade level).

4.3.1.3 Number of leaves:

The data with respect to number of leaves produced by anthurium plants under the influence of various shade levels at all the growth stages *i.e.*, 4, 8, 12, 16, 20 and 24 months after planting are presented in Table 31 and illustrated by Fig. 27. The data shows that number of leaves per anthurium plant produced were found significant influenced at 4, 8, 12 16, 20 and 24 months after planting.

The treatment T₃ *i.e.*, 90% shade level registered significantly maximum number of leaves per plant (4.86) which was statistically at par with the treatment T₂ *i.e.*, 75% shade level (4.29), whereas, the treatment T₁ *i.e.*, 50% shade level recorded minimum number of leaves (4.00) at 4 months after planting.

At the stage of 8 months after planting, significantly maximum number of leaves was counted with the treatment T₃ *i.e.*, 90% shade (6.29) which was statistically at par with treatment T₂ *i.e.*, 75% shade level (5.86), whereas, minimum leaves of anthurium per plant were recorded by the treatment T₁ *i.e.*, 50% shade level (5.29).

Table 31: Effect of shade levels on number of leaves per plant of anthurium cv. Tropical Red

Treatments	Number of leaves per plant					
	4 MAP	8 MAP	12 MAP	16 MAP	20 MAP	24 MAP
T₁- 50% shade level	4.00	5.29	7.14	8.14	8.71	9.29
T₂- 75% shade level	4.29	5.86	7.57	8.71	9.29	9.86
T₃- 90% shade level	4.86	6.29	8.14	9.14	9.71	10.29
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.20	0.25	0.23	0.25	0.17	0.21
CD at 5%	0.61	0.76	0.71	0.76	0.53	0.66

Similarly, at the stage of 12 months after planting, significantly maximum number of leaves per plant was recorded by the treatment T₃ i.e., 90% shade level (8.14) which was statistically at par with treatment T₂ i.e., 75% shade level (7.57) and significantly minimum number of leaves per anthurium plant was recorded by the treatment T₁ i.e., 50% shade level (7.14).

Significantly maximum number of leaves per plant (9.14) was counted with the treatment T₃ i.e., 90% shade level which was found statistically at par with the treatment T₂ i.e., 75% shade level (8.71), whereas, T₁ i.e., 50% shade level recorded minimum number of leaves per plant (8.14) at 16 months after planting.

At 20 months after planting, maximum number of leaves per plant was recorded in treatment T₃ i.e., 90% shade level (9.71) which was at par with treatment T₂ i.e., 75% shade level (9.29), however minimum number of leaves was recorded in treatment T₁ i.e., 50% shade level (8.71).

At 24 months after planting, the treatment T₃ i.e., 90% shade level recorded maximum number of leaves per plant (10.29) which was statistically at par with treatment T₂ i.e., 75% shade level (9.86), while minimum number of leaves was recorded by the treatment T₁ i.e., 50% shade level (9.29).

Anthurium plants seems to perform better under high shade level condition. Present findings are in line with earlier reports of Evans and Poorter (2001), Chazdon *et al.* (1996), Poorter and Nagel (2000) who reported that leaves show lesser investment of growth biomass for respiration, Sims and Pearcy (1989) who reported that at this condition, investment of rubisco reflect the chlorophyll content and N ratio which led to yield numbering of leaves, Hikosaka and Terashima, (1995), Poorter and Evans (1998), Salvi *et al.* (1997) in anthurium (80% shade level) reported similar results.

4.3.1.4 Leaf area (cm²):

The data with respect to effect of various shade levels on leaf area (cm²) in anthurium is presented in Table 32 and illustrated in Fig. 28. The data indicated that, the leaf area (cm²) in anthurium was influenced significantly due to different shade levels.

At 4 months after planting, treatment T₃ *i.e.*, 90% shade level recorded significantly maximum leaf area (39.56 cm²) which was followed by the treatment T₂ *i.e.*, 75% shade level (33.01 cm²) and the treatment 50% shade level (T₁) recorded significantly minimum leaf area (29.16 cm²).

At 8 months after planting, significantly maximum leaf area (58.11 cm²) was noticed with the treatment T₃ *i.e.*, 90% shade level and it was followed by treatments T₂ *i.e.*, 75% shade level (52.36 cm²), whereas, the treatment T₁ *i.e.*, 50% shade level recorded minimum leaf area (46.74 cm²) in anthurium

At 12 months after planting, the treatment T₃ *i.e.*, 90% shade level recorded significantly maximum leaf area in anthurium (86.69 cm²) and it was followed by treatments T₂ *i.e.*, 75% shade level (76.41 cm²), whereas, the treatment T₁ *i.e.*, 50% shade level recorded minimum leaf area (65.77 cm²).

Table 32: Effect of shade levels on leaf area of anthurium cv. Tropical Red

Treatments	Leaf area (cm ²)					
	4 MAP	8 MAP	12 MAP	16 MAP	20 MAP	24 MAP
T₁- 50% shade level	29.16	46.74	65.77	95.19	120.00	155.16
T₂- 75% shade level	33.01	52.36	76.41	104.97	134.10	163.39
T₃- 90% shade level	39.56	58.11	86.69	117.07	146.10	174.90
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.51	0.42	0.84	0.50	0.70	1.33
CD at 5%	1.55	1.28	2.54	1.52	2.16	4.09

At 16 months after planting, treatment T₃ i.e., 90% shade level recorded significantly maximum leaf area in anthurium (117.07 cm²) which was followed by treatment T₂ i.e., 75% shade level (104.97 cm²), however, the treatment T₁ i.e., 50% shade level recorded minimum leaf area (95.19 cm²).

Significantly maximum leaf area was counted with the treatment T₃ i.e., 90% shade level (146.10 cm²) which was followed by treatment T₂ i.e., 75% shade level (134.10 cm²), whereas, the treatment T₄ i.e., 50% shade level recorded minimum leaf area (120.00 cm²) at 20 months after planting.

At 24 months after planting, the treatment T₃ i.e., 90% shade level recorded significantly maximum (174.90 cm²) leaf area which was followed by T₂ i.e., 75% shade level (163.39 cm²), whereas, the treatment T₁ i.e., 50% shade level recorded minimum leaf area (155.16 cm²).

This is probably due to the fact that anthurium plants photosynthesis is good under low light intensity. Hosseini *et al.* (2014) reported that therefore they increase the leaf area and change photosynthetic pigments to compensate the light shortages (Hamerlynck *et al.* 2000). Similar results were found by Salvi *et al.* (1997) in anthurium (80 % shade level).

4.3.1.5 Plant spread (North-South):

The data with respect to effect of different shade levels on plant spread (cm) in anthurium is presented in Table 33 and depicted in Fig.29. The data indicated that plant spread (cm) in anthurium was significantly influenced by different shade levels.

At 4 months after planting, the treatment T_3 i.e., 90% shade level recorded significantly maximum plant spread (11.76 cm) which was followed by treatment T_2 i.e., 75% shade level (10.66 cm), whereas, minimum plant spread (10.17 cm) was found with the treatment T_1 i.e., 50% shade level.

At 8 months after planting, significantly maximum plant spread (14.24 cm) was measured with the treatment T_3 i.e., 90% shade level which was followed by the treatment T_2 i.e., 75% shade level (12.57 cm), whereas, T_1 i.e., 50% shade level recorded minimum plant spread (11.69 cm)

Table 33: Effect of shade levels on plant spread (North- south) of anthurium cv. Tropical Red

Treatments	Plant spread (North- south)					
	4 MAP	8 MAP	12 MAP	16 MAP	20 MAP	24 MAP
T₁- 50% shade level	10.17	11.69	13.27	15.27	17.81	21.56
T₂- 75% shade level	10.66	12.57	14.51	17.19	20.37	24.53
T₃- 90% shade level	11.76	14.24	16.60	19.16	22.53	26.56
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.16	0.20	0.12	0.16	0.15	0.11
CD at 5%	0.49	0.60	0.35	0.50	0.47	0.34

At 12 months after planting, maximum plant spread was found in treatment T_3 i.e., 90% shade level (16.60 cm) which was followed by treatment T_2 i.e., 75% shade level (14.51 cm), whereas minimum plant spread was recorded in treatment T_1 i.e., 50% shade level (13.27 cm).

At 16 months after planting, the treatment T_3 i.e., 90% shade level recorded maximum plant spread (19.16 cm) which was followed

by treatment T₂ *i.e.*, 75% shade level (17.19 cm), while minimum plant spread was recorded in treatment T₁ *i.e.*, 50% shade level (15.27 cm).

At 20 months after planting, maximum plant spread was noticed with the treatment T₃ *i.e.*, 90% shade level (22.53 cm) which was followed by T₂ *i.e.*, 75% shade level (20.37 cm) whereas, minimum plant spread was recorded with the treatment T₁ *i.e.*, 50% shade level (17.81 cm).

The treatment T₃ *i.e.*, 90% shade level recorded significantly maximum plant spread (26.56 cm) which was followed by treatment T₂ *i.e.*, 75% shade level (24.53 cm), whereas, minimum plant spread was recorded with the treatment T₁ *i.e.*, 50% shade level (21.56 cm) at the stage of 24 months after planting.

This might be due to the shade effect which helped improving the plant growth with good microclimate which reduced light intensities, temperature, high relative humidity and reduced wind speed which improved growth characteristics like plant spread (Medany *et al.* 2009 in sweet pepper). These finding are in line with those of Salvi *et al.* (1997) with 80 % shade net in anthurium.

4.3.1.6 Plant spread (East-West):

The data with respect to plant spread (cm) of anthurium as influenced by different shade levels is furnished in Table 34 and presented through Fig. 30. The data indicated that, different treatments of shade levels influenced plant spread (cm) in anthurium significantly.

At 4 months after planting, the treatment T₃ *i.e.*, 90% shade level recorded significantly maximum plant spread (14.63 cm) and it was followed by the treatments T₂ *i.e.*, 75% shade level (13.59 cm), whereas, significantly minimum plant spread were counted in T₁ *i.e.*, 50% shade level (11.63 cm).

Significantly maximum plant spread (16.56 cm) was found with the treatment T₃ *i.e.*, 90% shade level which was followed by the

treatments T₂ *i.e.*, 75% shade level (15.03 cm), whereas, the treatment T₁ *i.e.*, 50% shade level recorded minimum plant spread (13.61 cm) in anthurium at 8 months after planting.

Table 34: Effect of shade levels on plant spread (East-West) of anthurium cv. Tropical Red

Treatments	Plant spread (East- West)					
	4 MAP	8 MAP	12 MAP	16 MAP	20 MAP	24 MAP
T₁- 50% shade level	11.63	13.61	16.73	19.04	20.64	22.56
T₂- 75% shade level	13.59	15.03	18.50	20.47	22.61	24.66
T₃- 90% shade level	14.63	16.56	20.41	22.33	24.54	26.40
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.21	0.24	0.15	0.18	0.12	0.39
CD at 5%	0.64	0.74	0.45	0.55	0.36	1.19

The treatment T₃ *i.e.*, 90% shade level recorded significantly maximum plant spread in anthurium (20.41 cm) and it was followed by treatment T₂ *i.e.*, 75% shade level (18.50 cm), whereas, the treatment T₁ *i.e.*, 50% shade level recorded minimum plant spread (16.73 cm) at 12 months after planting.

At 16 months after planting, the treatment T₃ *i.e.*, 90% shade level recorded significantly maximum plant spread (22.33 cm) which was followed by treatments T₂ *i.e.*, 75% shade level (20.47 cm), whereas, the treatment T₁ *i.e.*, 50% shade level recorded minimum plant spread (19.04 cm).

Similarly, at 20 months after planting, maximum plant spread (24.54 cm) was recorded with the treatment T₃ *i.e.*, 90% shade level which was followed by the treatments T₂ *i.e.*, 75% shade level (22.61 cm), whereas, the treatment T₁ *i.e.*, 50% shade level recorded minimum plant spread (20.64 cm) in anthurium

The treatment T₃ *i.e.*, 90% shade level recorded significantly maximum plant spread in anthurium (26.40 cm) and it was followed by treatment T₂ *i.e.*, 75% shade level (24.66 cm), whereas, the

treatment T₁ *i.e.*, 50% shade level recorded minimum plant spread (22.56 cm) at 24 months after planting.

4.3.1.7 Length of leaf petiole (cm):

The data with respect to length of leaf petiole (cm) in anthurium as influenced by different shade levels is presented in Table 35. The data shows that effect of different shade levels on length of leaf petiole (cm) in anthurium was significant.

At 4 months after planting, treatment T₂ *i.e.*, 75% shade level recorded significantly maximum length of leaf petiole (12.37 cm) which was followed by the treatment T₃ *i.e.*, 90% shade level (10.26 cm) and the treatment 50% shade level (T₁) recorded significantly minimum length of leaf petiole (8.83 cm).

At 8 months after planting, the treatment T₂ *i.e.*, 75% shade level recorded significantly maximum length of leaf petiole (14.16 cm) which was followed by treatment T₃ *i.e.*, 90% shade level (12.09 cm), whereas, the treatment T₁ *i.e.*, 50% shade level recorded minimum length of leaf petiole (10.04 cm) at 8 months after planting.

Table 35: Effect of shade levels on length of leaf petiole of anthurium cv. Tropical Red

Treatments	Length of leaf petiole (cm)					
	4 MAP	8 MAP	12 MAP	16 MAP	20 MAP	24 MAP
T₁- 50% shade level	8.83	10.04	11.91	13.50	15.03	16.27
T₂- 75% shade level	12.37	14.16	15.91	17.67	19.04	20.57
T₃- 90% shade level	10.26	12.09	14.07	15.60	17.16	18.28
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.15	0.19	0.17	0.18	0.15	0.28
CD at 5%	0.45	0.57	0.51	0.54	0.46	0.87

At 12 months after planting, the treatment T₂ *i.e.*, 75% shade level recorded significantly maximum length of leaf petiole in anthurium (15.91 cm) and it was followed by treatment T₃ *i.e.*, 90% shade level (14.07 cm), whereas, the treatment T₁ *i.e.*, 50% shade level

recorded minimum length of leaf petiole (11.91 cm) at 12 months after planting.

At 16 months after planting, the treatment T_2 i.e., 75% shade level recorded significantly maximum length of leaf petiole (17.67 cm) which was followed by treatments T_3 i.e., 90% shade level (15.60 cm), whereas, the treatment T_1 i.e., 50% shade level recorded minimum ad length of leaf petiole (13.50 cm).

Similarly, maximum length of leaf petiole (19.04 cm) was recorded with the treatment T_2 i.e., 75% shade level which was followed by the treatments T_3 i.e., 90% shade level (17.16 cm), whereas, the treatment T_1 i.e., 50% shade level recorded minimum length of leaf petiole (15.03 cm) in anthurium at 20 months after planting.

The treatment T_2 i.e., 75% shade level recorded significantly maximum length of leaf petiole in anthurium (20.57 cm) and it was followed by treatment T_3 i.e., 90% shade level (18.28 cm), whereas, the treatment T_1 i.e., 50% shade level recorded minimum plant spread (16.27 cm) at 24 months after planting.

This might be due to the presence of light pigment which has helped to increase petiole length, physiologically as well as morphologically. Under the low light conditions cell number increase, as well as cell length increases which induces to increase petiole length. Similar results were found by Huber *et al.* (2008) and Weijsschede *et al.* (2008).

4.3.1.8 Number of suckers per plant:

The data with respect to number of suckers produced per plant by anthurium as affected by various shade levels is given in Table 36 and presented in Fig.31. The data indicated that, different treatments of shade levels influenced number of suckers produced per plant in anthurium significantly.

Table 36: Effect of shade levels on number of suckers produced per plant of anthurium cv. Tropical Red

Treatments	Number of suckers per plant
T₁- 50% shade level	2.71
T₂- 75% shade level	4.00
T₃- 90% shade level	3.29
F Test	Sig.
SE(m) ±	0.30
CD at 5%	0.90

The treatment T₂ *i.e.*, 75% shade level recorded significantly maximum number of suckers per plant (4.00) which was found statistically at par with the treatment T₃ *i.e.*, 90% shade level (3.29), however, minimum number of suckers per plant (2.71) were produced by the T₁ *i.e.*, 50% shade level.

Under 75 % shade level, radiation received through 75% shade net by the plants must have been appropriate for sucker production as compared to other shade levels. These results are in conformity with the results of Khawlhiring, (2019) and Muraleedharan and Karuppaiah, (2015) in anthurium.

4.3.1.9 Chlorophyll a (mg/g), Chlorophyll b (mg/g) and Total chlorophyll

The data with respect to chlorophyll a (mg/g), chlorophyll b (mg/g) and total chlorophyll in anthurium as influenced by various shade level is presented in Table 37. The data presented in Table 37 indicated that chlorophyll content in anthurium was significantly influenced by different shade levels.

During 2019, maximum chlorophyll a (2.25 mg/g), chlorophyll b (1.43 mg/g) and total chlorophyll (3.68 mg/g) was registered by treatment T₂ *i.e.*, 75% shade level which was followed by T₃ *i.e.*, 90% shade level chlorophyll a (1.77 mg/g), chlorophyll b (1.18 mg/g) and total chlorophyll (2.94 mg/g) whereas, the treatment T₁ *i.e.*, 50% shade level recorded minimum chlorophyll a (1.34 mg/g), chlorophyll b (1.01 mg/g) and total chlorophyll (2.35 mg/g).

In 2020, during the course of investigation maximum chlorophyll a (2.34 mg/g), chlorophyll b (1.50 mg/g) and total chlorophyll (3.83 mg/g) was registered by treatment T₂ i.e., 75% shade level which was followed by T₃ i.e., 90% shade level chlorophyll a (1.83 mg/g), chlorophyll b (1.22 mg/g) and total chlorophyll (3.05 mg/g) while minimum chlorophyll a (1.36 mg/g), chlorophyll b (1.04 mg/g) and total chlorophyll (2.40 mg/g) was observed in T₁ i.e., 50% shade level.

Pooled results showed that at maximum chlorophyll a (2.29 mg/g), chlorophyll b (1.47 mg/g) and total chlorophyll (3.76 mg/g) was registered by T₂ i.e., 75% shade level which was followed by T₃ i.e., 90% shade level chlorophyll a (1.80 mg/g), chlorophyll b (1.20 mg/g) and total chlorophyll (3.00 mg/g) whereas, the treatment T₁ i.e., 50% shade level recorded minimum chlorophyll a (1.35 mg/g), chlorophyll b (1.02 mg/g) and total chlorophyll (2.37 mg/g).

Table 37: Effect of shade levels on Chlorophyll a and Chlorophyll b and Total chlorophyll in anthurium cv. Tropical Red

Treatments	Chlorophyll a (mg/g)			Chlorophyll b (mg/g)			Total chlorophyll (mg/g)		
	1 st year (2019)	2 nd year (2020)	Pooled	1 st year (2019)	2 nd year (2020)	Pooled	1 st year (2019)	2 nd year (2020)	Pooled
T ₁ - 50% shade level	1.34	1.36	1.35	1.01	1.04	1.02	2.35	2.40	2.37
T ₂ - 75% shade level	2.25	2.34	2.29	1.43	1.50	1.47	3.68	3.83	3.76
T ₃ - 90% shade level	1.77	1.83	1.80	1.18	1.22	1.20	2.94	3.05	3.00
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.02	0.04	0.03	0.02	0.03	0.02	0.03	0.06	0.04
CD at 5%	0.06	0.12	0.08	0.05	0.09	0.07	0.09	0.18	0.12

Increase in leaf chlorophyll content under shaded conditions with 25% filtered sunlight demonstrates the plant's ability to maximize the light harvesting capacity under light-deficit conditions and the efficient use of light captured in photosynthesis with decreased respiration costs for maintenance (Kura-Hotta *et al.* (1987); Lei *et al.*

(1996); Dai *et al.* (2009) in anthurium). Results are in line with the results of Rezai *et al.* (2018) in salvia.

4.3.2 Evaluation of shade levels for flowering parameters

4.3.2.1 Days taken for flower bud initiation:

The data with respect to days taken for flower bud initiation in anthurium as influenced by different shade levels is presented in Table 38. The data indicated that days taken for flower bud initiation (days) in anthurium was significantly influenced by different treatments.

The earliest (213.57 days) flower bud initiation was noticed in the treatment T₂ *i.e.*, 75% shade level and it was followed by the treatment T₃ *i.e.*, 90 % shade level (225.29 days), whereas, the treatment T₁ *i.e.*, 50 % shade level recorded maximum days taken for flower bud initiation (234.57 days) in anthurium.

Table 38: Effect of shade levels on flower bud initiation, unfurling of spathe and flower longevity of anthurium on plant cv. Tropical Red

Treatments	Days taken for flower bud initiation (days)	Days taken for unfurling of spathe (days)	Flower longevity (days)		
			1 st year (2019)	2 nd year (2020)	Pooled
T₁- 50% shade level	234.57	259.71	53.43	55.08	54.26
T₂- 75% shade level	213.57	243.14	63.71	65.59	64.65
T₃- 90% shade level	225.29	251.71	57.29	59.10	58.19
F Test	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	1.87	3.86	0.61	0.67	0.61
CD at 5%	5.63	11.58	1.85	2.03	1.87

The ability of various environmental factors such as temperature, light and photoperiod under varying shade levels or to alter the earliness of a plant can be tentatively interpreted as relating to the expression of endogenous promoters and inhibitors. The similarities of environmental factors which can alter earliness to those

which can actually induce flowering (temperature and photoperiod) strongly suggest that the same mechanisms are involved in the earliness and flower induction processes under shade as reported by Leopold and Kriedenmann (1975) and Mayoli *et al.*, (2009) with 80% shade level in *Ranunculus* cut flower.

4.3.2.2 Days taken for unfurling of spathe:

The data with respect to days taken for unfurling of spathe in anthurium as influenced by different shade levels is exhibited in Table 38. The data revealed that different shade levels influenced days taken for unfurling of spathe (days) in anthurium significantly.

In this experiment, the treatment T₂ *i.e.*, 75% shade level recorded significantly minimum days (243.14 days) for unfurling of spathe and it was found to be statistically at par with the treatment T₃ *i.e.*, 90% shade level (251.71 days), whereas, the treatment T₁ *i.e.*, 50% shade level recorded maximum days taken for unfurling of spathe (259.71 days).

This might be due to the micro climate *i.e.*, temperature, light and humidity created inside shade under 25% light intensity which favoured earliness in unfurling of the spathe.

4.3.2.3 Flower longevity (days):

The data was recorded to observe flower longevity which is given in Table 38. During the present investigation among the three shade levels evaluated for flower longevity on anthurium plant for two years difference was found significant.

During 2019, the present studies revealed that maximum flower longevity (63.71 days) was registered by T₂ *i.e.*, 75% shade level of anthurium which was followed by T₃ *i.e.*, 90% shade level (57.29 days), whereas, minimum flower longevity (53.43 days) was recorded under T₁ *i.e.*, 50% shade level.

In 2020, during the course of investigation maximum flower longevity on plant (65.59 days) was registered by treatment T₂ *i.e.*,

75% shade level which was followed by treatment T₃ *i.e.*, 90% shade level (59.10 days), whereas minimum days flower longevity on plant was recorded under treatment T₁ *i.e.*, 50% shade level (55.08 days)

Pooled results showed that maximum flower longevity on plant (64.65 days) was registered by treatment T₂ *i.e.*, 75% shade level of anthurium which was followed by treatment T₃ *i.e.*, 90% shade level (58.19 days) whereas minimum flower longevity on plant (54.26 days) was recorded in treatment T₁ *i.e.*, 50% shade level.

This might be due to favourable surrounding environment under 75% shade level that laid to better plant performance which was responsible for longer flower longevity on plant.

4.3.3 Evaluation of shade level for quality parameters of anthurium:

4.3.3.1 Length of flower stalk (cm):

The data with respect to length of flower stalk (cm) of anthurium as influenced by different shade levels is given in Table 39. The data indicated that length of flower stalk (cm) of anthurium was significantly influenced by different treatments of shade levels.

In 2019, maximum length of flower stalk was registered with the treatment T₂ *i.e.*, 75% shade level (27.11 cm) which was followed by treatment T₃ *i.e.*, 90% shade level (25.30 cm), whereas, the treatment T₁ *i.e.*, 50% shade level recorded minimum length of flower stalk (20.14 cm) in anthurium.

During 2020, maximum length of flower stalk was recorded in treatment T₂ *i.e.*, 75% shade level (28.92 cm) which was followed by treatment T₃ *i.e.*, 90% shade level (26.93 cm), whereas, the treatment T₁ *i.e.*, 50% shade level recorded minimum length of flower stalk (22.06 cm) in anthurium.

Table 39: Effect of shade levels on length of flower stalk and diameter of flower stalk of anthurium cv. Tropical Red

Treatments	Length of flower stalk (cm)			Diameter of flower stalk (mm)		
	1 st year (2019)	2 nd year (2020)	Pooled	1 st year (2019)	2 nd year (2020)	Pooled
T₁- 50% shade level	20.14	22.06	21.10	3.04	3.09	3.06
T₂- 75% shade level	27.11	28.92	28.02	4.25	4.20	4.22
T₃- 90% shade level	25.30	26.93	26.11	3.61	3.81	3.71
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.47	0.49	0.47	0.13	0.09	0.07
CD at 5%	1.43	1.51	1.44	0.41	0.26	0.22

Pooled results showed that maximum length of flower stalk was recorded in treatment T₂ *i.e.*, 75% shade level (28.02 cm) which was followed by treatment T₃ *i.e.*, 90% shade level (26.11 cm), however, the treatment T₁ *i.e.*, 50% shade level recorded minimum length of flower stalk (21.10 cm) in anthurium.

In low light condition inter nodal length improved due to higher far red:red ratio. (Downs *et al.* 1957). It means photosynthetic assimilation rates collects high percentage of photosynthesis in low light compared to the high light because light intensity affects the photosynthetic rate, (Salisbury and Ross, 1991) and Pasian and Lieth, (1994). Similar results were found by Mayoli *et al.* (2009) in Ranunculus and Armitage (1991) in Easter lily.

4.3.3.2 Diameter of flower stalk (mm):

The data with respect to effect of different shade levels on diameter of flower stalk (mm) in anthurium is presented in Table 39. The data indicated that diameter of flower stalk (mm) in anthurium was significantly influenced by different treatments of shade levels.

In 2019, the treatment T₂ *i.e.*, 75% shade level recorded significantly maximum diameter of flower stalk (4.25 mm) which was

followed by the treatments T_3 *i.e.*, 90% shade level (3.61 mm), whereas, minimum diameter of flower stalk (3.04 mm) was recorded with the treatment 50% shade level (T_1).

During 2020, the treatment T_2 *i.e.*, 75% shade level registered significantly maximum diameter of flower stalk (4.20 mm) which was followed by the treatments T_3 *i.e.*, 90% shade level (3.81 mm), while minimum diameter of flower stalk (3.09 mm) was recorded with the treatment 50% shade level (T_1).

Pooled data revealed that maximum diameter of flower stalk was recorded in T_2 *i.e.*, 75% shade level (4.22 mm) which was followed by the treatments T_3 *i.e.*, 90% shade level (3.71 mm), while, minimum diameter of flower stalk (3.06 mm) was recorded with the treatment 50% shade level (T_1).

This might be due to favourable environmental conditions *i.e.*, light, temperature and relative humidity during plant growth and development stages improved flowering quality (Dolatkhahi *et al.* 2013 in rose). Results are in line with those of Mayoli *et al.* (2009) in *Ranunculus*.

4.3.3.3 Length of spathe (cm):

The data recorded on length of spathe in anthurium as influenced by different shade levels is presented in Table 40. The data indicated that length of spathe in anthurium was significantly influenced by different treatments of various shade levels.

In 2019, treatment T_2 *i.e.*, 75% shade level recorded maximum length of spathe (7.10 cm) and it was found to be at par with treatment T_3 *i.e.*, 90% shade level (6.21 cm), whereas, treatment T_1 *i.e.*, 50% shade level recorded maximum length of spathe (5.09 cm) in anthurium.

In 2020, studies revealed that maximum length of spathe was recorded in treatment T_2 *i.e.*, 75% shade level (7.23 cm) which was followed by T_3 *i.e.*, 90% shade level (6.37 cm), while the treatment T_1

i.e., 50% shade level recorded minimum length of spathe (5.31 cm) in anthurium.

Pooled data showed that significantly maximum (7.16 cm) length of spathe was recorded in treatment T₂ *i.e.*, 75% shade level and it was followed by treatment T₃ *i.e.*, 90% shade level (6.29 cm), whereas, the treatment T₁ *i.e.*, 50% shade level recorded minimum length of spathe (5.20 cm) in anthurium.

Flower quality of anthurium is also affected by environmental factors such as light and temperature, Nirmala *et al.* (1999) and (Hatibarua *et al.* 2005 in orchids). Results were in agreement with the finding of Khawlhrring *et al.* (2019) in anthurium (75% shade level) and Agasimani *et al.* (2011) in anthurium (75% shade level).

4.3.3.4 Width of spathe (cm):

The data in respect of width of spathe (cm) in anthurium under Konkan climatic condition is given in Table 40.

During 2019, the significantly maximum width of spathe (6.07 cm) was recorded by treatment T₂ *i.e.*, 75% shade level and followed by treatment T₃ *i.e.*, 90% shade level (5.09 cm). Width of spathe was recorded minimum in treatment T₃ *i.e.*, 50% shade level (4.53 cm).

Table 40: Effect of shade levels on length and width of spathe of anthurium cv. Tropical Red

Treatments	Length of spathe (cm)			Width of spathe (cm)		
	1st year (2019)	2nd year (2020)	Pooled	1st year (2019)	2nd year (2020)	Pooled
T₁- 50% shade level	5.09	5.31	5.20	4.53	4.71	4.62
T₂- 75% shade level	7.10	7.23	7.16	6.07	6.24	6.16
T₃- 90% shade level	6.21	6.37	6.29	5.09	5.29	5.19
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.08	0.09	0.09	0.13	0.13	0.13
CD at 5%	0.26	0.28	0.26	0.41	0.40	0.40

In 2020 maximum width of spathe was recorded in treatment T₂ *i.e.*, 75% shade level (6.24 cm) which was followed by treatment T₃ *i.e.*, 90% shade level (5.29 cm), whereas, minimum width of spathe was recorded in treatment T₁ *i.e.*, 50% shade level (4.71 cm).

Pooled results showed that width of spathe was maximum in treatment T₂ *i.e.*, 75% shade level (6.16 cm) of anthurium which was followed by treatment T₃ *i.e.*, 90% shade level (5.19 cm), whereas minimum width of spathe was recorded in treatment T₁ *i.e.*, 50% shade level (4.62 cm).

Low rate of stomatal conduction causes decrease in soluble protein and soluble sugar. Besides, this increase the diameter of flower in low light level (Zhao *et al.* 2012). Results were in line with Khawlhiring *et al.* (2019)(75% shade level) and Agasimani *et al.* (2011) in anthurium (75% shade level).

4.3.3.5 Length of spadix (cm):

The data was recorded for spadix length (cm) which are given in Table 41. The data indicated that, length of spadix (cm) of anthurium was significantly influenced by different treatments of shade levels.

In 2019, maximum length of spadix (4.14 cm) was recorded in treatment T₂ *i.e.*, 75% shade level, which was at par with T₃ *i.e.*, 90% shade level (3.57 cm). The treatment T₁ *i.e.*, 50% shade level recorded minimum length of spadix (3.00 cm).

During 2020, maximum length of spadix (4.80 cm) was recorded in treatment T₂ *i.e.*, 75% shade level which was at par with T₃ *i.e.*, 90% shade level (3.99 cm), whereas, the treatment T₁ *i.e.*, 50% shade level recorded minimum spadix length (3.36 cm).

Pooled results show that maximum length of spadix (4.47 cm) was registered by treatment T₂ *i.e.*, 75% shade level which was followed by treatment T₃ *i.e.*, 90% shade level (3.78 cm), while, length of spadix was recorded minimum in treatment T₁ *i.e.*, 50% shade level (3.18 cm).

Table 41: Effect of shade levels on length of spadix and diameter of spadix of anthurium cv. Tropical Red

Treatments	Length of spadix (cm)			Diameter of spadix (mm)		
	1 st year (2019)	2 nd year (2020)	Pooled	1 st year (2019)	2 nd year (2020)	Pooled
T₁- 50% shade level	3.00	3.36	3.18	7.61	7.73	7.67
T₂- 75% shade level	4.14	4.80	4.47	8.81	8.87	8.84
T₃- 90% shade level	3.57	3.99	3.78	8.03	8.24	8.14
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.27	0.12	0.15	0.22	0.24	0.22
CD at 5%	0.83	0.38	0.46	0.68	0.74	0.67

This might be due to appropriate growing conditions like light and temperature during growth stage which might have enhanced flowering quality. Similar results were reported by Khawlhiring *et al.* (2019) in anthurium (75% shade level).

4.3.3.6 Diameter of spadix (mm):

The data recorded for diameter of spadix in anthurium as influenced by different shade levels is presented in Table 41. The data indicated that, diameter of spadix in anthurium was significantly influenced by different treatments of various shade levels.

During 2019, treatment T₂ *i.e.*, 75% shade level recorded maximum diameter of spadix (8.81 mm) and it was followed by treatment T₃ *i.e.*, 90% shade level (8.03 mm), whereas, treatment T₁ *i.e.*, 50% shade level recorded maximum diameter of spadix (7.61 mm) in anthurium.

In 2020, studies revealed that maximum diameter of spadix was recorded in treatment T₂ *i.e.*, 75% shade level (8.87 mm) which was at par with T₃ *i.e.*, 90% shade level (8.24 mm), while, the treatment T₁ *i.e.*, 50% shade level recorded minimum diameter of spadix (7.73 mm) in anthurium.

Pooled data showed that significantly the maximum diameter of spadix (8.84 mm) was recorded in treatment T₂ *i.e.*, 75% shade level and it was followed by treatment T₃ *i.e.*, 90% shade level (8.14 mm), whereas, the treatment T₁ *i.e.*, 50% shade level recorded maximum diameter of spadix (7.67 mm) in anthurium.

This might be due to optimum light received by plants for better growth and development of anthurium plants. Similar results were found by Khawlhiring *et al.* (2019) in anthurium (75% shade level).

4.3.3.7 Anthocyanin content (mg/g):

The data pertaining to anthocyanin content is presented in Table 42.

The anthocyanin content was found maximum (0.72 mg/g) in treatment T₃ *i.e.*, 90% shade level which was followed by treatment T₂ *i.e.*, 75% shade level (0.62 mg/g), whereas, minimum anthocyanin content was recorded in treatment T₁ *i.e.*, 50% shade level (0.48 mg/g) during 2019.

In 2020, treatment T₃ *i.e.*, 90% shade level (0.73 mg/g) recorded maximum anthocyanin content which was followed by treatment T₂ *i.e.*, 75% shade level (0.64 mg/g), while, minimum anthocyanin content was recorded in treatment T₁ *i.e.*, 50% shade level (0.50 mg/g).

Table 42: Effect of shade levels on anthocyanin content of anthurium plants (mg/g) cv. Tropical Red

Treatments	Anthocyanin content mg/g		
	1 st year (2019)	2 nd year (2020)	Pooled
T₁- 50% shade level	0.48	0.50	0.49
T₂- 75% shade level	0.62	0.64	0.63
T₃- 90% shade level	0.72	0.73	0.72
F Test	Sig.	Sig.	Sig.
SE(m) ±	0.01	0.01	0.01
CD at 5%	0.03	0.03	0.03

In the pooled results, maximum anthocyanin content (0.72 mg/g) was observed in treatment T₃ *i.e.*, 90% shade level which was followed by treatment T₂ *i.e.*, 75% shade level (0.63 mg/g). The minimum anthocyanin content (0.49 mg/g) of anthurium was reported in treatment T₁ *i.e.*, 50% shade level.

This might be due to shade level and reduction in intensity of light improved anthocyanin content. Similar results were found by Salvi *et al.* (1997) in anthurium (80% shade level).

4.3.4 Evaluation of shade level with respect to yield parameters

4.3.4.1 Number of flower spikes per plant:

The data with respect to number of flowers spikes per plant in anthurium under Konkan climatic conditions at 8, 10, 12, 14, 16, 18, 20, 22 and 24 months after planting is presented in Table 43 and illustrated in Fig. 32. The data indicated that number of flower spikes produced per plant in anthurium was found significant at 8, 10, 12, 14, 16, 18, 20 and 24 months after planting among various shade levels.

Significantly, maximum number of flower spikes per plant was produced in treatment T₂ *i.e.*, 75% shade level (1.71 flowers) which was statistically at par with treatment T₃ *i.e.*, 90% shade level (1.57 flowers), whereas, the treatment T₁ *i.e.*, 50% shade level recorded minimum number of flowers spikes per plant (1.29 flowers) at 8 months after planting.

At the stage of 10 months after planting, significantly maximum number of flowers per plant was counted with the treatment T₂ *i.e.*, 75% shade level (1.86 flowers) which was statistically at par with treatment T₃ *i.e.*, 90% shade level (1.71 flowers), whereas, minimum number of flower spikes per plant was recorded with the treatment T₁ *i.e.*, 50% shade level (1.43 flowers).

Similarly, at the stage of 12 months after planting, significantly maximum number of flower spikes per plant was noticed in the

treatment T₂ *i.e.*, 75% shade level (2.57 flowers) which was statistically at par with treatment T₃ *i.e.*, 90% shade level (2.14 flowers) and significantly minimum number of flowers per plant in anthurium plant was recorded with the treatment T₁ *i.e.*, 50% shade level (1.71 flowers).

The number of flower spikes produced per plant at the stage of 14 months was found to be significantly superior (3.29 flowers) in treatment T₂ *i.e.*, 75% shade level which was at par with treatment T₃ *i.e.*, 90% shade level (2.71 flowers), whereas, minimum number of flowers per plant was recorded in treatment T₁ *i.e.*, 50% shade level (1.86 flowers).

Table 43: Effect of shade levels on number of flowers spikes per plant at bimonthly intervals in anthurium cv. Tropical Red

Treatments	Number of flowers spikes per plant									Mean
	8 MAP	10 MAP	12 MAP	14 MAP	16 MAP	18 MAP	20 MAP	22 MAP	24 MAP	
T₁- 50% shade level	1.29	1.43	1.71	1.86	2.14	2.57	2.86	3.43	3.57	2.31
T₂- 75% shade level	1.71	1.86	2.57	3.29	3.86	4.43	4.71	5.29	5.71	3.71
T₃- 90% shade level	1.57	1.71	2.14	2.71	3.14	3.57	3.86	4.43	4.86	3.11
F Test	NS	NS	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	
SE(m) ±	0.20	0.15	0.18	0.22	0.24	0.23	0.22	0.27	0.23	
CD at 5%	0.61	0.47	0.56	0.68	0.74	0.71	0.66	0.82	0.70	

Significantly highest number of flower spikes per plant (3.86 flowers) at 16 month stage was counted with the treatment T₂ *i.e.*, 75% shade level which was statistically at par with treatment T₃ *i.e.*, 90% shade level (3.14 flowers), whereas, treatment T₁ *i.e.*, 50% shade level recorded minimum number of flower spikes per plant (2.14 flowers) at 16 months after planting.

At 18 months after planting, significantly maximum number of flowers per plant was recorded with the treatment T₂ *i.e.*, 75% shade level (4.43 flowers) which was followed by treatment T₃ *i.e.*, 90% shade

level (3.57 flowers), whereas, minimum number of flower spikes per plant was recorded in the treatment T₁ *i.e.*, 50% shade level (2.57 flowers).

Similarly, the treatment T₂ *i.e.*, 75% shade level exhibited significantly maximum number of flower spikes per plant (4.71 flowers) which was followed by T₃ *i.e.*, 90% shade level (3.86 flowers) and minimum number of flower spikes per plant was recorded by the treatment T₁ *i.e.*, 50% shade level (2.86 flowers) at 20 months after planting.

At 22 months after planting, treatment T₂ *i.e.*, 75% shade level recorded maximum number of flowers per plant (5.29 flowers) which was followed by the treatment T₃ *i.e.*, 90% shade level (4.43 flowers), whereas, minimum number of flowers per plant was recorded in treatment T₁ *i.e.*, 50% shade level (3.43 flowers).

At 24 months after planting, treatment T₂ *i.e.*, 75% shade level recorded significantly maximum number of flower spikes per plant in anthurium (5.71 flowers) and it was followed by treatment T₃ *i.e.*, 90% shade level (4.86 flowers), whereas, treatment T₁ *i.e.*, 50% shade level recorded minimum number of flower spikes per plant (3.57 flowers).

Present findings clearly showed that pre- flower bearing period of tissue cultured plants are 8 months. Initial flower spikes were smallest in size up to 12 months period. As the stage of growth advanced the normal size flower spikes were produced from 14 months period onwards. This might be due to micro climate created under shade which enhanced plant growth, flowering quality and yield and also due to shade tolerant nature of plants. Results are in line with those of Khawlhiring *et al.* (2019) (75% shade level), Nakasone and Kamemoto^a (1962)^a and Muraleedharan and Karuppaiah, 2015 in anthurium.

4.3.4.2 Economics:

The data with respect to gross returns (Rs) from anthurium plants grown under different shade levels is presented in Table 44 and Fig. 33.

The gross returns were significantly maximum from the treatment T₂ *i.e.*, 75% shade level (Rs. 275375.00) which was followed by treatment T₃ *i.e.*, 90% shade level (Rs. 246750.00). The gross returns were found to be significantly minimum from the treatment T₁ *i.e.*, 50% shade level (Rs. 206125.00).

4.3.4.3 Net returns

The data in respect of net returns in anthurium (Rs) of plants grown under different shade levels is presented in Table 44 and Fig. 33.

The treatment T₂ *i.e.*, 75% shade level recorded maximum net returns (Rs. 217934.00) which followed by treatment T₃ *i.e.*, 90% shade level (Rs. 187709.00), whereas, the net returns were found to be significantly minimum with the treatment T₁ *i.e.*, 50% shade level (Rs. 151484.00).

Table 44: Economics of anthurium cultivation under different shade level (100m²)

Treatments	Total expendit ure (Rs)	Income (Rs)			Mother plant (Rs)	Gross return (Rs)	Net return (Rs)	B:C ratio
		Suckers (Rs)	Flowers (Rs)					
			A grade	B grade				
T ₁ - 50% shade level	54641	82875	14375	3875	105000	206125	151484	3.77
T ₂ - 75% shade level	57441	141375	23875	5125	105000	275375	217934	4.79
T ₃ - 90% shade level	59041	117000	19750	5000	105000	246750	187709	4.18
F Test		Sig.	Sig.	Sig.		Sig.	Sig.	
SE (m) ±		357.22	686.55	334.63		6809.74	6809.74	0.11
CD at 5%		1072.70	2115.48	1003.89		20431.22	20431.22	0.34

Market rate: A grade flower: Rs. 10
Suckers- Rs. 65

B grade flower: Rs. 5
Pot plant – Rs. 200

4.3.4.4: Benefit: Cost

The data with respect to cost: benefit ratio as influenced by different shade levels in anthurium is presented in Table 44 and depicted through Fig. 33.

The maximum benefit: cost ratio was recorded in the treatment T₂ *i.e.*, 75% shade level (4.79) which was followed by treatment T₃ *i.e.*, 90% shade level (4.18), whereas, minimum benefit: cost ratio was recorded with the treatment T₁ *i.e.*, 50% shade level (3.77).

Higher benefit: cost ratio was recorded due to good quality plants and maximum number of sucker produced per plant (Salvi, 1997).

4.4 To study the vase life of anthurium cut flowers by using of various chemicals

The various holding solutions of anthurium *viz.*, - T₁- Tapwater, T₂- Tapwater + Bavistin 0.2%, T₃- Distilled water, T₄- 8 HQC 200 ppm, T₅- 8 HQC 400 ppm, T₆- BA 25 ppm, T₇- BA 50 ppm, T₈- Triadimefon 30 ppm, T₉- AgNO₃ 10 ppm, T₁₀- AgNO₃ 20 ppm were evaluated at laboratory, College of Horticulture, Dapoli to increase vase life of anthurium.

4.4.1 Effect of different holding solutions on vase life of anthurium

4.4.1.1 Final weight of inflorescence:

The data recorded to observe final weight of inflorescences given in Table 45. During the present investigation among the 10 holding solutions evaluated with respect to final weight of inflorescence there was significant difference in weight of spikes of anthurium.

During 2019, the maximum final weight of inflorescence (6.07 g) was recorded in the treatment T₇ *i.e.*, BA 50 ppm which was followed by treatment T₈ *i.e.*, Triadimefon 30 ppm (5.72 g) and treatment T₅ *i.e.*, 8 HQC 400 ppm (5.22 g), whereas, minimum final weight of inflorescence (2.10 -g) was recorded in T₃ *i.e.*, distilled water.

In 2020, maximum final weight of inflorescence (6.52 g) was recorded by treatment T₇ *i.e.*, BA 50 ppm which was followed by T₈ *i.e.*, Triadimefon 30 ppm (5.85 g) and treatment T₅ *i.e.*, 8 HQC 400 ppm (5.72 g) in anthurium, whereas minimum final weight of inflorescence was recorded in treatment T₃ *i.e.*, distilled water (2.66 g).

Table 45: Effect of holding solutions on initial and final weight of inflorescence of anthurium cv. Tropical Red

Treatments No.	Initial weight of inflorescence (g)			Final weight of inflorescence (g)		
	1 st year (2019)	2 nd year (2020)	Pooled	1 st year (2019)	2 nd year (2020)	Pooled
T₁	7.04	7.29	7.17	3.14	3.61	3.37
T₂	7.91	8.31	8.11	4.88	5.18	5.03
T₃	6.83	7.11	6.97	2.10	2.66	2.38
T₄	7.54	7.84	7.69	4.03	4.37	4.20
T₅	8.18	8.74	8.46	5.22	5.72	5.47
T₆	7.22	7.42	7.32	4.53	4.84	4.69
T₇	9.21	9.57	9.39	6.07	6.52	6.29
T₈	8.80	9.02	8.91	5.72	5.85	5.79
T₉	6.51	7.03	6.77	3.73	4.05	3.89
T₁₀	6.25	6.89	6.57	3.41	3.77	3.59
F test				Sig.	Sig.	Sig.
SE(m) ±				0.04	0.10	0.06
CD at 1%				0.18	0.40	0.26

T₁- Tapwater

T₆- BA 25 ppm

T₂- Tapwater + Bavistin 0.2%

T₇- BA 50 ppm

T₃- Distilled water

T₈- Triadimefon 30 ppm

T₄- 8 HQC 200 ppm

T₉- AgNo₃ 10 ppm

T₅- 8 HQC 400 ppm

T₁₀- AgNo₃ 20 ppm

Pooled analysis showed that maximum final weight of inflorescence (6.29 g) was recorded by the treatment T₇ *i.e.*, BA 50 ppm which was followed by T₈ *i.e.*, Triadimefon 30 ppm (5.79 g) and treatment T₅ *i.e.*, 8 HQC 400 ppm (5.47 g) in anthurium, whereas, minimum final weight of inflorescence (2.38 g) was recorded in treatment T₃ *i.e.*, distilled water.

This might be due to decrease of microbial load with increase of water uptake and cumulative water which retained fresh weight. Similar results were found by Patil and Reddy (1997) in golden rod, Singh *et al.* (2008) in gladiolus and Singh *et al.* (2003) in carnation and Danaee *et al.* (2011) in gerbera.

4.4.1.2 Physiological loss in weight (g):

The data with respect to physiological loss in weight (g) in anthurium as influenced by various holding solutions is presented in Table 46. The data indicated that, physiological loss in weight anthurium spikes was significantly influenced by different holding solutions.

Table 46: Effect of holding solutions on physiological loss in weight of anthurium cv. Tropical Red

Treatments No.	Physiological loss in weight (%)		
	1 st year (2019)	2 nd year (2020)	Pooled
T₁	55.46	50.47	51.96
T₂	38.27	37.66	37.47
T₃	69.21	62.57	65.64
T₄	46.54	44.22	46.57
T₅	37.17	34.70	35.30
T₆	34.10	31.89	32.20
T₇	36.19	34.54	36.58
T₈	34.91	35.13	35.10
T₉	42.75	42.29	44.54
T₁₀	45.41	45.21	47.44
F test	Sig.	Sig.	Sig.
SE(m) ±	0.83	1.44	1.31
CD at 1%	3.35	5.84	5.27

T₁- Tapwater

T₂- Tapwater + Bavistin 0.2%

T₃- Distilled water

T₄- 8 HQC 200 ppm

T₅- 8 HQC 400 ppm

T₆- BA 25 ppm

T₇- BA 50 ppm

T₈- Triadimefon 30 ppm

T₉- AgNo₃ 10 ppm

T₁₀- AgNo₃ 20 ppm

In 2019, minimum physiological loss in weight (%) was registered by treatment T₆ *i.e.*, BA 25 ppm (34.10 %) which was at par with treatment T₇ *i.e.*, BA 50 ppm (36.19 %) and T₅- 8 HQC 400 ppm (37.17 %), whereas, the treatment T₃ *i.e.*, distilled water (69.21 %) recorded maximum physiological loss in weight.

In 2020, during the course of investigation minimum physiological loss in weight (31.89 %) was recorded by treatment T₆ *i.e.*, BA 25 ppm which was at par with treatment T₇ *i.e.*, BA 50 ppm (34.54 %), T₅ *i.e.*, 8 HQC 400 ppm (34.70 %) and T₈ *i.e.*, Triadimefon 30 ppm (35.13 %), while maximum physiological loss in weight (62.57 %) was observed in T₃ *i.e.*, distilled water.

Pooled results showed that minimum physiological loss in weight (32.20 %) was recorded by treatment T₆ *i.e.*, BA 25 ppm which was found to be at par with treatment T₈ *i.e.*, Triadimefon 30 ppm (35.10 %), T₅ *i.e.*, 8 HQC 400 ppm (35.30 %), T₇ *i.e.*, BA 50 ppm (36.58 %) and T₂ *i.e.*, Tapwater + Bavistin 0.2% (37.47 %), whereas, the treatment T₃ *i.e.*, distilled water recorded maximum physiological loss in weight (65.64%).

This might be due to the fact that BA slowed down the process of plugging of stem vascular tissue which decreases the absorption of water and cause physiological loss in weight (Salvi *et al.* 1997). Results are in line with the findings of Paull and Goo (1985) and Mawlong *et al.* (2020) in anthurium.

4.4.1.3 Final volume of holding solution (ml):

The data recorded for final volume of holding solution of anthurium as influenced by different holding solutions is presented in Table 47 and depicted in Fig. 34. The data indicated that final volume of holding solution of anthurium was significantly influenced by different treatments of holding solutions.

During 2019, treatment T₆ *i.e.*, BA 25 ppm recorded minimum final volume of holding solution (78.22 ml) and it was statistically at

par with T₇ *i.e.*, BA 50 ppm (83.67 ml), whereas, treatment T₃ *i.e.*, distilled water recorded maximum final volume of holding solution (92.89 ml) of anthurium.

In 2020, studies revealed that minimum final volume of holding solution was recorded in treatment T₆ *i.e.*, BA 25 ppm (80.89 ml) which was at par with T₇ *i.e.*, BA 50 ppm (81.44 ml) and T₈ *i.e.*, Triadimefon 30 ppm (83.56 ml), whereas, the treatment T₃ *i.e.*, distilled water recorded maximum final volume of holding solution (91.00 ml) of anthurium.

Pooled results showed that the minimum final volume of holding solution (79.56 ml) was recorded in treatment T₆ *i.e.*, BA 25 ppm and it was followed by treatment T₇ *i.e.*, BA 50 ppm (82.56 ml) and T₈ *i.e.*, Triadimefon 30 ppm (82.11 ml), whereas, the treatment T₃ *i.e.*, distilled water recorded maximum final volume of holding solution (91.95 ml) of anthurium.

This might be due to increase in water uptake by flower stems to retain fresh weight of flowers. The balance between the rate of water uptake and the rate of transpiration is directly related to anthurium flower turgidity and flower keeping quality (Sankat and Mujaffar 1994). Similar results were found by Salvi *et al.* (1997)^a and Sahare and Singh, (2015) in anthurium.

4.4.1.4 Uptake of vase solution (%):

The data with respect of uptake of vase solution (%) of anthurium influenced by different holding solutions is given in Table 47 and depicted in Fig. 35.

During 2019, significantly maximum uptake of vase solution (21.78 %) was recorded in treatment T₆ *i.e.*, BA 25 ppm which was found to be at par with treatment T₈ *i.e.*, Triadimefon 30 ppm (19.33%), whereas, uptake of vase solution was recorded minimum in treatment T₃ *i.e.*, distilled water (7.11 %).

In 2020, maximum uptake of vase solution was recorded in treatment T₆ *i.e.*, BA 25 ppm (19.11 %) which was statistically at par with T₇ *i.e.*, BA 50 ppm (18.56 %), T₈ *i.e.*, Triadimefon 30 ppm (16.44%) and T₂ *i.e.*, Tapwater + Bavistin 0.2% (15.78 %), whereas, minimum uptake of vase solution was recorded in treatment T₃ *i.e.*, distilled water (9.00 %).

Table 47: Final volume of holding solution and uptake of holding solutions during vase life studies in anthurium cv. Tropical Red

Treatment No.	Initial volume of holding solution (ml)	Final volume of holding solution (ml)			Uptake of vase solution (%)		
		1 st year (2019)	2 nd year (2020)	Pooled	1 st year (2019)	2 nd year (2020)	Pooled
T₁	100	87.44	89.33	88.39	12.56	10.67	11.61
T₂	100	85.89	84.22	85.05	14.11	15.78	14.95
T₃	100	92.89	91.00	91.95	7.11	9.00	8.06
T₄	100	86.78	85.33	86.06	13.22	14.67	13.94
T₅	100	87.33	89.00	88.17	12.67	11.00	11.84
T₆	100	78.22	80.89	79.56	21.78	19.11	20.45
T₇	100	83.67	81.44	82.56	16.33	18.56	17.45
T₈	100	80.67	83.56	82.11	19.33	16.44	17.89
T₉	100	88.55	90.33	89.44	11.45	9.67	10.56
T₁₀	100	89.78	91.67	90.72	10.22	8.33	9.28
F test		Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±		1.17	0.91	0.82	1.17	0.91	0.82
CD at 1%		4.70	3.66	3.28	4.70	3.66	3.30

T₁- Tapwater

T₂- Tapwater + Bavistin 0.2%

T₃- Distilled water

T₄- 8 HQC 200 ppm

T₅- 8 HQC 400 ppm

T₆- BA 25 ppm

T₇- BA 50 ppm

T₈- Triadimefon 30 ppm

T₉- AgNO₃ 10 ppm

T₁₀- AGNO₃ 20 ppm

Pooled results showed that uptake of vase solution was maximum in treatment T₆ *i.e.*, BA 25 ppm (20.45 %) in anthurium which was at par with T₈ *i.e.*, Triadimefon 30 ppm (17.89 %) and T₇ *i.e.*, BA 50 ppm (17.45 %), whereas, minimum uptake of vase solution was recorded in treatment T₃ *i.e.*, distilled water (8.06 %).

This might be due to the effect of benzyladenine which by reducing ethylene production could help for increasing water absorption and preventing blockage of cells, thereby increasing the vase life of flowers. The present findings are in line with the earlier reports of Paull and Goo (1985), Salvi *et al.* (1997)^a in anthurium, Kumar *et al.* (2008) in heliconia, and Singh *et al.* (2008) in gladiolus.

4.4.1.5 Days to spadix necrosis initiation:

The data recorded to observe days to spadix necrosis initiation is given in Table 48 and Fig. 36. During the present investigation among the ten holding solutions evaluated with respect to days to spadix necrosis initiation for two years different holding solution were found to have significant effect on spadix necrosis.

Table 48: Effect of holding solutions on days to spadix necrosis initiation and days to spathe blueing initiation in anthurium cut flower cv. Tropical Red

Treatments No.	Days to spadix necrosis initiation			Days to spathe blueing initiation		
	1 st year (2019)	2 nd year (2020)	Pooled	1 st year (2019)	2 nd year (2020)	Pooled
T₁	07.70	07.76	07.73	09.67	09.89	09.78
T₂	10.30	10.11	10.21	12.34	12.51	12.42
T₃	07.54	07.88	07.71	09.35	09.54	09.44
T₄	08.54	08.79	08.66	10.66	10.76	10.71
T₅	09.28	09.62	09.45	11.24	11.29	11.27
T₆	15.18	15.51	15.35	17.51	17.93	17.72
T₇	11.34	11.90	11.62	13.35	13.44	13.40
T₈	13.33	13.86	13.60	15.28	15.66	15.47
T₉	08.08	08.70	08.39	10.07	10.41	10.24
T₁₀	07.94	08.23	08.09	09.94	10.08	10.01
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.11	0.24	0.13	0.15	0.19	0.16
CD at 1%	0.44	0.97	0.54	0.60	0.78	0.66

T₁- Tapwater

T₂- Tapwater + Bavistin 0.2%

T₃- Distilled water

T₄- 8 HQC 200 ppm

T₅- 8 HQC 400 ppm

T₆- BA 25 ppm

T₇- BA 50 ppm

T₈- Triadimefon 30 ppm

T₉- AgNo₃ 10 ppm

T₁₀-AgNo₃ 20 ppm

The present studies revealed that in 2019, maximum days to spadix necrosis initiation (15.18 days) were registered in treatment T₆ *i.e.*, BA 25 ppm which was followed by treatment T₈ *i.e.*, Triadimefon 30 ppm (13.33 days) and T₇ *i.e.*, BA 50 ppm (11.34 days), whereas, minimum days to spadix necrosis initiation (07.54 days) were recorded in T₃ *i.e.*, distilled water.

In 2020, during the course of investigation maximum days to spadix necrosis initiation (15.51 days) was registered by treatment T₆ *i.e.*, BA 25 ppm in anthurium which was followed by treatment treatment T₈ *i.e.*, Triadimefon 30 ppm (13.86 days) and T₇ *i.e.*, BA 50 ppm (11.90 days), whereas, minimum days to spadix necrosis initiation were recorded in treatment T₁ *i.e.*, Tapwater (07.76 days).

Pooled results showed that maximum days to spadix necrosis initiation (15.35 days) were registered by treatment T₆ *i.e.*, BA 25 ppm which was followed by treatment T₈ *i.e.*, Triadimefon 30 ppm (13.60 days) and T₇ *i.e.*, BA 50 ppm (11.62 days), whereas, minimum days to spadix necrosis initiation were recorded in treatment T₃ *i.e.*, distilled water (07.71 days).

This might be due to benzyl adenine which reduces the rate of respiration and is a natural anti-senescence agent which helps to maintain flower quality. Results are in agreement with earlier reports of Mawlong *et al.* (2020) and Salvi *et al.* (1997)^a in anthurium.

4.4.1.6 Days to spathe blueing initiation:

The data recorded on days to spathe blueing initiation in anthurium as influenced by different holding solutions is presented in Table 48 and illustrated in Fig. 37. The data indicated that days to spathe blueing initiation of anthurium were significantly influenced by different treatments of holding solutions.

During 2019, treatment T₆ *i.e.*, BA 25 ppm recorded maximum days to spathe blueing initiation (17.51 days) and it was followed by treatment T₈ *i.e.*, Triadimefon 30 ppm (15.28 days) and T₇ *i.e.*, BA 50

ppm (13.35 days), whereas, treatment T₃ *i.e.*, distilled water (09.35 days) recorded minimum days to spathe blueing initiation in anthurium.

In 2020, studies revealed that maximum days to spathe blueing initiation were recorded in treatment T₆ *i.e.*, BA 25 ppm (17.93 days) which was followed by T₈ *i.e.*, Triadimefon 30 ppm (15.66 days) and T₇ *i.e.*, BA 50 ppm (13.44 days), whereas, treatment T₃ *i.e.*, distilled water (09.54 days) recorded minimum days to spathe blueing initiation in anthurium.

Pooled results showed that maximum days to spathe blueing initiation (17.72 days) were recorded in treatment T₆ *i.e.*, BA 25 ppm and it was followed by treatment T₈ *i.e.*, Triadimefon 30 ppm (15.47 days) and T₇ *i.e.*, BA 50 ppm (13.40 days), whereas, treatment T₃ *i.e.*, distilled water (09.44 days) recorded minimum days to spathe blueing initiation in anthurium.

This might be due to benzyladenine which is a synthetic cytokinin which has anti-ethylene property which delays senescence and reduces aging of flowers and retains colour. Similar results were recorded by Davis (1998); Dudareva *et al.* (1998), Asil and Karim (2010) in *Eustoma* and Salvi *et al.* (1997)^a in anthurium.

4.4.1.7 Days to gloss loss (days):

The data recorded for days to gloss loss in anthurium as influenced by different holding solutions is presented in Table 49 and interpreted through Fig. 38. The data indicated that days to gloss loss in anthurium were significantly influenced by different treatments of holding solutions.

During 2019, treatment T₆ *i.e.*, BA 25 ppm recorded maximum days to gloss loss (15.78 days) which was followed by treatment T₈ *i.e.*, Triadimefon 30 ppm (13.67 days) and T₇ *i.e.*, BA 50 ppm (11.22 days), however, treatment T₃ *i.e.*, distilled water (7.74 days) recorded minimum days to gloss loss in anthurium.

During 2020, studies revealed that maximum days to gloss loss was recorded in treatment T₆ *i.e.*, BA 25 ppm (16.39 days) which was followed by T₈ *i.e.*, Triadimefon 30 ppm (14.49 days) and T₇ *i.e.*, BA 50 ppm (11.79 days), whereas, treatment T₃ *i.e.*, distilled water (8.40 days) recorded minimum days to gloss loss in anthurium.

Pooled results showed that significantly the maximum days to gloss loss (16.08 days) were recorded in treatment T₆ *i.e.*, BA 25 ppm and it was followed by treatment T₈ *i.e.*, Triadimefon 30 ppm (14.08 days) and T₇ *i.e.*, BA 50 ppm (11.51 days), whereas, treatment T₃ *i.e.*, distilled water (8.07 days) recorded minimum days to gloss loss in anthurium.

Table 49: Effect of holding solutions on days to gloss loss and vase life of inflorescence of anthurium cv. Tropical Red

Treatments No.	Days to gloss loss (days)			Vase life of inflorescence (days)		
	1 st year (2019)	2 nd year (2020)	Pooled	1 st year (2019)	2 nd year (2020)	Pooled
T₁	8.30	8.74	8.52	14.85	15.59	15.22
T₂	10.44	10.89	10.67	16.10	16.62	16.36
T₃	7.74	8.40	8.07	13.40	13.87	13.64
T₄	8.67	9.41	9.04	15.03	15.76	15.39
T₅	9.89	10.47	10.18	15.62	15.89	15.75
T₆	15.78	16.39	16.08	20.52	21.39	20.96
T₇	11.22	11.79	11.51	16.30	16.89	16.59
T₈	13.67	14.49	14.08	17.18	17.85	17.52
T₉	9.56	9.94	9.75	14.07	14.74	14.41
T₁₀	8.52	8.93	8.72	14.52	15.22	14.87
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.42	0.37	0.39	0.20	0.29	0.21
CD at 1%	1.70	1.50	1.58	0.80	1.18	0.86

T₁- Tapwater

T₂- Tapwater + Bavistin 0.2%

T₃- Distilled water

T₄- 8 HQC 200ppm

T₅- 8 HQC 400ppm

T₆- BA 25 ppm

T₇- BA 50 ppm

T₈- Triadimefon 30 ppm

T₉- AgNO₃ 10 ppm

T₁₀- AgNO₃ 20 ppm

This might be due to BA which inhibits anthocyanin pigment discoloration in flowers by retention in the petals which helps to retain flower colour and delay senescence (Asil and Karim, 2010 in *Eustoma* flowers). Results are in line with those of Matak and Hashemabadi (2016) in *Alstomeria*.

4.4.1.8 Vase life of inflorescence (days):

The data in respect of vase life of inflorescence (days) of anthurium influenced by different holding solutions is given in Table 49 and depicted in Fig. 39.

During 2019 significantly maximum vase life of inflorescence (20.52 days) was recorded in treatment T₆ *i.e.*, BA 25 ppm which was followed by treatment T₈ *i.e.*, Triadimefon 30 ppm (17.18 days) and T₇ *i.e.*, BA 50 ppm (16.30 days), whereas, treatment T₃ *i.e.*, distilled water (13.40 days) recorded minimum vase life of inflorescence in anthurium.

In 2020, maximum vase life of inflorescence was recorded in treatment T₆ *i.e.*, BA 25 ppm (21.39 days) which was followed by T₈ *i.e.*, Triadimefon 30 ppm (17.85 days) and T₇ *i.e.*, BA 50 ppm (16.89 days), whereas, minimum vase life of inflorescence was recorded in treatment T₃ *i.e.*, distilled water (13.87 days).

Pooled results showed that vase life of inflorescence was recorded maximum in treatment T₆ *i.e.*, BA 25 ppm (20.96 days) of anthurium which was followed by treatment T₈ *i.e.*, Triadimefon 30 ppm (17.52 days) and T₇ *i.e.*, BA 50 ppm (16.59 days), whereas, minimum vase life of inflorescence was recorded in treatment T₃ *i.e.*, distilled water (13.64 days).

This might be due to the application of benzyl adenine which must have helped to extend the vase life of flowers by reducing the abscission process. The enhancement of vase life by exogenous application of cytokinins might have resulted into decrease in the rate of respiration that led to delayed flower senescence. Benzyl adenine

also led to improved cell membrane permeability, delayed lipid peroxidation and decrease in leakage of ions resulting in increased vase life of cut flowers (Emami *et al.* 2011 in anthurium). Results are in line with those of Asil and Karim (2010) in *Eustoma* flowers, Mawlong *et al.* (2020) and Salvi *et al.* (1997)^a in anthurium.

CHAPTER V

SUMMARY AND CONCLUSION

Anthurium is one of the top ten flowers in the global flower trade and most commercialized cut flower in the world which is grown throughout the year and it commands good price not only for cut flower but also as a pot plant. Research was undertaken on different aspects of anthurium cultivation like evaluation of varieties under Konkan agroclimatic conditions, media, shade levels and vase life studies systematically for two successive years. On this background a project entitled “(Optimization of shade level, media and vase life for cut flower production in Anthurium (*Anthurium andreanum* Linn)” was undertaken during the year 2019-20 to 2020-21 at Hi-Tech Unit, College of Horticulture, Dapoli with four sets of experiments.

- 5.1 To study the varietal performance of different anthurium varieties under Konkan conditions.
- 5.2 To optimize growing media for anthurium cultivation
- 5.3 To optimize shade level for anthurium cultivation
- 5.4 To study the vase life of anthurium cut flowers by using various chemicals

5.1 To study the varietal performance of different anthurium varieties

The different varieties of anthurium *viz.* Baby White, Baby Purple, Prince Orange, Princess Amellia, Fancy Red, Queen Black were evaluated for two years. The survival percentage was found maximum in variety V₅ *i.e.*, Fancy Red (96%) and minimum in variety V₆ *i.e.*, Queen Black (87 %).

The plant height was found significant at 4, 8, 12 and 16 months after planting. The maximum plant height was registered by variety V₅ *i.e.*, Fancy Red (13.95, 35.54, 39.80 and 40.96 cm) at 4, 8, 12 and 16 months after planting, respectively.

Significantly maximum number of leaves (11.85) was recorded in variety V₁ *i.e.*, Baby White which was at par with V₂ *i.e.*, Baby Purple (11.50) at 16 months after planting. The average leaf area (105.17 cm²) was maximum in V₅ *i.e.*, Fancy Red which was at par with treatment V₄ *i.e.*, princess Amellia (102.93 cm²).

The maximum length of leaf petiole at 16 month after planting was recorded in V₅ *i.e.*, Fancy Red (21.72 cm) which was at par with treatment V₁ *i.e.*, Baby White (20.78 cm) and followed by V₂ *i.e.*, Baby Purple (20.25 cm). Minimum length of leaf petiole was recorded in V₆ *i.e.*, Queen Black (18.85 cm).

The number of suckers per plant were maximum (4.40) in V₅ *i.e.*, Fancy Red at 16 month stage which was at par with V₁ *i.e.*, Baby White (4.20). Treatment V₆ *i.e.*, Queen Black (2.90) recorded lowest number of suckers per plant.

The early flower bud initiation was registered in treatment V₅ *i.e.*, Fancy Red (206.20 days) which was followed by V₁ *i.e.*, Baby White (210.45 days) and V₂ *i.e.*, Baby Purple (213.80 days). The maximum days taken for flower bud initiation was recorded in V₆ *i.e.*, Queen Black (224.20 days).

The minimum days taken for unfurling of spathe were recorded in treatment V₅ *i.e.*, Fancy Red (234.85 days) which was followed by V₁ *i.e.*, Baby White (239.20 days) and V₂ *i.e.*, Baby Purple (243.15 days). The maximum days taken for unfolding of spathe were recorded in V₆ *i.e.*, Queen Black (252.10 days).

The flower longevity of the plant was recorded maximum in treatment V₅ *i.e.*, Fancy Red (62.79 days) which was at par with V₁ *i.e.*, Baby White (61.97 days) and was followed by V₂ *i.e.*, Baby Purple (59.15 days). The minimum flower longevity on the plant was recorded in V₆ *i.e.*, Queen Black (54.85 days).

The highest flower stalk length was recorded in treatment V₅ *i.e.*, Fancy Red (28.65 cm) and lowest flower stalk length was recorded in V₆ *i.e.*, Queen Black (19.03 cm).

The longest spadix length was registered by V₅ *i.e.*, Fancy Red (4.38 cm) which was at par with V₁ *i.e.*, Baby White (4.26 cm). The shortest spadix length was found in V₆ *i.e.*, Queen Black (3.57 cm).

The variety V₅ *i.e.*, Fancy Red registered maximum length of spathe (6.07 cm) and the minimum length of spathe was recorded in V₆ *i.e.*, Queen Black (4.21 cm).

The variety V₅ *i.e.*, Fancy Red recorded maximum breadth of spathe (5.00 cm) which was at par V₁ *i.e.*, Baby White (4.89 cm). The minimum length of spathe was observed in V₆ *i.e.*, Queen Black (4.03 cm).

The maximum vase life of flower on plant was recorded in variety V₅ *i.e.*, Fancy Red (14.28 days) which was at par with V₁ *i.e.*, Baby White (14.21 days) and followed by V₂ *i.e.*, Baby Purple (13.80 days). The minimum vase life of flower was recorded in V₆ *i.e.*, Queen Black (11.96 days).

The angle of spadix to spathe was recorded maximum in treatment V₅ *i.e.*, Fancy Red (38.51°) which was followed by V₄ *i.e.*, Princess Amellia (35.80°) and V₃ *i.e.*, Prince Orange (35.62°). The minimum angle of spadix to spathe was recorded in V₂ *i.e.*, Baby Purple (28.86°).

The more number of flowers was produced in V₁ *i.e.*, Baby White (5.30 flowers) and least number of flowers per plant was observed in V₄ *i.e.*, Princess Amellia (3.30 flowers) at 16 months after planting stage.

The variety V₅ *i.e.*, Fancy Red recorded higher gross returns (Rs. 276456), maximum net returns (Rs. 193690) and highest B:C ratio (3.34) and lowest gross returns (Rs. 215618), minimum net returns (Rs. 132852) and B:C ratio was observed in V₆ *i.e.*, Queen Black (2.60).

5.2 To optimize growing media for anthurium cultivation

The maximum survival was registered in treatment T₂ *i.e.*, Sand+ FYM+ coconut husk + brick pieces + charcoal (1:1:1:1:1) (95.33%) which was at par with T₅ *i.e.*, Brick pieces + wood shavings + Sand+ FYM+ coconut husk+ charcoal (1:1:1:1:1:1) (94.67%) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (93.33%). Minimum survival was recorded in T₄ *i.e.*, Cocopeat + wooden shavings +FYM+ brick pieces + charcoal (2:1:1:1:1) (89.33 %) at 24 month after planting.

It was observed that maximum plant height at 24 month after planting was recorded in T₂ *i.e.*, Sand+ FYM+ coconut husk + brick pieces + charcoal (1:1:1:1:1) (40.99 cm) and minimum plant height was noticed in T₄ *i.e.*, Cocopeat + wood shavings +FYM+ brick pieces + charcoal (2:1:1:1:1) (31.13 cm).

Maximum number of leaves at 24 month after planting was recorded in T₂ *i.e.*, Sand+ FYM+ coconut husk + brick pieces + charcoal (1:1:1:1:1) (9.80) which was at par with T₅ *i.e.*, Brick pieces + wood shavings + sand+ FYM+ coconut husk+ charcoal (1:1:1:1:1:1) (9.13), T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (9.00), T₆ *i.e.*, Saw dust+ wood shavings + sand+ FYM + brick pieces + charcoal (2:1:1:1:1:1) (8.80) and T₁ *i.e.*, Coconut husk + charcoal (3:1) (8.60). Minimum number of leaves was observed in T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (7.13).

It was found that maximum length of leaf at 24 months after planting was recorded in T₂ *i.e.*, Sand+ FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) (15 cm) which was at par with treatment T₅ *i.e.*, Brick pieces + wood shavings + sand+ FYM + coconut husk+ charcoal (1:1:1:1:1:1) (14.93 cm), T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (14.69 cm) and T₆ *i.e.*, Saw dust+ wood shavings + sand+ FYM+ brick pieces + charcoal (2:1:1:1:1:1) (13.91 cm) and T₁ *i.e.*, Coconut husk + charcoal (3:1) (13.76 cm).

Minimum length of leaf was noticed in T₄ *i.e.*, Cocopeat + woods shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (12.81 cm).

It was recorded that maximum breadth of leaf at 24 months after planting was recorded in T₂ *i.e.*, Sand + FYM+ coconut husk + brick pieces + charcoal (1:1:1:1:1) (9.65 cm) which was at par with treatment T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM+ coconut husk+ charcoal (1:1:1:1:1:1) (9.43 cm), T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (9.40 cm), T₆ *i.e.*, Saw dust+ wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1) (9.30 cm), T₁ *i.e.*, Coconut husk + charcoal (3:1) (9.10 cm) and T₇ *i.e.*, Sand+ cowdung clumps + coconut husk + wood shaving + charcoal+ earthen crocks + brick pieces + Cocopeat (2:1:2:1:0.5:0.5:1:1) (8.85 cm). Minimum breadth of leaf was observed in T₄ *i.e.*, Cocopeat + wooden shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (7.89 cm).

It was observed that leaf area (176.33 cm²) at 24 months after planting was recorded maximum in T₂ *i.e.*, Sand + FYM+ coconut husk + brick pieces + charcoal (1:1:1:1:1) and minimum leaf area was observed in T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (160.21 cm²).

The maximum number of suckers per plant at 24 months after planting was produced by T₂ *i.e.*, Sand+ FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) (3.87) which was at par with T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (3.73) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (3.60). Treatment T₄ *i.e.*, Cocopeat + wood shavings +FYM+ brick pieces + charcoal (2:1:1:1:1) (2.60) recorded minimum number of suckers per plant.

It was recorded that maximum chlorophyll a (2.16 mg/g) was recorded in T₂ *i.e.*, Sand+ FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) and minimum chlorophyll a was recorded in T₄

i.e., Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (1.87 cm).

It was found that maximum chlorophyll b (1.33 mg/g) was recorded in T₂ *i.e.*, sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was at par with treatment T₅ *i.e.*, Brick pieces + wood shavings + sand+ FYM + coconut husk + charcoal (1:1:1:1:1) (1.31 mg/g) and T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (1.29 mg/g). Minimum chlorophyll b was found in T₄ *i.e.*, Cocopeat + wood shavings +FYM+ brick pieces + charcoal (2:1:1:1:1) (1.15 mg/g).

It was recorded that maximum total chlorophyll was recorded in T₂ *i.e.*, Sand+ FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) (3.49 mg/g) which was at par with treatment T₅ *i.e.*, Brick pieces + wood shavings + Sand+ FYM+ coconut husk+ charcoal (1:1:1:1:1) (3.41 mg/g). Minimum total chlorophyll was noticed in T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (3.03 mg/g)

The minimum days taken for inflorescence emergence was observed in treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) (224.20 days) and the maximum days taken for inflorescence emergence was seen in T₄ *i.e.*, Cocopeat + wooden shavings +FYM+ brick pieces + charcoal (2:1:1:1:1) (279.80 days).

The minimum days required for first flowering was registered in treatment T₂ *i.e.*, Sand+ FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) (248.80 days) and the maximum days required for first flowering was registered in T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (310.53 days).

The minimum period of infloroscence emergence to spathe unfurling was recorded in treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) (19.60 days) which was at

par with T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (21.50 days). The maximum period of inflorescence emergence to spathe unfurling was observed in T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (24.73 days).

The maximum flower longevity on the plant was recorded in treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) (64.86 days) and the minimum flower longevity of the plant (55.14 days) was noted in T₄ *i.e.*, Cocopeat + wooden shavings + FYM + brick pieces + charcoal (2:1:1:1:1).

The flower stalk length (27.43 cm) was recorded maximum in treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was at par with T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (26.16 cm). The lowest flower stalk length was recorded in T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (16.53 cm).

The maximum spadix length (4.55 cm) was recorded by T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) which was at par with T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (4.46 cm) and followed by T₃ *i.e.*, Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1) (4.23 cm). The minimum spadix length was found in T₄ *i.e.*, Cocopeat + wooden shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (3.33 cm).

Treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) registered maximum length of spathe (7.09 cm) which was at par with T₅ *i.e.*, Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1:1) (6.90 cm) and the minimum length of spathe was observed in T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (5.72 cm).

Treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) recorded maximum breadth of spathe (6.17 cm)

which was at par with T₅ *i.e.*, Brick pieces + wood shavings + sand+ FYM+ coconut husk + charcoal (1:1:1:1:1) (5.89 cm) and minimum breadth of spathe was observed in T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (4.51 cm).

The maximum anthocyanin content was recorded in treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) (0.68 mg/g) which was at par with T₅ *i.e.*, Brick pieces + wood shavings + sand+ FYM+ coconut husk+ charcoal (1:1:1:1:1) (0.66 mg/g) and minimum anthocyanin content was recorded in T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (0.55 mg/g)

The maximum vase life of flowers (14.76 days) was recorded in treatment T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) and minimum vase life of flowers was recorded in T₄ *i.e.*, Cocopeat + wood shavings +FYM+ brick pieces + charcoal (2:1:1:1:1) (11.40 days).

The maximum number of flowers per plant (4.40 flowers) was produced in T₂ *i.e.*, Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) and minimum number of flowers per plant were observed in T₄ *i.e.*, Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1) (2.73 flowers).

It was seen that T₂ *i.e.*, Sand+ FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1) had the higher gross returns (Rs. 264116.67), maximum net returns (Rs. 207366.67) and highest B:C ratio (4.65) which was at par with T₅ *i.e.*, Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1) (4.48). The lowest B:C ratio (3.70) was observed in T₄ *i.e.*, T₄ *i.e.*, Cocopeat + wood shavings +FYM+ brick pieces + charcoal (2:1:1:1:1).

5.3 To optimize shade level for anthurium cultivation

The maximum survival percentage (95.63%) was recorded in treatment T₃ *i.e.*, 90% shade level which was followed by T₂ *i.e.*, 75% shade level (92.57%). Minimum survival was recorded in T₁ *i.e.*, 50% shade level (89.63 %).

It was observed that maximum plant height (41.11 cm) at 24 month after planting was recorded in T₂ *i.e.*, 75% shade level which was followed by treatment T₃ *i.e.*, 90% shade level (38.43 cm). Minimum plant height was recorded in T₁ *i.e.*, 50% shade level (36.34 cm).

Maximum number of leaves at 24 month after planting was recorded in T₃ *i.e.*, 90% shade level (10.29) which was at par with T₂ *i.e.*, 75% shade level (9.86) and minimum number of leaves was found in T₁ *i.e.*, 50% shade level (9.29).

It was observed that maximum leaf area at 24 months after planting was recorded in T₃ *i.e.*, 90% shade level (174.90 cm²) which was followed by treatment T₂ *i.e.*, 75% shade level (163.39 cm²) and minimum leaf area was observed in T₁ *i.e.*, 50% shade level (155.16 cm²).

It was observed that maximum plant spread (N-S) at 24 months after planting was recorded in T₃ *i.e.*, 90% shade level (26.56 cm) which was followed by treatment T₂ *i.e.*, 75% shade level (24.53 cm) and minimum plant spread was observed in T₁ *i.e.*, 50% shade level (21.56 cm).

The maximum plant spread (E-W) at 24 months after planting was registered in T₃ *i.e.*, 90% shade level (26.40 cm) which was followed by treatment T₂ *i.e.*, 75% shade level (24.66 cm) and minimum plant spread was noticed in T₁ *i.e.*, 50% shade level (22.56 cm).

Maximum length of leaf petiole at 24 months after planting was recorded in T₃ *i.e.*, 90% shade level (20.57 cm) which was at par with

treatment T₂ *i.e.*, 75% shade level (18.28 cm) and minimum length of leaf petiole was observed in T₁ *i.e.*, 50% shade level (16.27 cm).

The maximum number of suckers per plant (4.00) at 24 months after planting was produced under T₂ *i.e.*, 75% shade level which was at par with T₃ *i.e.*, 90% shade level (3.29) and treatment T₁ *i.e.*, 50% shade level (2.71) recorded minimum number of suckers per plant.

It was observed that maximum chlorophyll a was recorded in T₂ *i.e.*, 75% shade level (2.29 mg/g) which was followed by treatment T₃ *i.e.*, 90% shade level (1.80 mg/g) and minimum chlorophyll a was observed in T₁ *i.e.*, 50% shade level (1.35 mg/g).

It was observed that maximum chlorophyll b was recorded in T₂ *i.e.*, 75% shade level (1.47 mg/g) which was followed by treatment T₃ *i.e.*, 90% shade level (1.20 mg/g) and minimum chlorophyll b was observed in T₁ *i.e.*, 50% shade level (1.02 mg/g).

The maximum total chlorophyll (3.76 mg/g) were registered in T₂ *i.e.*, 75% shade level which was followed by treatment T₃ *i.e.*, 90% shade level (3.00 mg/g) and minimum total chlorophyll was recorded in T₁ *i.e.*, 50% shade level (2.37 mg/g).

The minimum days taken for flower bud initiation were observed in treatment T₂ *i.e.*, 75% shade level (213.57 days) which was at par with T₃ *i.e.*, 90% shade level (225.29 days) and maximum days taken for flower bud initiation were recorded in T₁ *i.e.*, 50% shade level (234.57 days).

The minimum days taken for unfurling of spathe were recorded in treatment T₂ *i.e.*, 75% shade level (243.14 days) which was followed by T₃ *i.e.*, 90% shade level (251.71 days) and maximum days taken for unfolding of spathe were recorded in T₁ *i.e.*, 50% shade level (259.71 days).

The maximum flower longevity on the plant was recorded in treatment T₂ *i.e.*, 75% shade level (64.65 days) which was followed by

T₃ *i.e.*, 90% shade level (58.19 days) and lowest flower longevity on the plant was recorded in T₁ *i.e.*, 50% shade level (54.26 days)

The length of flower stalk was recorded maximum in treatment T₂ *i.e.*, 75% shade level (28.02 cm) which was followed by T₃ *i.e.*, 90% shade level (26.11 cm) and minimum length of flower stalk was recorded in T₁ *i.e.*, 50% shade level (21.10 cm).

The diameter of flower stalk was recorded maximum in T₂ *i.e.*, 75% shade level (4.22 mm) which was followed by T₃ *i.e.*, 90% shade level (3.71 mm) and minimum diameter of flower stalk was found in T₁ *i.e.*, 50% shade level (3.06 mm)

Treatment T₂ *i.e.*, 75% shade level observed maximum length of spathe (7.16 cm) which was followed by T₃ *i.e.*, 90% shade level (6.29 cm) and minimum length of spathe was observed in T₁ *i.e.*, 50% shade level (5.20 cm).

The width of spathe was recorded maximum in treatment T₂ *i.e.*, 75% shade level (6.16 cm) which was followed by T₃ *i.e.*, 90% shade level (5.19 cm) and the minimum width of spathe was observed in T₁ *i.e.*, 50% shade level (4.62 cm).

Treatment T₂ *i.e.*, 75% shade level registered maximum length of spadix (4.47 cm) which was followed by T₃ *i.e.*, 90% shade level (3.78 cm) and minimum length of spadix was observed in T₁ *i.e.*, 50% shade level (3.18 cm)

The diameter of spadix (8.84 mm) was recorded maximum in Treatment T₂ *i.e.*, 75% shade level which was followed by T₃ *i.e.*, 90% shade level (8.14 mm) and the minimum diameter of spadix was observed in T₁ *i.e.*, 50% shade level (7.67 mm).

The highest anthocyanin content was recorded in treatment T₃ *i.e.*, 90% shade level (0.72 mg/g) which was followed by T₂ *i.e.*, 75% shade level (0.63 mg/g) and lowest anthocyanin content was recorded in T₁ *i.e.*, 50% shade level (0.49 mg/g).

The number of flowers per plant was produced maximum in T₂ *i.e.*, 75% shade level (5.71 flowers) followed by T₃ *i.e.*, 90% shade level (4.86 flowers) and minimum number of flowers per plant was observed in T₁ *i.e.*, 50% shade level (3.57 flowers).

The treatment T₂ *i.e.*, 75% shade level recorded maximum gross returns (Rs. 275375.00), maximum net returns (Rs. 217934.00) and highest B:C ratio (4.79) which was followed by T₃ *i.e.*, 90% shade level (4.18) and lowest B:C ratio was observed in T₁ 50% shade level (3.77).

5.4 To study the vase life of anthurium cut flowers by using various chemicals

At the end of experiment the final weight of inflorescence was registered maximum in treatment T₇ *i.e.*, BA 50 ppm (6.29 g) which was followed by T₈ *i.e.*, Triadimefon 30 ppm (5.79g) and T₅ *i.e.*, 8 HQC 400 ppm (5.47 g). The minimum final weight of inflorescence was recorded in T₃ *i.e.*, Distilled water (2.38 g).

The minimum physiological loss in weight was recorded in T₆ *i.e.*, BA 25 ppm (32.20 %) which was found to be at par with treatment T₈ *i.e.*, Triadimefon 30 ppm (35.10 %), T₅ *i.e.*, 8 HQC 400 ppm (35.30 %), T₇ *i.e.*, BA 50 ppm (36.58 %) and T₂ *i.e.*, Tapwater + Bavistin 0.2% (37.47 %), whereas, the treatment T₃ *i.e.*, distilled water recorded maximum physiological loss in weight (65.64 %).

Maximum final volume of holding solution was observed in T₃ *i.e.*, Distilled water (91.95 ml) which was followed by T₁₀ *i.e.*, AgNO₃ 20 ppm (90.72 ml) and T₉ *i.e.*, AgNO₃ 10 ppm (89.44 ml). Minimum final volume of holding solution was observed in T₆ *i.e.*, BA 25 ppm (79.56 ml).

Uptake of vase solution was registered maximum in T₆ *i.e.*, BA 25 ppm (20.45 %) which was followed by T₈ *i.e.*, Triadimefon 30 ppm (17.89 %) and T₇ *i.e.*, BA 50 ppm (17.45 %). Minimum uptake of vase solution was observed in T₃ *i.e.*, Distilled water (8.06 %).

The maximum days to spadix necrosis initiation were observed in treatment T₆ *i.e.*, BA 25 ppm (15.35 days) which was followed by T₈ *i.e.*, Triadimefon 30 ppm (13.60 days) and T₇ *i.e.*, BA 50 ppm (11.62 days). The minimum days to spadix necrosis initiation were noted in T₃ *i.e.*, Distilled water (07.71 days).

The maximum days to spathe blueing initiation were observed in treatment T₆ *i.e.*, BA 25 ppm (17.72 days) which was followed by T₈ *i.e.*, Triadimefon 30 ppm (15.47 days) and T₇ *i.e.*, BA 50 ppm (13.40 days). The minimum days to spadix necrosis initiation were recorded in T₃ *i.e.*, Distilled water (9.44 days).

It was revealed that maximum days to gloss loss were observed in treatment T₆ *i.e.*, BA 25 ppm (16.08 days) which was followed by T₈ *i.e.*, Triadimefon 30 ppm (14.08 days) and T₇ *i.e.*, BA 50 ppm (11.51 days). The minimum days to spadix necrosis initiation was noted in T₃ *i.e.*, Distilled water (08.07 days).

The maximum vase life of inflorescence was recorded in treatment T₆ *i.e.*, BA 25 ppm (20.96 days) which was followed by T₈ *i.e.*, Triadimefon 30 ppm (17.52 days) and T₇ *i.e.*, BA 50 ppm (16.59 days). Minimum vase life of inflorescence was recorded in T₃ *i.e.*, Distilled water (13.64 days).

Conclusion:

1. From the present investigation, it can be concluded that Fancy Red variety was found to be best with respect to vegetative, flowering and quality parameters and also recorded maximum gross returns, net returns and highest B: C ratio. It was followed by Baby White
2. Media combination of Sand+ FYM + coconut husk + brick pieces + charcoal in 1:1:1:1:1 ratio was found to be the best for vegetative parameters, flowering parameters, quality parameters and yield parameter like number of flowers per plant, highest net returns and B:C ratio as compared to all other media

combination treatments. It takes 12 months minimum period for normal size flower production. Frequent foliar sprays of nutrient solutions containing major, minor and macro nutrients is necessary. As the age of plant advances and more the number of suckers per plant (3 to 4); it leads to more number of flower spikes production per month.

3. From present findings it can be concluded that anthurium plants grown under 90% shade net recorded maximum values for vegetative parameters whereas, 75% shade net was good for flowering, quality and yield parameters. Highest net returns and B:C ratio was recorded maximum under 75% shade.
4. For better survival and growth of tissue cultured anthurium plants it is necessary to grow them initially with cup size pots under 90% shade net. After 6 months age these plantlets should be repotted in 6" to 9" pot size under same shade level and should be harden for one month, before they are transferred for flower production under 75% shade net.
5. Holding solution of BA 25 ppm recorded minimum physiological loss in weight, final volume of holding solution and maximum uptake of vase solution, days to spadix necrosis initiation, days to spathe blueing initiation, days to gloss loss and was found to be best to extend the vase life of anthurium cut flowers and maintain its quality.
6. Results of the present studies are based on two years data hence, need further confirmation by conducting studies with similar aspects again for one more year for giving the recommendation to the farmers of Konkan region.

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APPENDIX I

Abbreviations used

%	:	per cent
&	:	and
/	:	per
@	:	At the rate
°B	:	degree Brix
°C	:	degree Celsius
µg	:	microgram
Agno ₃	:	Silver nitrate
Anon.	:	Anonymous
BA	:	Benzyl adenine
BSS	:	Bright sunshine
Ca	:	Calcium
C.D.	:	critical difference
Cm	:	Centimeter (s)
Cm ₂	:	Centimeter square
Cu	:	Copper
Cv.	:	cultivar
Dr.	:	Doctor
EC	:	Electrical conductivity
<i>et al.</i>	:	and others
etc	:	Ecetera
Fe	:	Iron
fig	:	Figure
FYM	:	Farm yard mannure
g	:	Gram
GA ₃	:	Giberellic acid
ha	:	hectare
HQC	:	Hydroxy qunoline citrate
i.e.	:	Et cetera
K	:	Potassium
kg	:	Kilogram (s)
Kmph	:	Kilometer per hour
L.	:	Linnaeus
m	:	Meter (s)

Mn	:	Manganese
MAP		Months after planting
M.S.	:	Maharashtra
Max.	:	Maximum
mg	:	Milligram (s)
Min.	:	Minimum
ml	:	Milliliter (s)
mm	:	Millimeter (s)
MSL	:	Mean sea level
mt.	:	Metric tone
N	:	Normal
N	:	Nitrogen
no.	:	Number
NS	:	Non-significant
P	:	Phosphorous
pH	:	Potential of hydrogen
ppm	:	Parts per million
R.H.	:	Relative humidity
RD	:	Rainy days
Rs	:	Rupees
S	:	Sulphur
S.E.	:	Standard error
Sq.m	:	Square meter
t	:	tones
T	:	Treatment
T max	:	Temperature maximum
T min	:	Temperature minimum
TSS	:	Total soluble solids
TNC	:	Total non-structural carbohydrates
var.	:	variety
viz.	:	Namely
WHC	:	Water holding capacity

APPENDIX II

Weekly weather data during the period of study at Dapoli (March 2019 to March 2020)

Period	Tmax	Tmin	RH-I	RH-II	Wind speed	Rain	RD	BSS	Epan
	(°C)	(°C)	(%)	(%)	(Kmph)	(mm)	day	(hrs.)	(mm)
10.03 - 16.03	28.3	23.8	97	90	3.4	167.2	7	2.8	3.1
17.03 - 23.03	29.1	24.1	95	86	2.9	53.4	6	4.5	2.9
24.03 - 30.03	29.7	23.4	93	85	2.1	55.0	3	5.4	3.8
01.04 - 07.04	30.7	22.7	92	75	1.6	0.2	0	8.9	4.0
08.04 - 14.04	31.7	19.8	94	71	1.3	29.8	2	7.6	3.7
15.05 - 21.05	31.7	23.0	89	73	0.5	63.4	3	4.7	2.9
22.05 – 28.05	28.8	21.9	94	79	1.9	61.2	5	2.6	2.1
29.05 – 04.06	31.9	22.0	90	67	2.3	2.6	1	8.3	3.8
05.06 – 11.06	31.0	21.5	94	71	2.5	9.6	1	8.4	3.6
12.06 – 18.06	33.3	20.6	89	55	2.3	0.0	0	7.8	3.3
19.06 – 25.06	33.0	19.1	93	55	2.1	0.0	0	7.2	3.5
26.06 – 02.07	33.3	18.9	90.9	51.4	2.2	0.0	0	7.6	3.8
03.07 – 09.07	31.4	20.1	91	57	2.7	0.0	0	6.1	3.2
10.07 – 16.07	31.8	17.4	92	58	2.4	0.0	0	9.2	3.4
17.07 – 23.07	32.1	17.1	93	56	2.3	0.0	0	7.9	3.9
24.07 – 31.07	31.8	18.8	92	60	2.2	0.0	0	7.3	3.5
01.08 - 07.08	29.4	13.9	91	55	3.0	0.0	0	9.4	3.2
08.08 - 14.08	31.1	16.6	92	58	2.9	0.0	0	8.8	3.3
15.08 - 21.08	29.5	12.7	94	57	3.4	0.0	0	9.5	3.6
22.08 - 28.08	33.4	15.7	92	51	2.9	0.0	0	9.7	3.7
29.08 - 04.09	28.3	12.7	94	54	3.1	0.0	0	9.5	3.5
05.09 - 11.09	30.1	13.1	93	55	3.3	0.0	0	9.0	3.7
12.09 - 18.09	34.4	16.0	92	45	3.0	0.0	0	7.2	4.4
19.09 - 25.09	34.6	15.2	90	45	3.0	0.0	0	9.5	4.6
26.09 - 04.10	34.9	14.3	89	48	3.4	0.0	0	10.1	4.7
05.10 - 11.10	29.9	15.2	89	54	4.1	0.0	0	10.3	5.2
12.10 - 18.10	32.4	14.5	85	56	4.8	0.0	0	7.6	5.7
19.10 - 25.10	33.0	14.6	89	52	4.4	0.0	0	7.6	6.4
26.10 - 01.11	34.6	20.5	88	64	4.7	0.0	0	7.3	6.3
02.11 - 08.11	33.2	20.1	89	53	5.0	0.0	0	7.2	6.6
09.11 - 15.11	33.7	21.7	90	52	5.7	0.0	0	7.2	6.9
16.11 - 22.11	33.6	19.6	90	56	5.7	0.0	0	8.4	6.8
23.11 - 29.11	34.9	23.4	85	65	6.0	0.0	0	7.9	6.4
30.11 - 06.12	33.0	21.1	85	60	5.2	0.0	0	8.0	6.7

07.12 - 13.12	33.5	22.5	82	60	6.2	0.0	0	8.8	6.7
14.12 - 20.12	33.7	21.1	81	55	6.9	0.0	0	9.3	6.8
21.12 - 27.12	33.9	23.7	83	56	6.5	0.0	0	9.0	6.9
28.12 - 03.01	34.0	23.9	81	57	6.2	0.0	0	8.6	7.2
04.01 - 10.01	34.5	25.9	86	61	6.4	10.0	1	6.7	6.8
11.01 - 17.01	32.6	25.1	91	81	11.1	110.4	5	6.4	4.0
18.01 - 24.01	31.1	24.2	94	84	4.7	162.3	5	5.1	3.3
26.01-01.02	34.0	23.9	81	57	6.2	0.0	0	8.6	7.2
02.02- 08.02	33.9	23.7	83	56	6.5	0.0	0	9.0	6.9
09.02- 15.02	33.5	22.5	82	60	6.2	0.0	0	8.8	6.7
16.02- 22.02	33.9	23.7	83	56	6.5	0.0	0	9.0	6.9
23.02- 28.02	34.5	25.9	86	61	6.4	10.0	1	6.7	6.8
01.03-07.03	34.0	23.9	81	57	6.2	0.0	0	8.6	7.2

(March 2020 to March 2021)

Period	Tmax	Tmin	RH-I	RH-II	Wind speed	Rain	RD	BSS	Epan
	(°C)	(°C)	(%)	(%)	(Kmph)	(mm)	day	(hrs.)	(mm)
10.03 - 16.03	28.3	23.8	97	90	3.4	167.2	7	2.8	3.1
17.03 - 23.03	29.1	24.1	95	86	2.9	53.4	6	4.5	2.9
24.03 - 30.03	29.7	23.4	93	85	2.1	55.0	3	5.4	3.8
01.04 - 07.04	30.7	22.7	92	75	1.6	0.2	0	8.9	4.0
08.04 - 14.04	31.7	19.8	94	71	1.3	29.8	2	7.6	3.7
15.05 - 21.05	31.7	23.0	89	73	0.5	63.4	3	4.7	2.9
22.05– 28.05	28.8	21.9	94	79	1.9	61.2	5	2.6	2.1
29.05 – 04.06	31.9	22.0	90	67	2.3	2.6	1	8.3	3.8
05.06 – 11.06	31.0	21.5	94	71	2.5	9.6	1	8.4	3.6
12.06 – 18.06	33.3	20.6	89	55	2.3	0.0	0	7.8	3.3
19.06 – 25.06	33.0	19.1	93	55	2.1	0.0	0	7.2	3.5
26.06 – 02.07	33.3	18.9	90.9	51.4	2.2	0.0	0	7.6	3.8
03.07 – 09.07	31.4	20.1	91	57	2.7	0.0	0	6.1	3.2
10.07 – 16.07	31.8	17.4	92	58	2.4	0.0	0	9.2	3.4
17.07 – 23.07	32.1	17.1	93	56	2.3	0.0	0	7.9	3.9
24.07 – 31.07	31.8	18.8	92	60	2.2	0.0	0	7.3	3.5
01.08 - 07.08	29.8	14.6	91.3	55.5	3.0	0.0	0.0	9.3	3.3
08.08 - 14.08	29.7	14.9	91.0	53.9	3.1	0.0	0.0	9.2	3.2
15.08 - 21.08	29.9	15.1	90.8	54.6	3.0	0.0	0.0	9.1	3.2
22.08 - 28.08	29.9	15.3	91.0	55.1	3.0	0.0	0.0	9.1	3.2
29.08 - 04.09	30.3	15.9	90.9	54.6	3.0	0.0	0.0	9.0	3.2
05.09 - 11.09	31.0	16.3	90.8	55.6	2.9	0.0	0.0	9.1	3.3
12.09 - 18.09	31.3	16.5	91.4	56.6	2.9	0.0	0.0	9.0	3.3

19.09 - 25.09	30.9	16.3	91.7	58.2	2.9	0.0	0.0	8.9	3.3
26.09 - 04.10	30.6	15.7	91.8	57.7	3.0	0.0	0.0	8.9	3.3
05.10 - 11.10	30.3	15.4	92.0	59.0	3.2	0.0	0.0	8.9	3.4
12.10 - 18.10	30.4	15.4	92.1	58.9	3.3	0.0	0.0	9.0	3.4
19.10 - 25.10	30.1	14.5	92.3	58.8	3.5	0.0	0.0	9.1	3.5
26.10 - 01.11	29.4	13.7	92.4	59.8	3.7	0.0	0.0	9.2	3.5
02.11 - 08.11	29.1	13.4	92.8	59.8	3.7	0.0	0.0	9.3	3.5
09.11 - 15.11	29.1	13.0	93.1	58.3	3.6	0.0	0.0	9.4	3.6
16.11 - 22.11	29.6	13.0	93.4	57.1	3.4	0.0	0.0	9.5	3.6
23.11 - 29.11	29.9	13.4	93.3	57.6	3.3	0.0	0.0	9.6	3.6
30.11 - 06.12	30.6	13.7	93.3	55.9	3.0	0.0	0.0	9.6	3.6
07.12 - 13.12	31.1	13.7	93.4	53.8	3.1	0.0	0.0	9.7	3.6
14.12 - 20.12	31.5	14.4	93.3	53.2	2.8	0.0	0.0	9.6	3.6
21.12 - 27.12	32.6	15.0	93.4	51.2	2.7	0.0	0.0	9.6	3.7
28.12 - 03.01	33.2	15.2	92.9	50.5	2.7	0.0	0.0	9.7	3.7
04.01 - 10.01	33.3	15.3	92.8	50.7	2.8	0.0	0.0	9.7	3.6
11.01 - 17.01	33.1	15.4	92.5	51.5	2.9	0.0	0.0	9.7	3.7
18.01 - 24.01	32.6	15.3	92.5	51.1	2.9	0.0	0.0	9.7	3.6
26.01-01.02	29.4	13.7	92.4	59.8	3.7	0.0	0.0	9.2	3.5
02.02- 08.02	30.3	15.4	92.0	59.0	3.2	0.0	0.0	8.9	3.4
09.02- 15.02	31.1	13.7	93.4	53.8	3.1	0.0	0.0	9.7	3.6
16.02- 22.02	30.3	15.4	92.0	59.0	3.2	0.0	0.0	8.9	3.4
23.02- 28.02	29.1	13.0	93.1	58.3	3.6	0.0	0.0	9.4	3.6
01.03-07.03	29.6	13.0	93.4	57.1	3.4	0.0	0.0	9.5	3.6

APPENDIX III

Nutrient status of media

Treatments	N %		P %		K %		Ca %		Mg %	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
T₁ - Coconut husk + charcoal (3:1)	0.36	0.61	0.03	0.15	0.07	0.15	0.05	0.15	0.02	0.12
T₂ - Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)	0.33	0.42	0.07	0.21	0.04	0.20	0.10	0.18	0.08	0.15
T₃ - Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1)	0.51	0.60	0.2	0.23	0.04	0.67	0.04	0.16	0.03	0.13
T₄ - Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1)	0.32	0.53	0.13	0.16	0.09	0.21	0.08	0.12	0.06	0.09
T₅ - Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1:1)	0.45	0.49	0.16	0.24	1.10	0.27	0.12	0.16	0.08	0.12
T₆ - Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1)	0.36	0.58	0.2	1.07	0.03	0.12	0.06	0.14	0.04	0.08
T₇ - Sand + cowdung clumps + coconut husk + wood shaving + charcoal + earthen crocks + brick pieces + Cocopeat (2:1:2:1:0.5:0.5:1:1)	0.44	0.51	0.15	0.2	0.01	0.11	0.08	0.13	0.10	0.14

Physical properties of media

Treatments	pH		EC		WHC %		Porocity		Moisture content %	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
T₁ - Coconut husk + charcoal (3:1)	5.85	6.22	0.62	0.70	21	18	48.78	64.45	49	40
T₂ - Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)	6.18	6.25	0.75	0.82	26	24	56.99	63.34	58	50
T₃ - Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1)	5.80	5.89	0.57	0.68	25	23	62.60	65.94	59	56
T₄ - Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1)	5.16	6.10	0.62	0.75	24	21	52.71	58.86	72	45
T₅ - Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1:1)	6.12	6.29	0.60	0.72	22	19	57.87	65.29	65	59
T₆ - Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1)	6.14	6.24	0.72	0.80	20	18	57.90	70.57	72	69
T₇ - Sand + cowdung clumps + coconut husk + wood shaving + charcoal + earthen crocks + brick pieces + Cocopeat (2:1:2:1:0.5:0.5:1:1)	5.87	6.15	0.65	0.76	23	20	41.04	58.60	66	45

Physical properties of media

Treatments	Organic Carbon %		Organic matter %	
	Initial	Final	Initial	Final
T₁ - Coconut husk + charcoal (3:1)	3.12	3.38	5.37	5.82
T₂ - Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)	2.38	3.90	4.10	6.72
T₃ - Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1)	2.87	3.02	4.94	5.20
T₄ - Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1)	2.62	2.80	4.51	4.82
T₅ - Brick pieces + wood shavings + Sand + FYM + coconut husk + charcoal (1:1:1:1:1:1)	2.10	2.35	3.62	4.05
T₆ - Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1)	1.85	2.12	3.18	3.65
T₇ - Sand + cowdung clumps + coconut husk + wood shaving + charcoal + earthen crocks + brick pieces + Cocopeat (2:1:2:1:0.5:0.5:1:1)	1.42	1.68	2.44	2.89

APPENDIX IV

Experiment No. 1

Cost of cultivation of 100sq.m for 2 years

A) Fixed cost	Area	Rate	Total cost
Shade construction	100sq.m	35000	
life of structure	20 years		
Depreciation cost			3500
Shade net	100 m	5000/50m	10000
Life of shade net	4 years		
Repair and maintainance at 2%			800
Equipment (sprayer)	1		1500
Fogger		Rs 35/m2	2800
Electricity			2000
land revenue			500
Interest on fixed cost at 10%			2110
B) Input cost			
Pots 7'		Rs 25/Pot	13125
Planting material		Rs 65/plant	34125
Media		1.97 Rs/pot	1034
Fertilizers			
19:19:19	2g/1	Rs 0.14/g	555
Calcium nitrate	2g/1	Rs 0.053/g	200
Magnesium sulphate	2g/1	Rs 0.036/g	136
Micronutrients	2g/1	Rs 0.30/gm	1381
Labours		RS 28/hr	9000
Total			82766

Experiment No. 2

Cost of cultivation of 100sq.m for 2 years

A) Fixed cost	Area	Rate	Total cost
Shade construction	100sq.m	35000	
life of structure	20 years		
Depreciation cost			3500
Shade net	100 m	5000/50m	10000
Repair and maintainance at 2%			800
Equipment (sprayer)	1		1500
Fogger		Rs 35/m2	2800
Electricity			2000
land revenue			500
Interest on fixed cost at 10%			2110
B) Input cost			
Pots 7'		Rs 25/POT	13125
Planting material		Rs 20/plant	10500
Fertilizers			
19:19:19	2g/l	Rs 0.14/g	555
Calcium nitrate	2g/l	Rs 0.053/g	200
Magnesium sulphate	2g/l	Rs 0.036/g	136
Micronutrients	2g/l	Rs 0.30/gm	881
Labours		RS 28/hr	7250
Total			55857
Media for 100Sq m		Cost of media required	Total cost
T ₁ - Coconut husk + charcoal (3:1)		961	56818
T ₂ - Sand+ FYM+ coconut husk + brick pieces + charcoal (1:1:1:1:1)		893	56750
T ₃ - Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1)		2772	58629

T ₄ - Cocopeat + wooden shavings +FYM+ brick pieces + charcoal (2:1:1:1:1)		4126	59983
T ₅ - Brick pieces + wooden shavings + Sand+ FYM+ brick pieces + charcoal		1034.25	56891
T ₆ - Saw dust+ wooden shavings + sand+ FYM+ brick pieces + charcoal		1376	57233
T ₇ - Sand+ rotten cowdung clumps+ coconut husk + wood shaving+		2315	58172
Cost of media			
Coconut husk	2 Rs/kg		
FYM	2.5 Rs/kg		
Charcoal	9.50 Rs/kg		
Saw dust	5 Rs/kg		

Experiment No. 3

Cost of cultivation of 100sq.m for 2 years

A) Fixed cost	Area	Rate	Total cost	
Shade construction	100sq.m	35000		
life of structure	20 years			
Depreciation cost			3500	
Repair and maintainance at 2%			800	
Equipment (sprayer)	1		1500	
Fogger		Rs 35/m ²	2800	
Electricity			2000	
land revenue			500	
Interest on fixed cost at 10%			1110	
B) Input cost				
Pots 7'		Rs 25/POT	13125	
Planting material		Rs 20/plant	10500	
Media		1.97 Rs/pot	1034	
Fertilizers				
19:19:19	2g/l	Rs 0.14/g	555	
Calcium nitrate	2g/l	Rs 0.053/g	200	
Magnesium sulphate	2g/l	Rs 0.036/g	136	
Micronutrients	2g/l	Rs 0.30/gm	881	
Labours		RS 28/hr	8000	
Total			46641	
SHADE NETS				Total
50%	100m	4000 Rs/50m	8000	54641
75%	100m	5400 Rs/50m	10800	57441
90%	100m	6200 Rs/50m	12400	59041

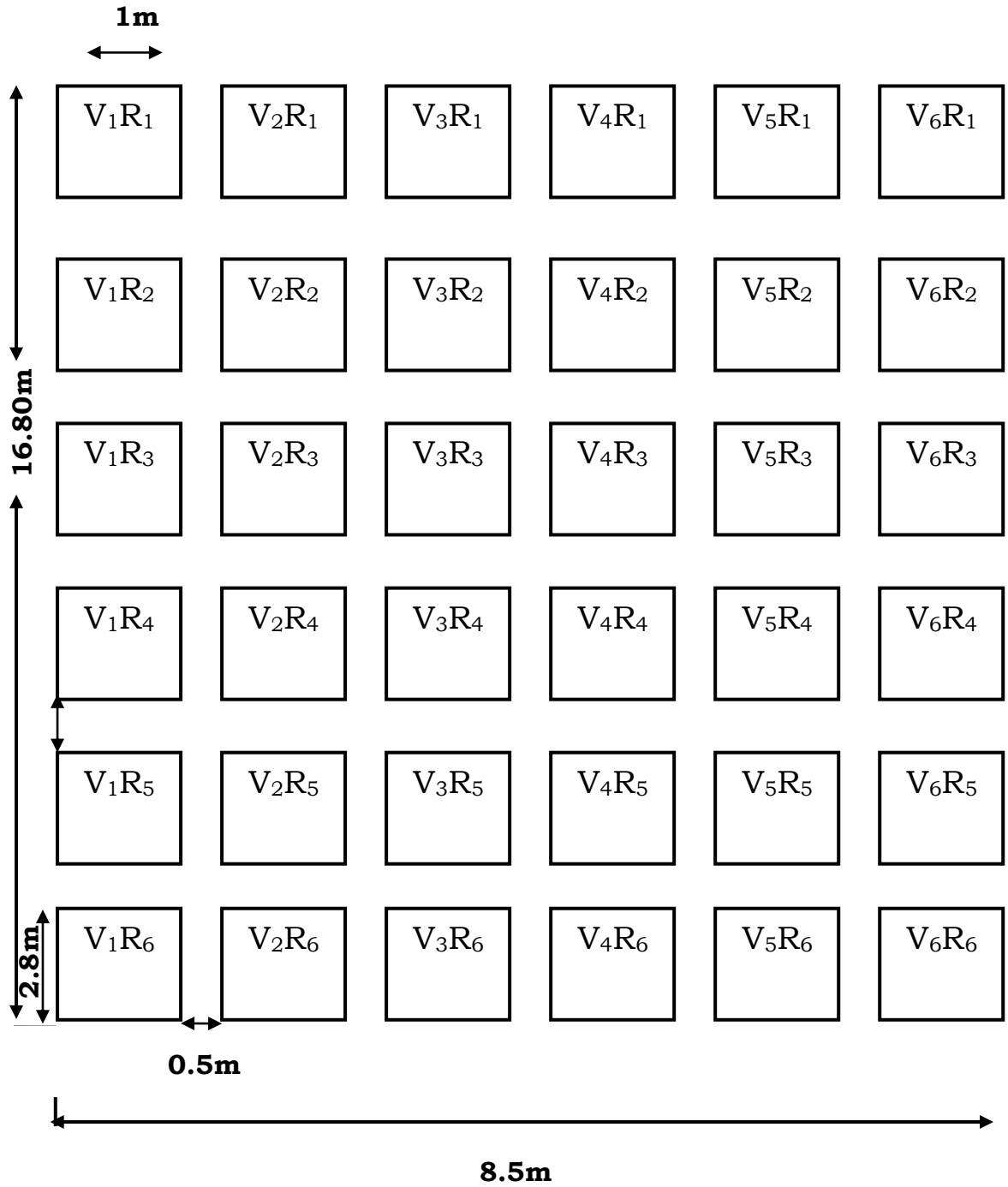


Fig. 1: Plan of experimental layout for varietal performance of anthurium (*Anthurium andreanum* Linn)

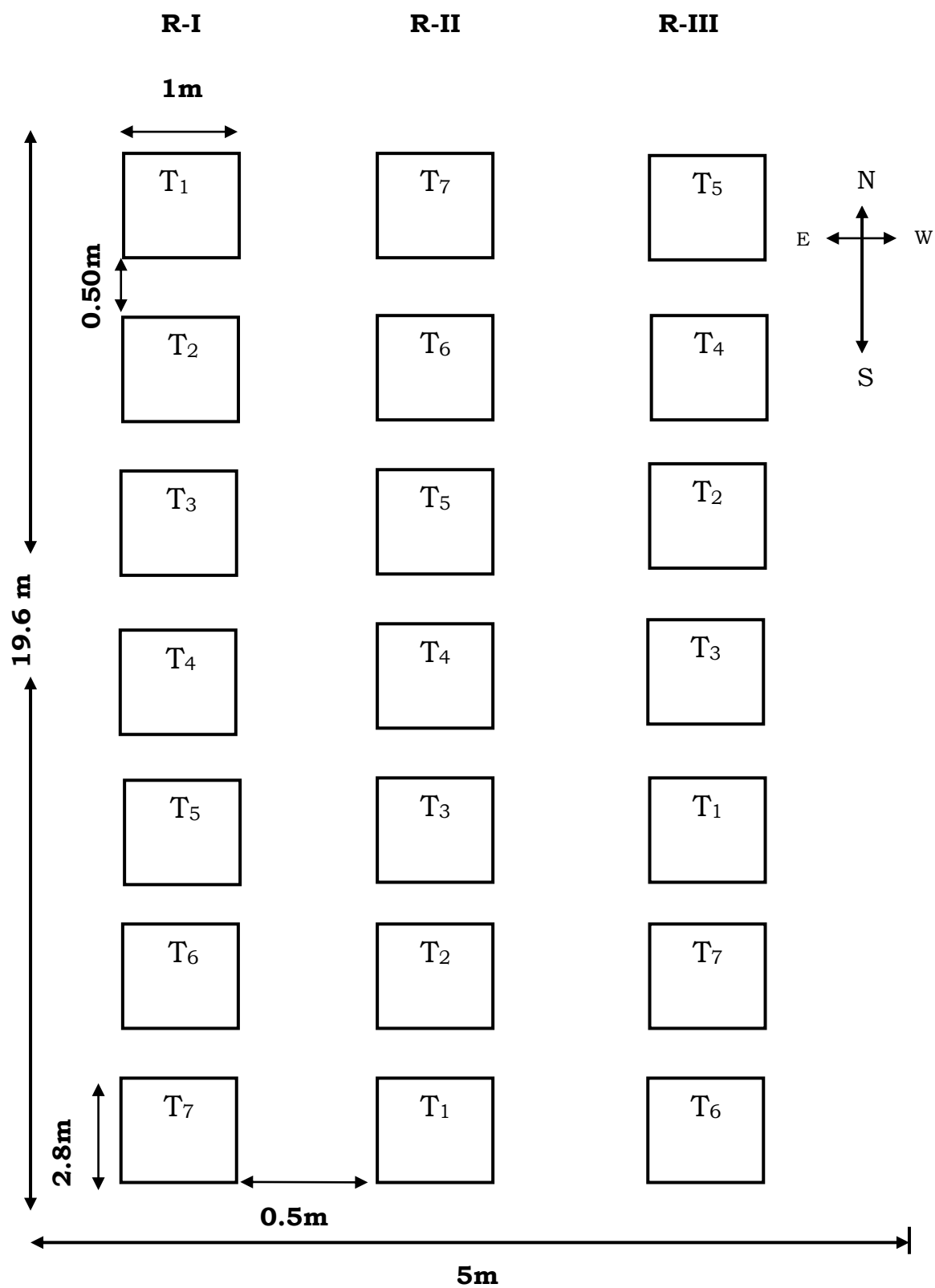


Fig. 2: Plan of experimental layout for optimization of media for cultivation of anthurium cv. Tropical Red

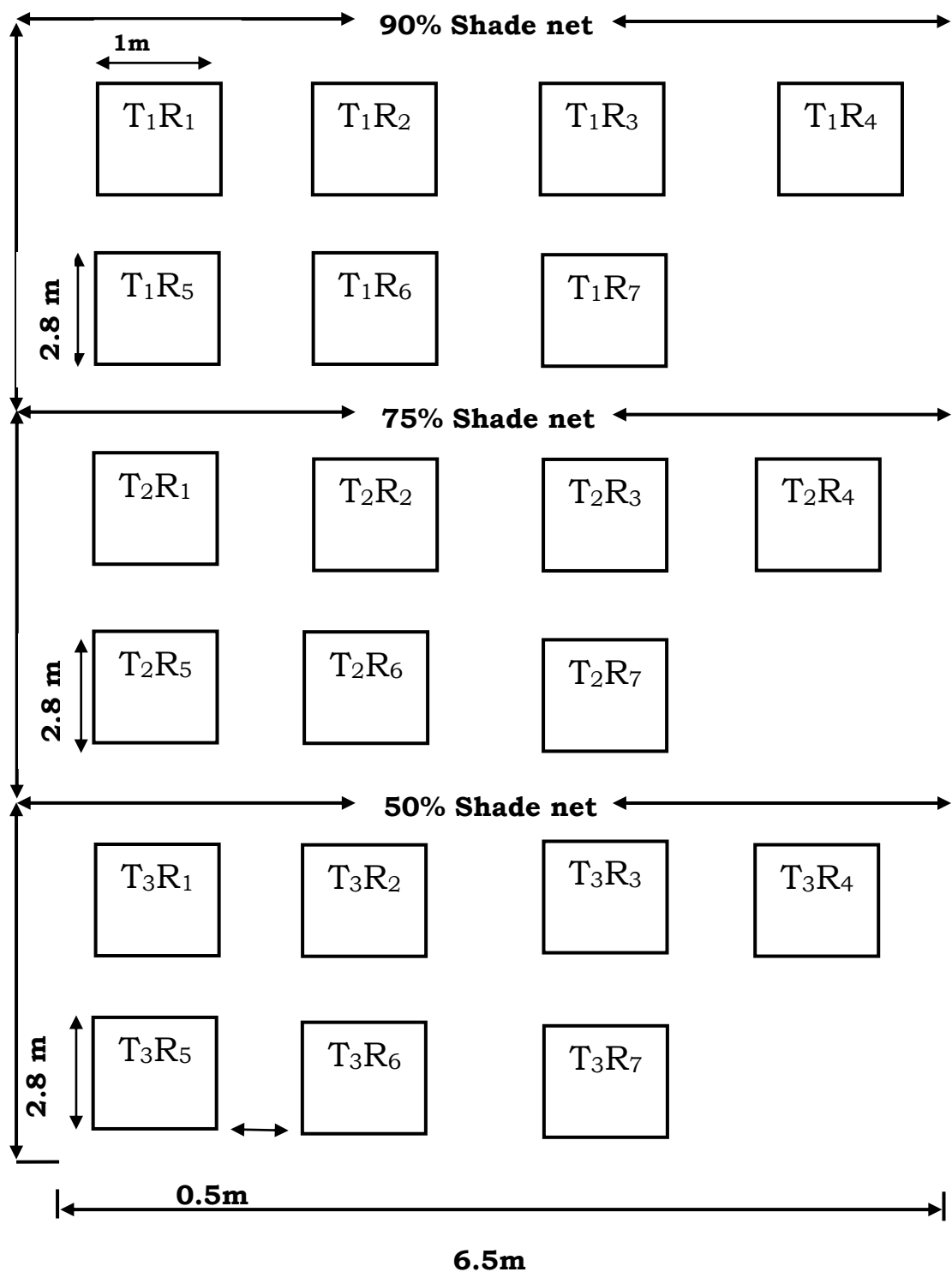


Fig. 3: Plan of experimental layout optimization of shade level for cultivation of anthurium cv. Tropical Red



Tropical Red



Princess Amellia



Queen Black



Baby Purple



Prince Orange



Baby White

Plate I: Flower of different anthurium varieties



Plate II: General view of varietal performance of anthurium



Plate III: General view of different media of anthurium



Brick pieces



Coconut husk



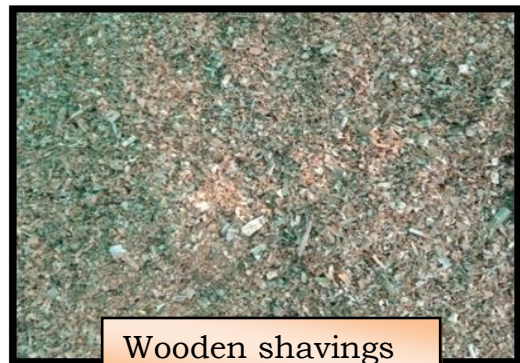
Saw dust



Charcoal



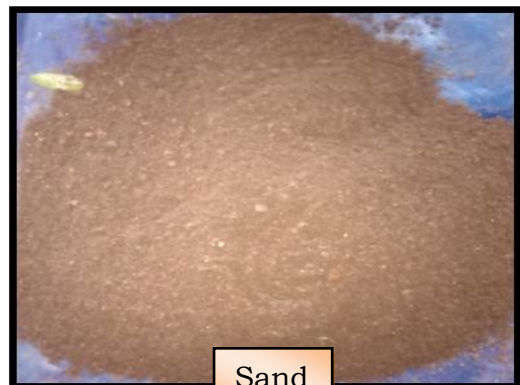
Cocopeat



Wooden shavings



Earthen crocks



Sand

Plate IV: Different media used in experiment



Plate V: General view of different shade levels



Plate VI: Plant height of Fancy Red variety at 8 months age



V₆- Queen Black



V₅- Fancy Red

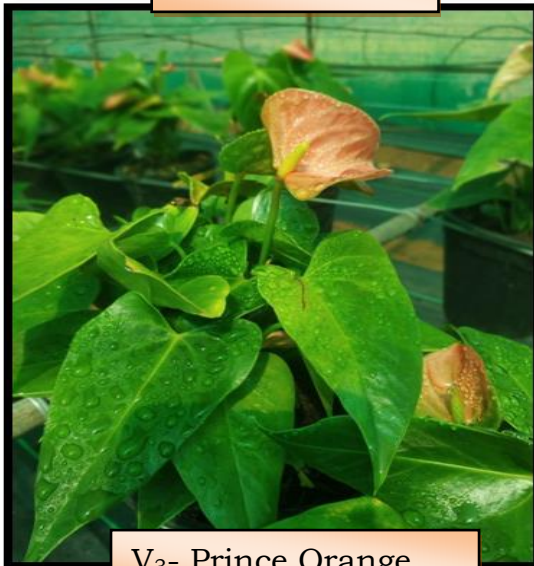
Plate VII: Number of suckers produced in different varieties of anthurium



V₁- Baby White



V₂- Baby Purple



V₃- Prince Orange



V₄- Princess Amellia



V₅- Fancy Red

Plate VIII: Flowering stage of different anthurium varieties



V2- Baby Purple



V1- Baby White



V5- Fancy Red



V4- Princess

Plate IX: Spadix length of different anthurium varieties



V₅- Fancy Red

V₂- Baby Purple



V₄- Princess

V₁- Baby White

Plate X: Length of spathe in different anthurium varieties



V₁- Baby White



V₂- Baby Purple



V₄- Princess



V₅- Fancy Red

Plate XI: Breadth of spathe in different anthurium varieties



T₂



T₄

Length



T₂



T₄

Breadth

Plate XII: Length and breadth of anthurium in different media



Plate XIII: Vegetative growth at 8 months stage of anthurium in different media

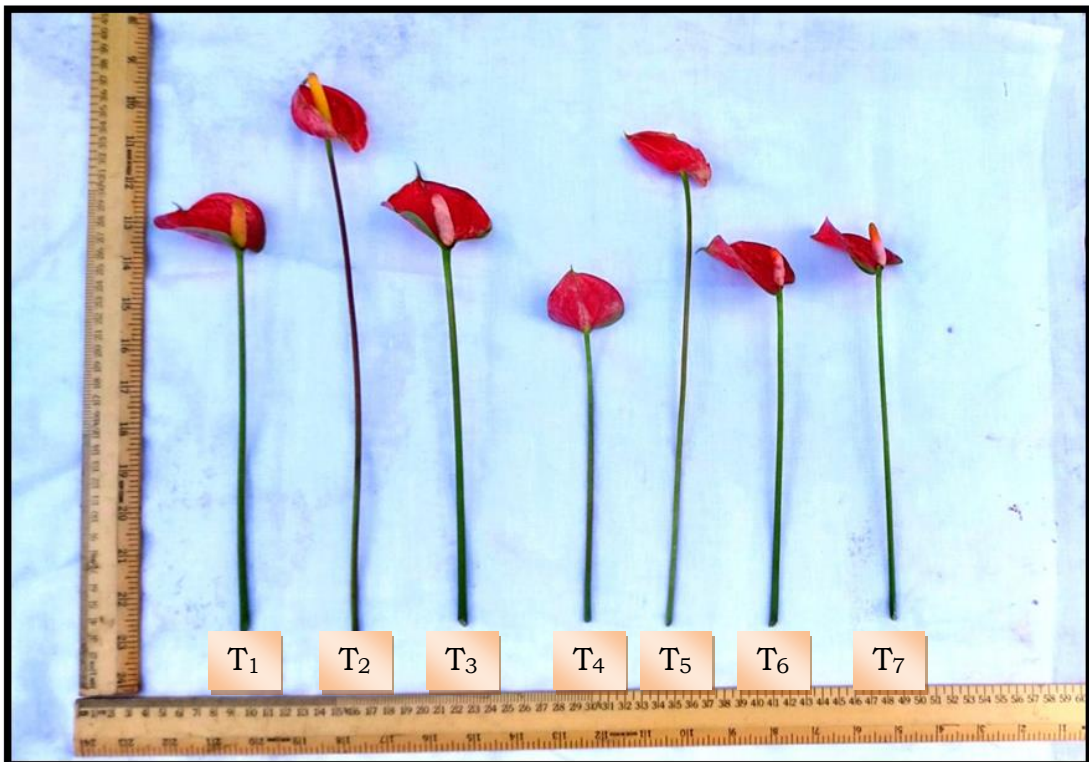


T₂

Flowering stage



T₄



T₁

T₂

T₃

T₄

T₅

T₆

T₇

Flower stalk length

Plate XIV: Flowering stage at 16 months after planting and flower stalk length of anthurium in different media

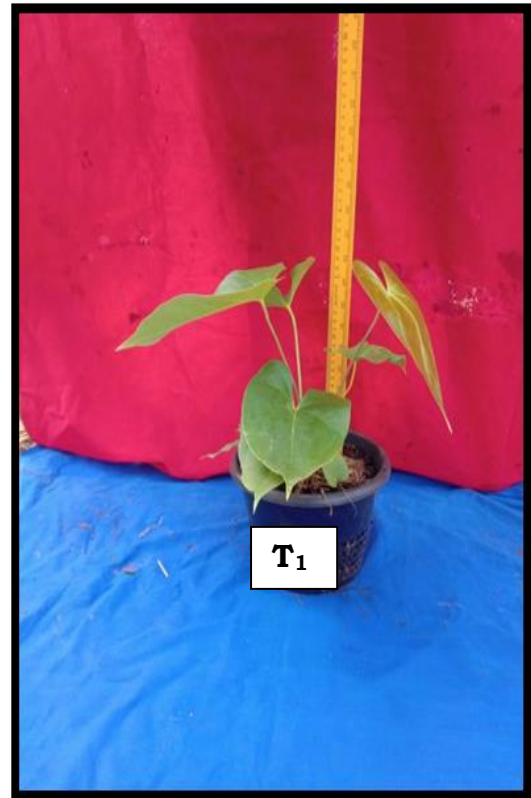
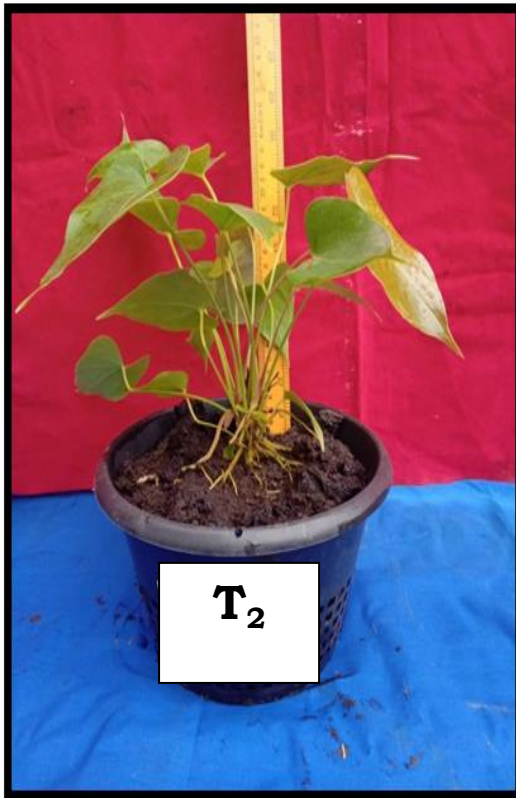


Plate XV: Comparative plant height under different shade levels

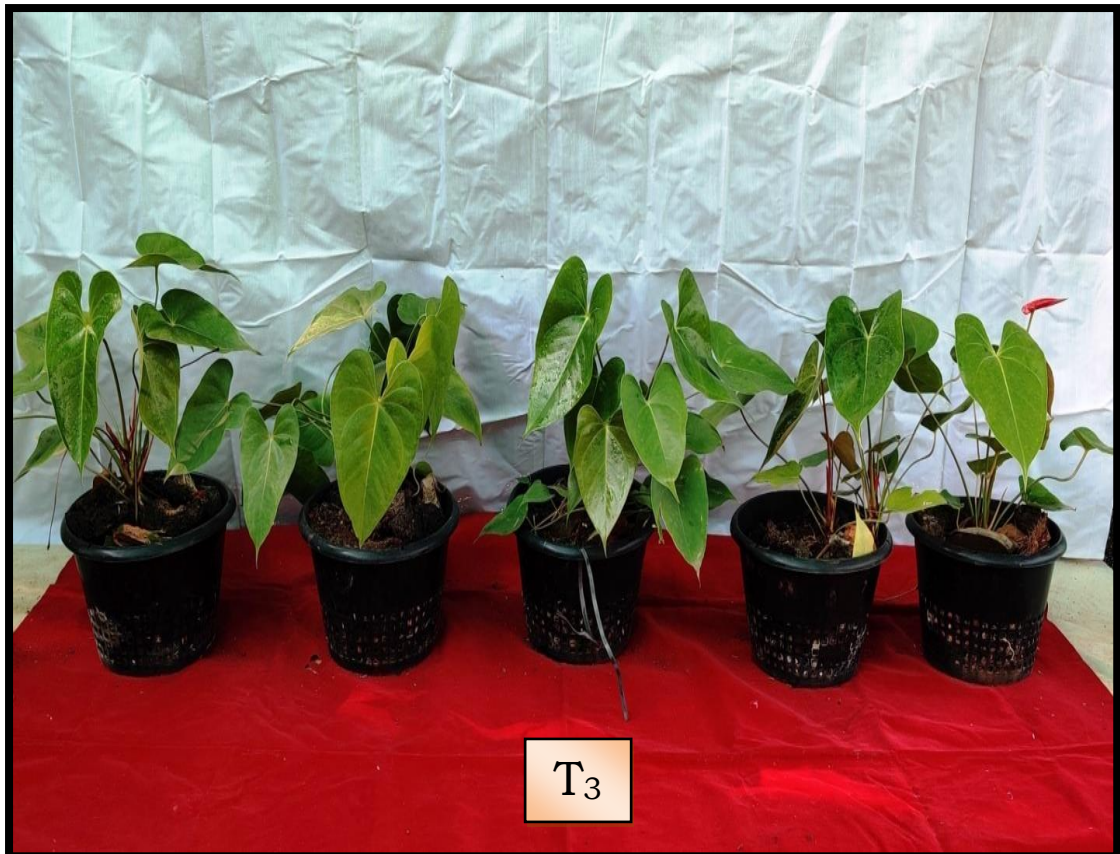
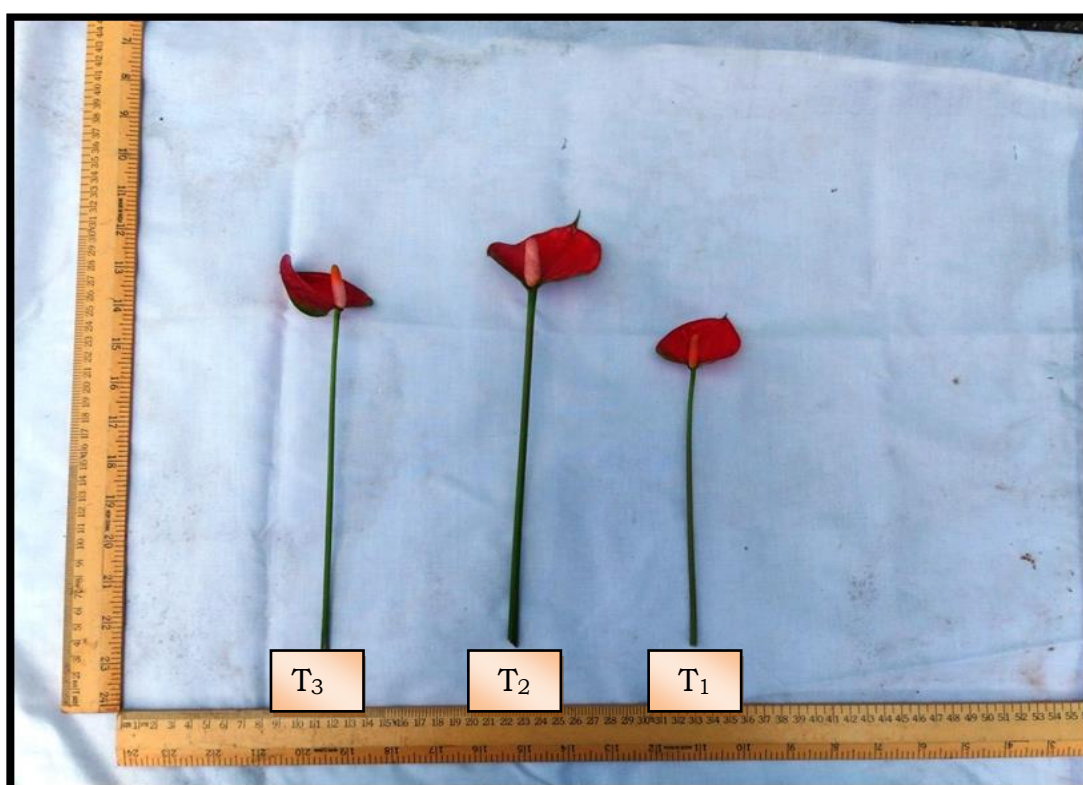


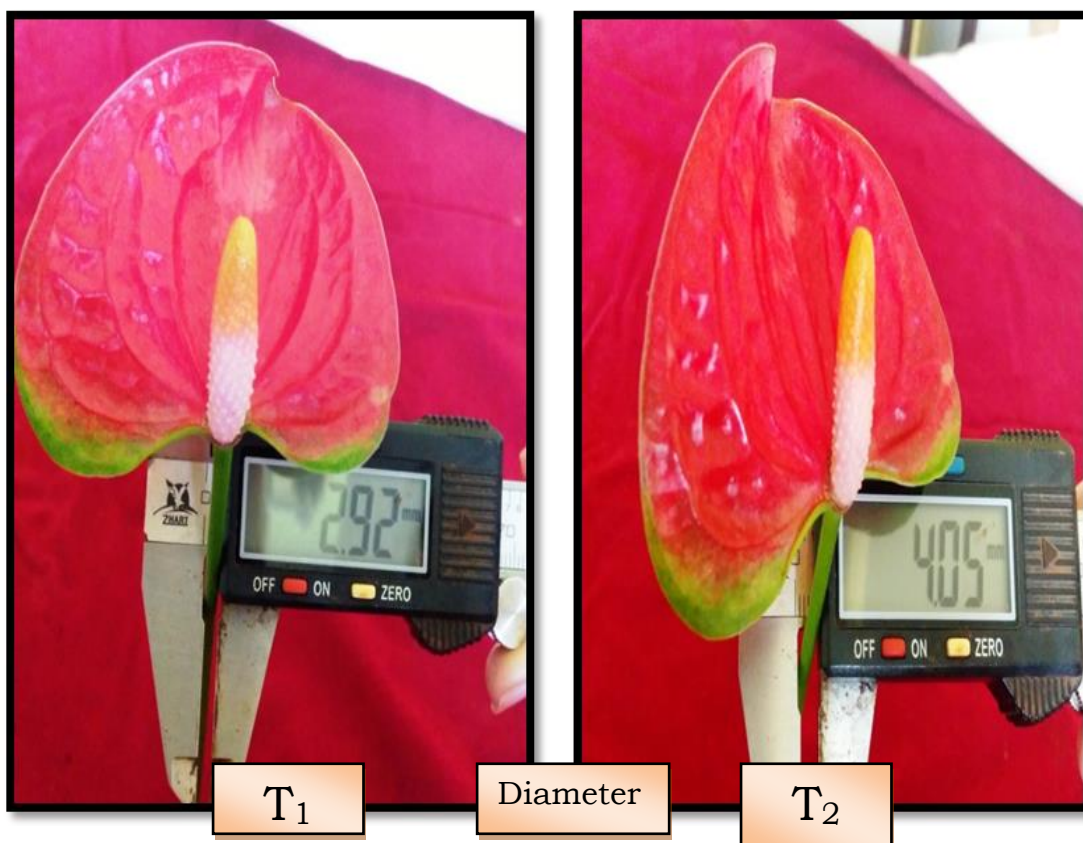
Plate XVI: Vegetative growth at 8 months stage of anthurium under different shade levels



Plate XVII: Flowering stage of anthurium at 16 months under different shade levels



Flower stalk length



Diameter

Plate XVIII: Flower stalk length and diameter under different shade levels



T₂

Length



T₁



T₂

Width



T₁

Plate XIX: Length and width of spathe under different shade levels

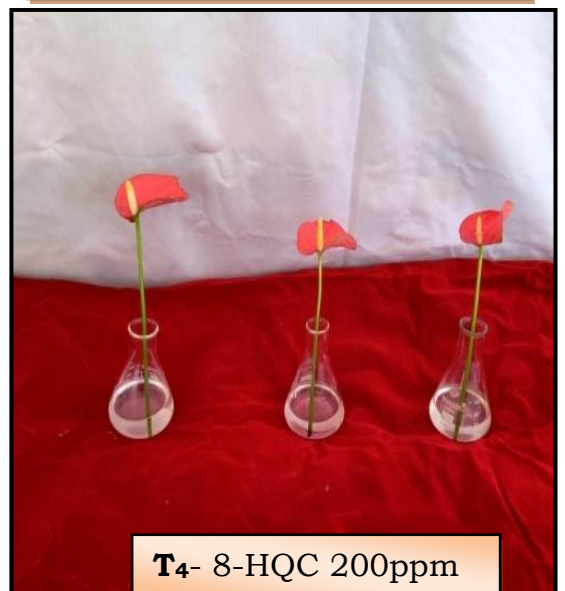
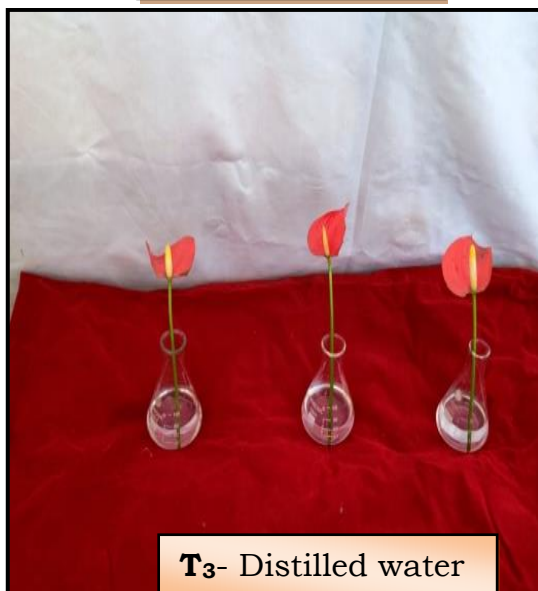


Plate XXa: Different holding solutions used to extend vase life of anthurium

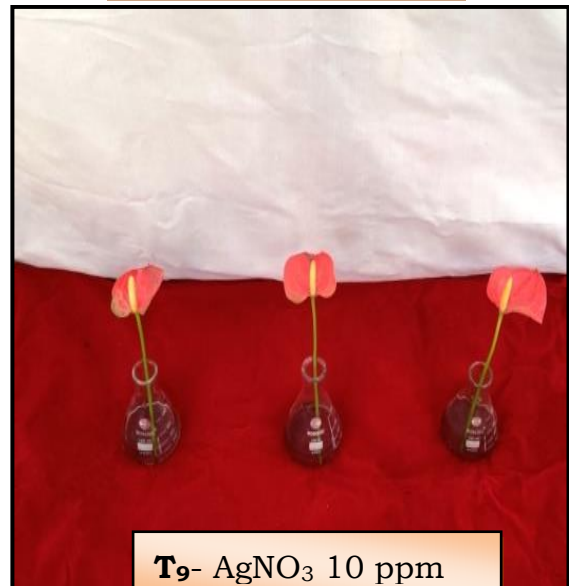
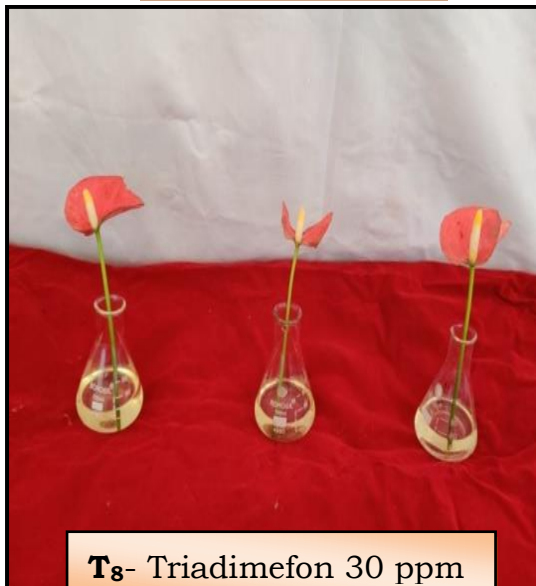
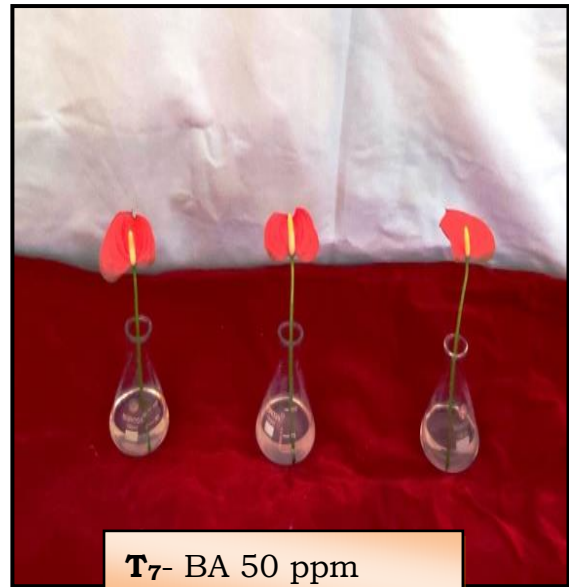
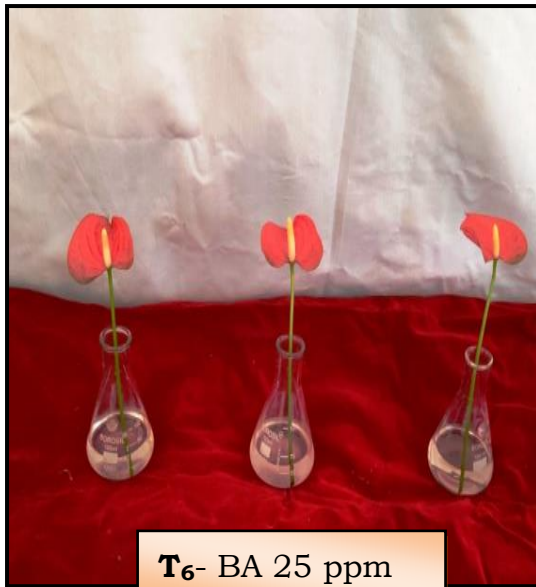


Plate XXb: Different holding solutions used to extend vase life of anthurium



Plate XXI: Spadix necrosis initiation of anthurium

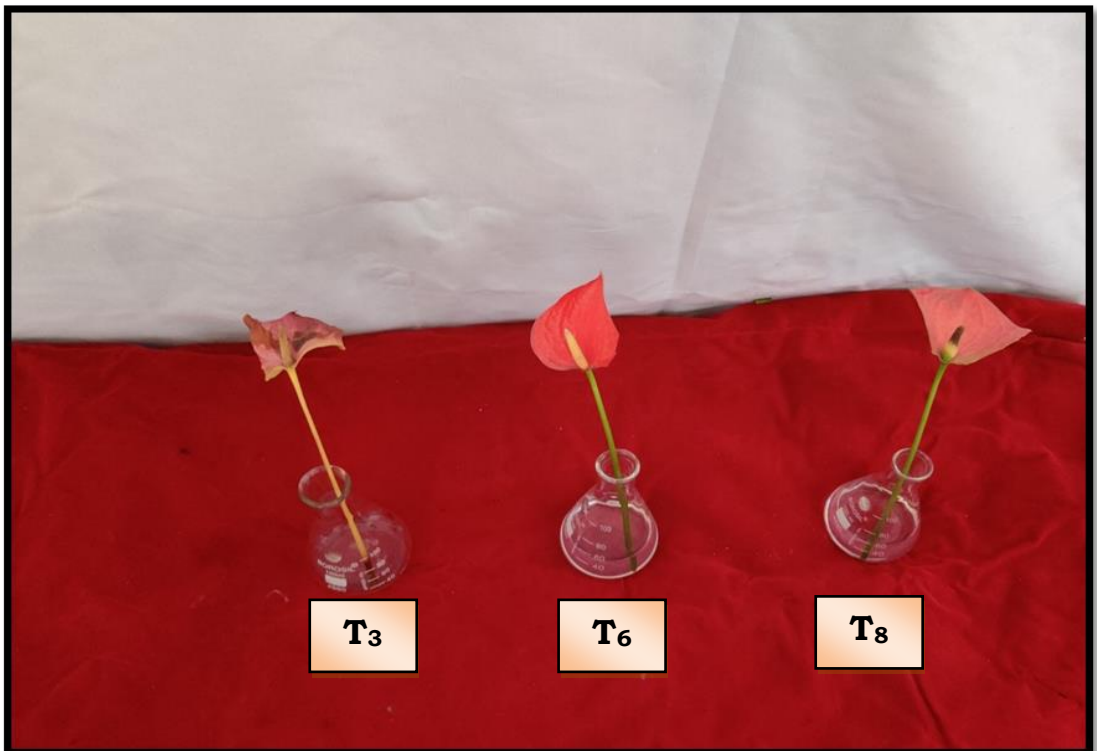


Plate XXII: Vase life of anthurium after 16 days

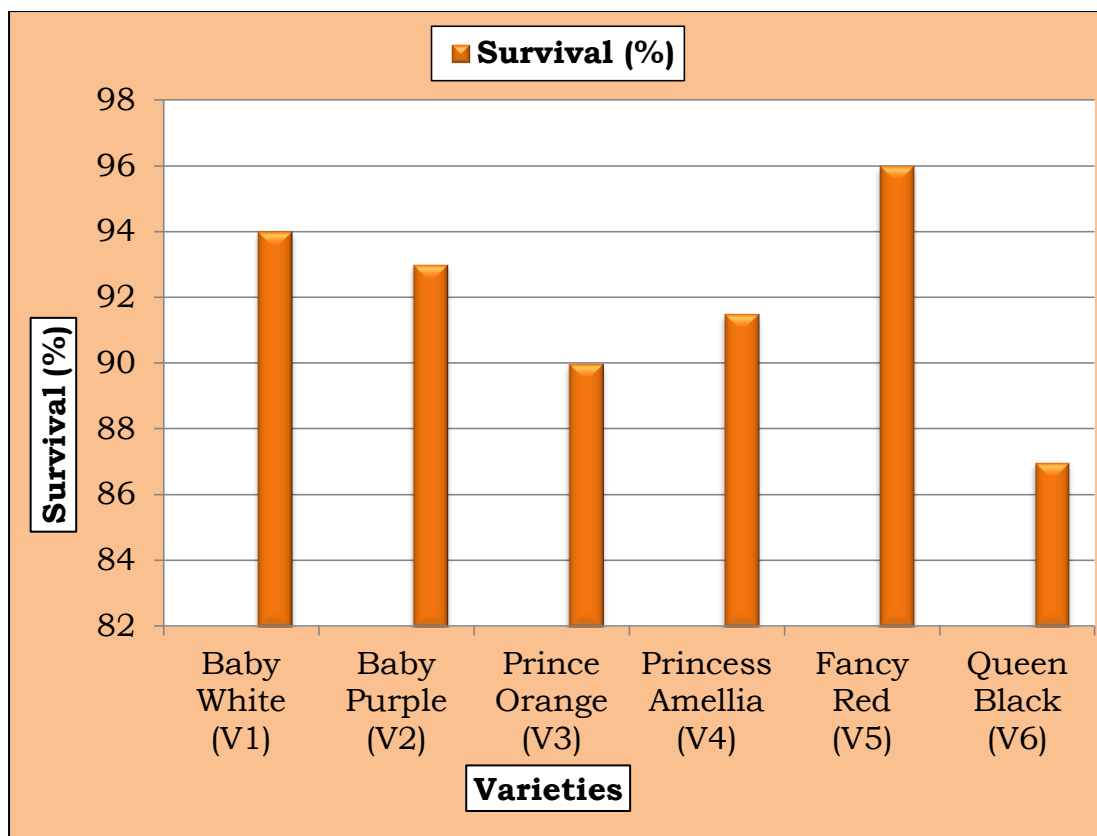


Fig. 4: Survival percentage in different varieties of anthurium

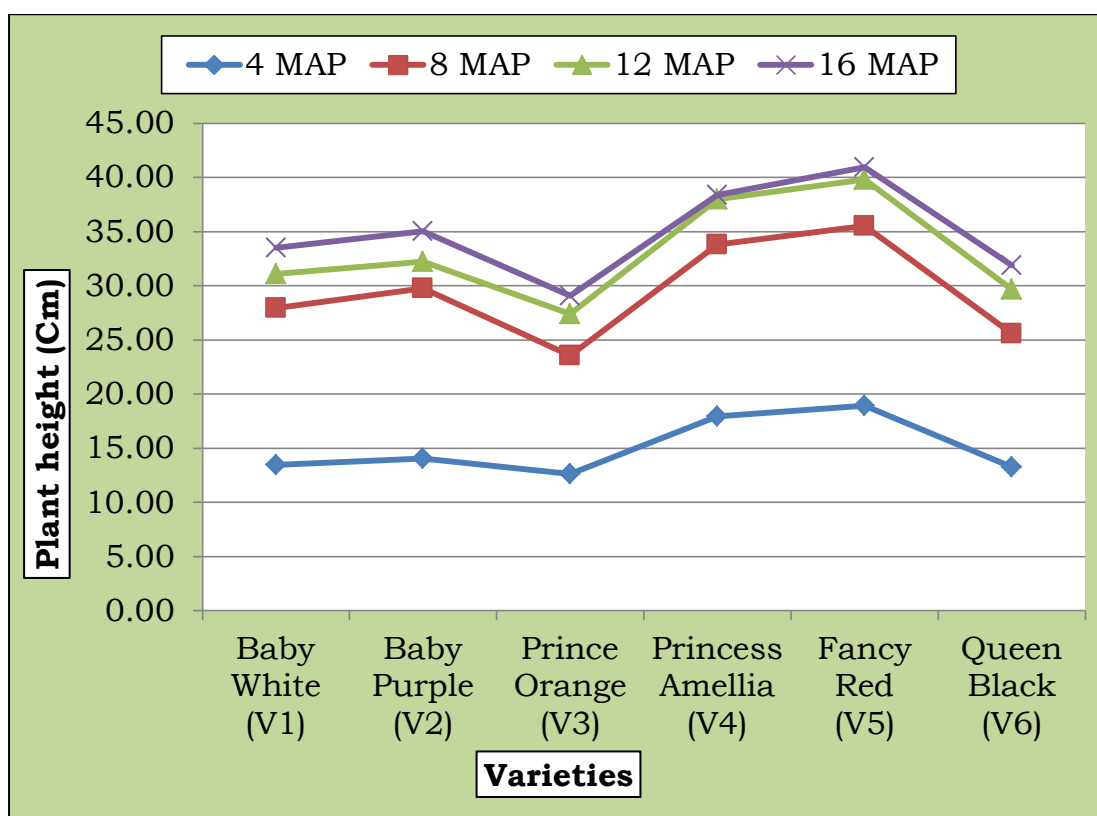


Fig. 5: Periodical plant height in different varieties of anthurium

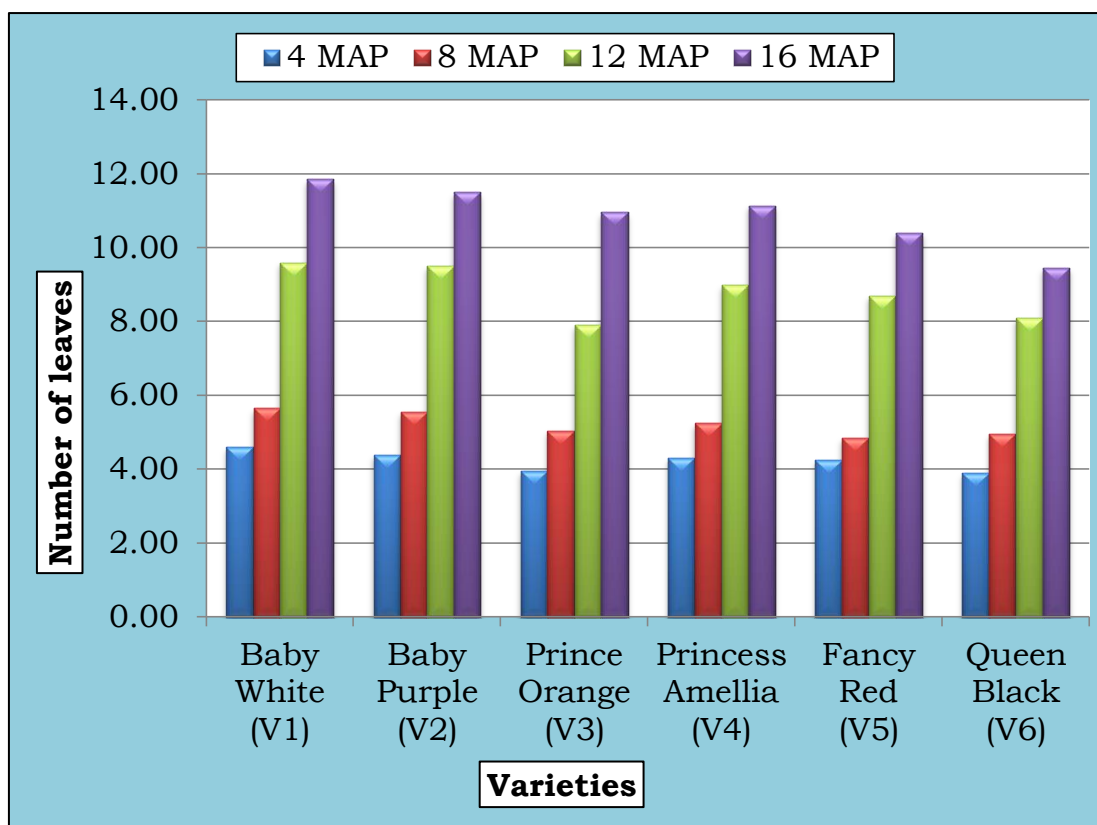


Fig. 6: Number of leaves in different anthurium varieties

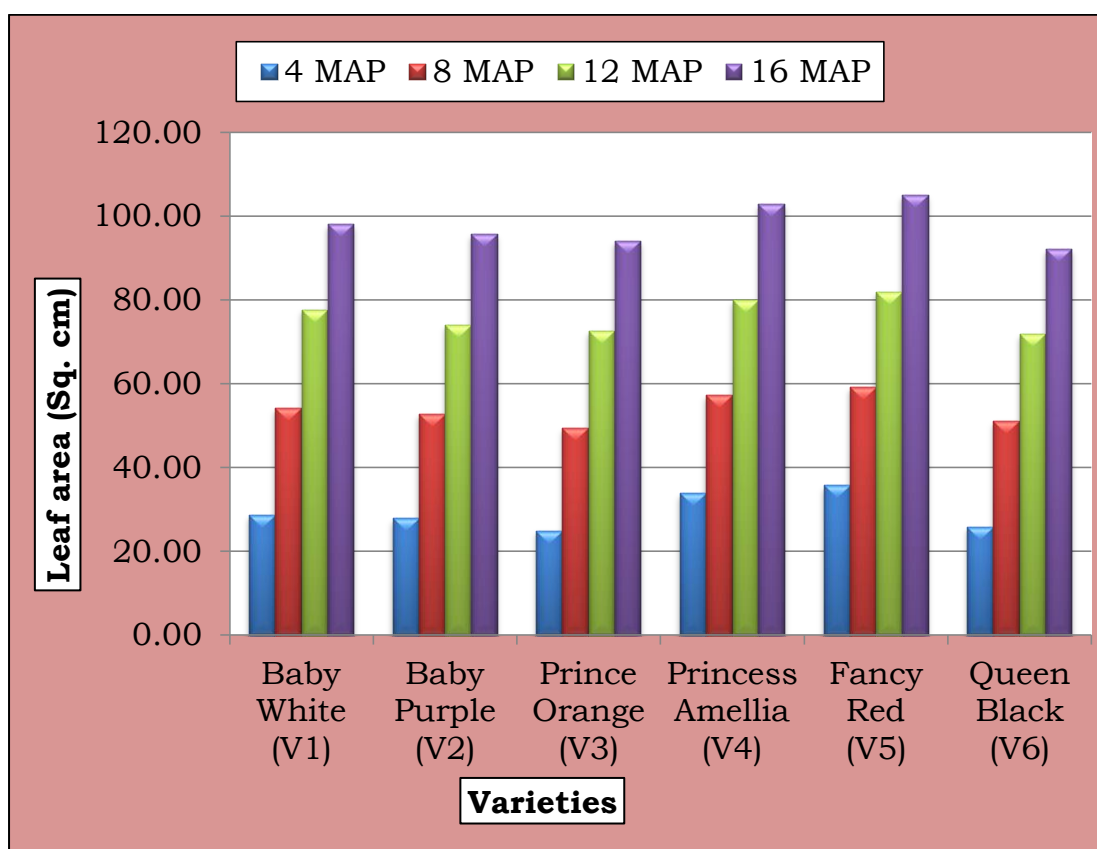


Fig. 7: Leaf area in different anthurium varieties

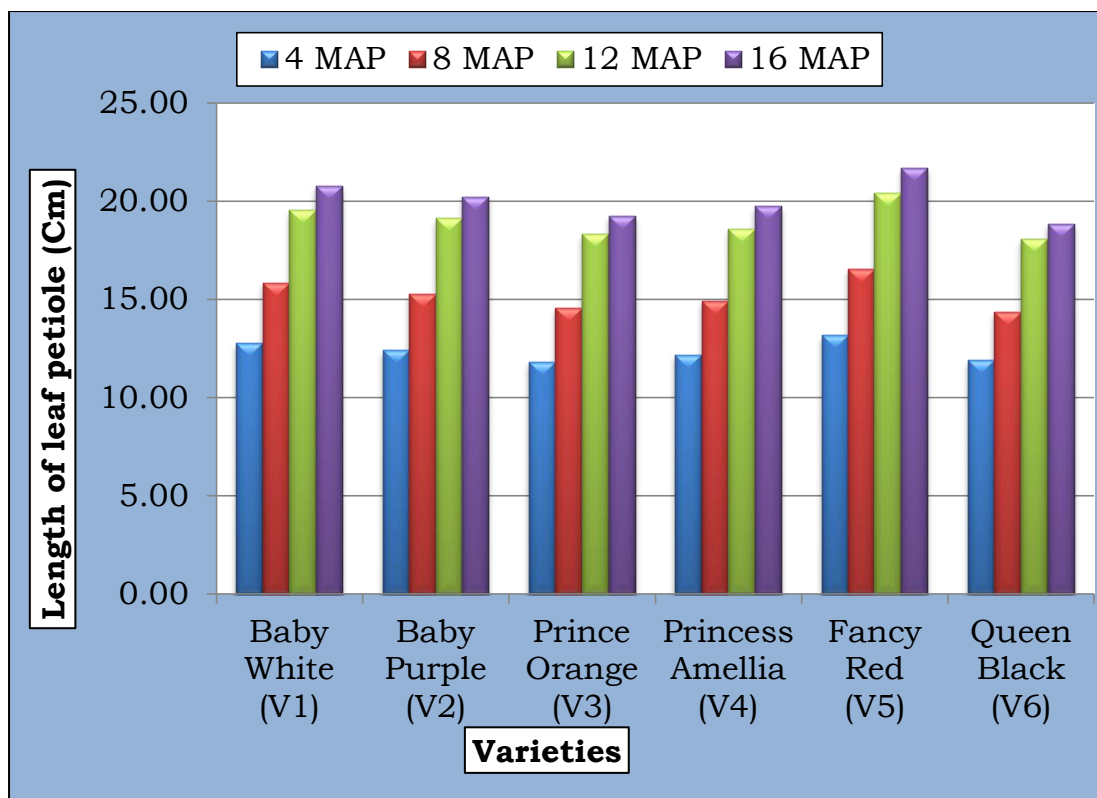


Fig. 8: Length of leaf petiole in different anthurium varieties

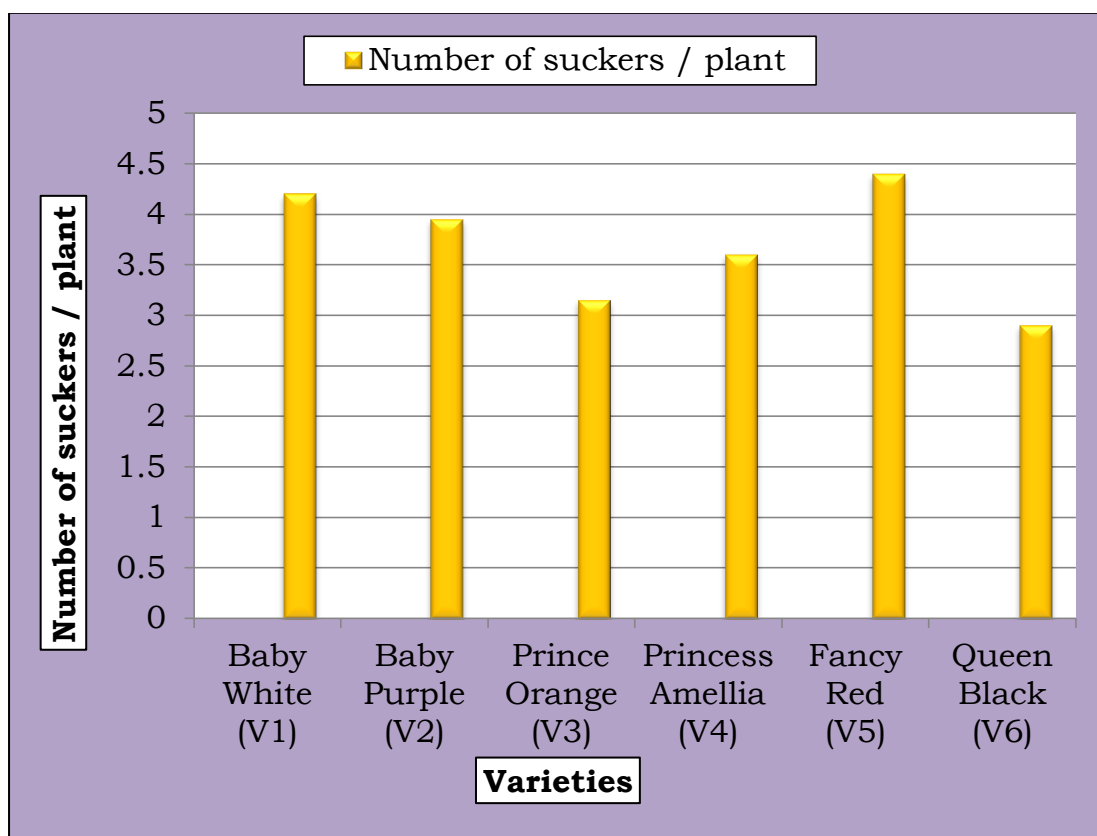


Fig. 9: Number of suckers per plant in different anthurium varieties

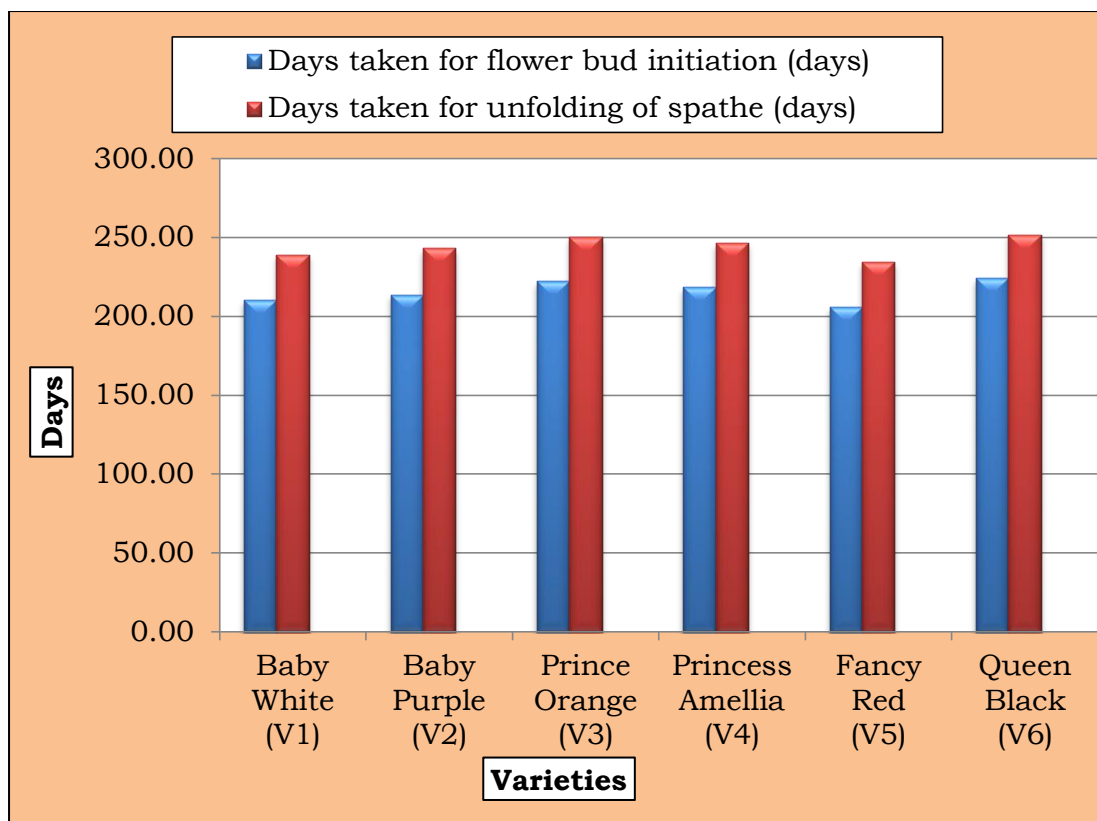


Fig. 10: Days taken for flower bud initiation, days taken for unfolding of spathe in different anthurium varieties

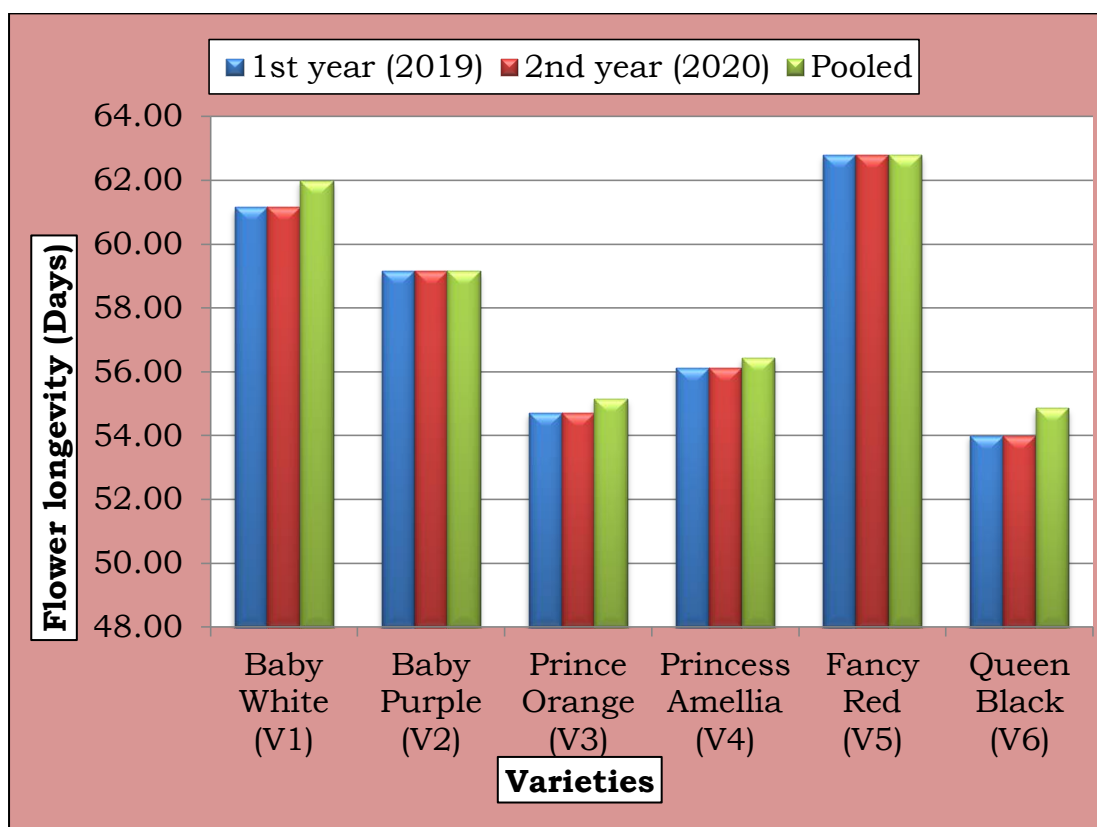


Fig. 11: Flower longevity in different anthurium varieties

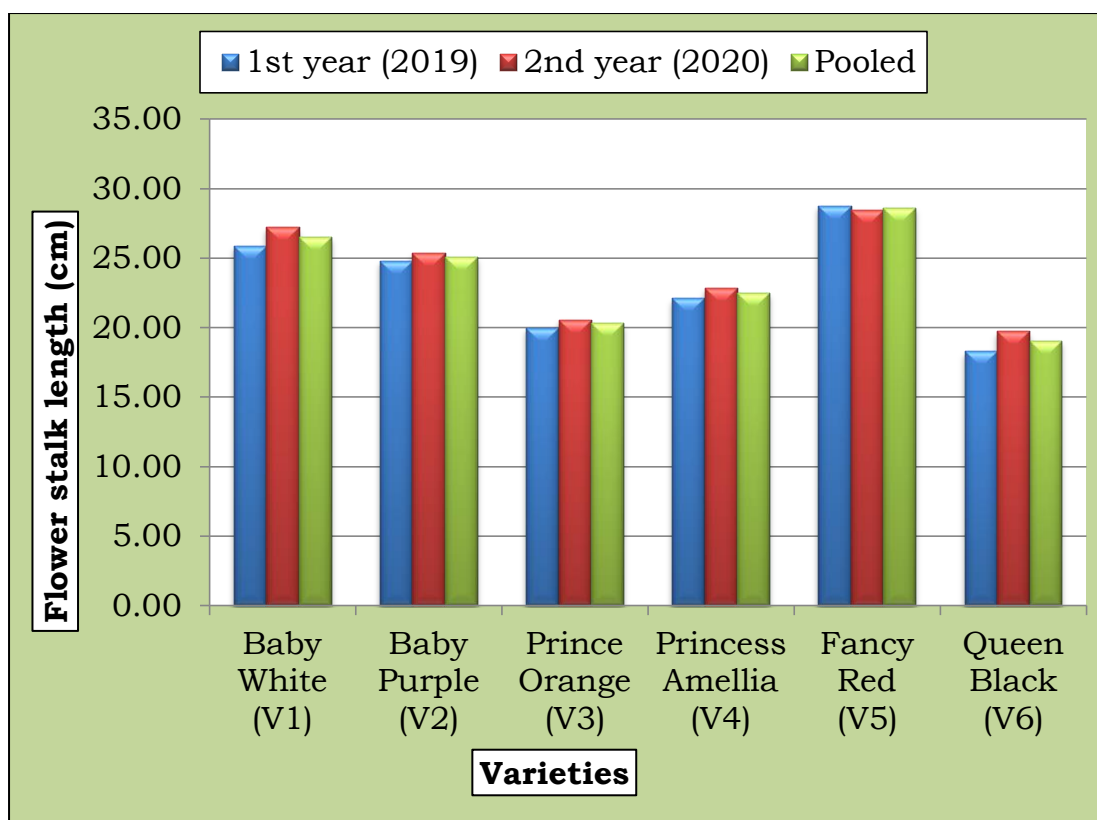


Fig. 12: Flower stalk length in different anthurium varieties

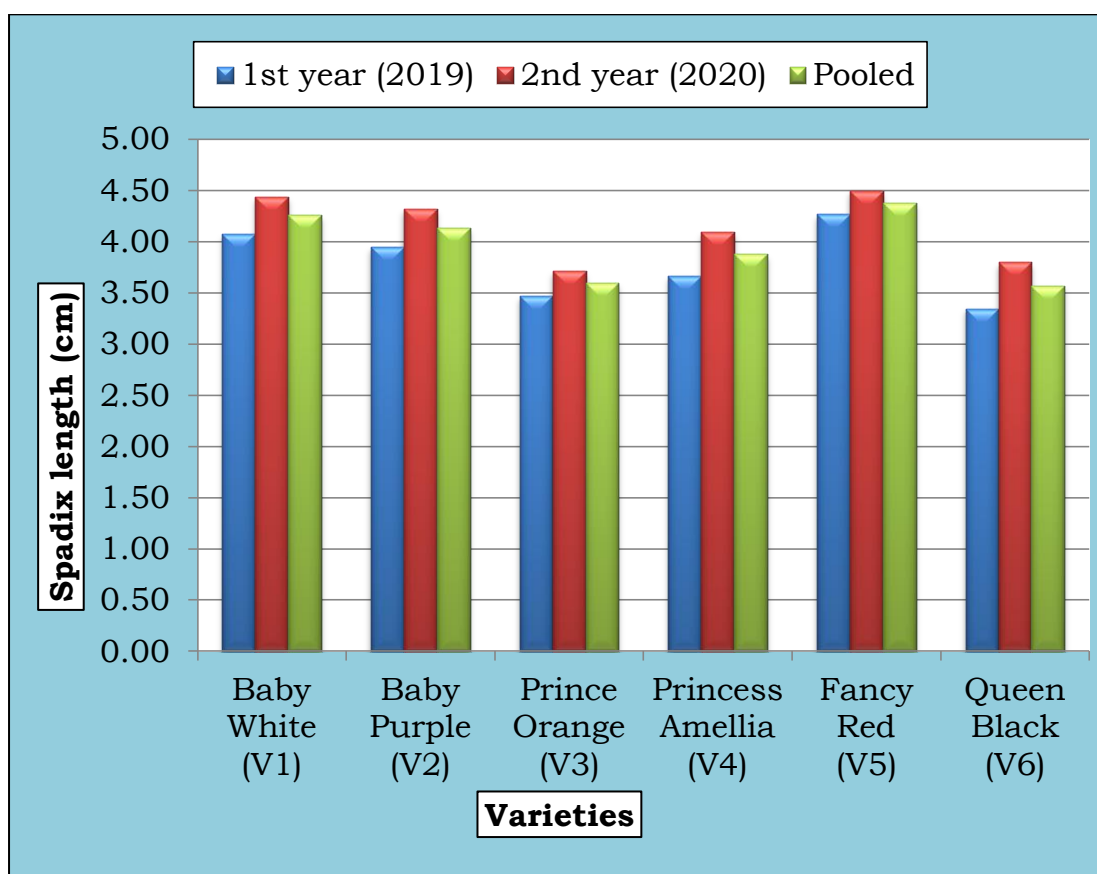


Fig. 13: Spadix length in different anthurium varieties

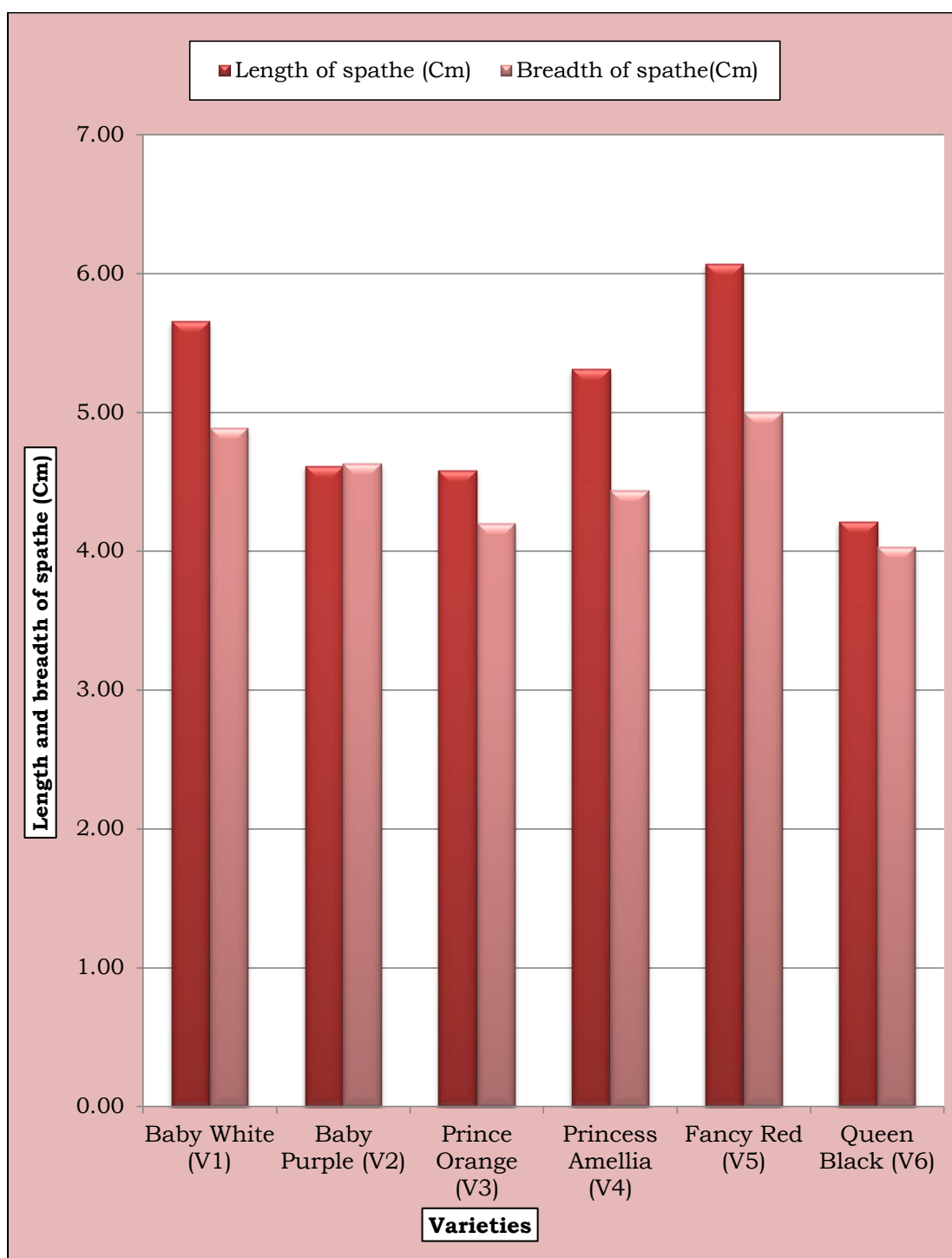


Fig. 14: Length and breadth of spathe in different anthurium varieties

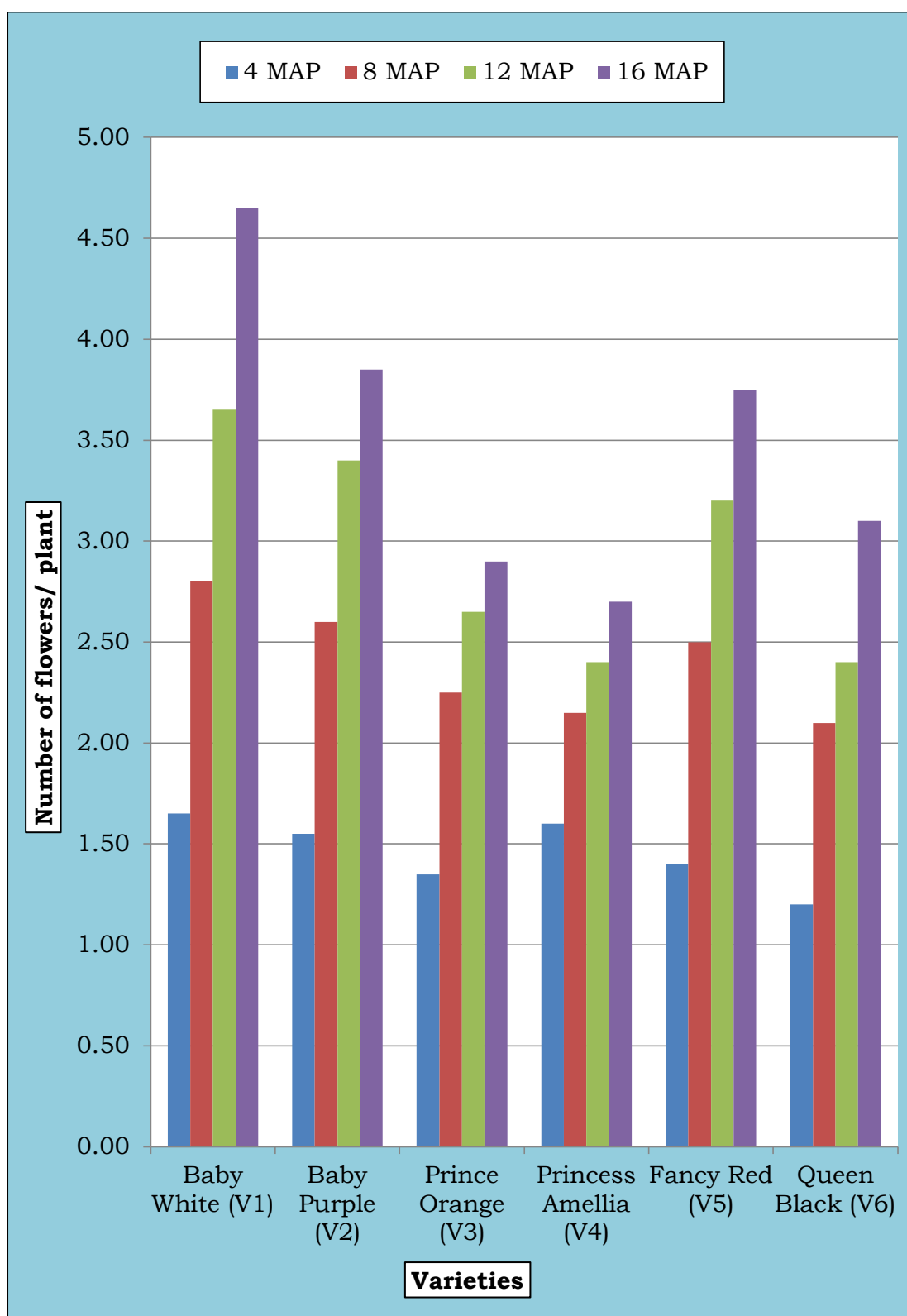


Fig. 15: Number of flowers produced per plant at bimonth interval in different anthurium varieties

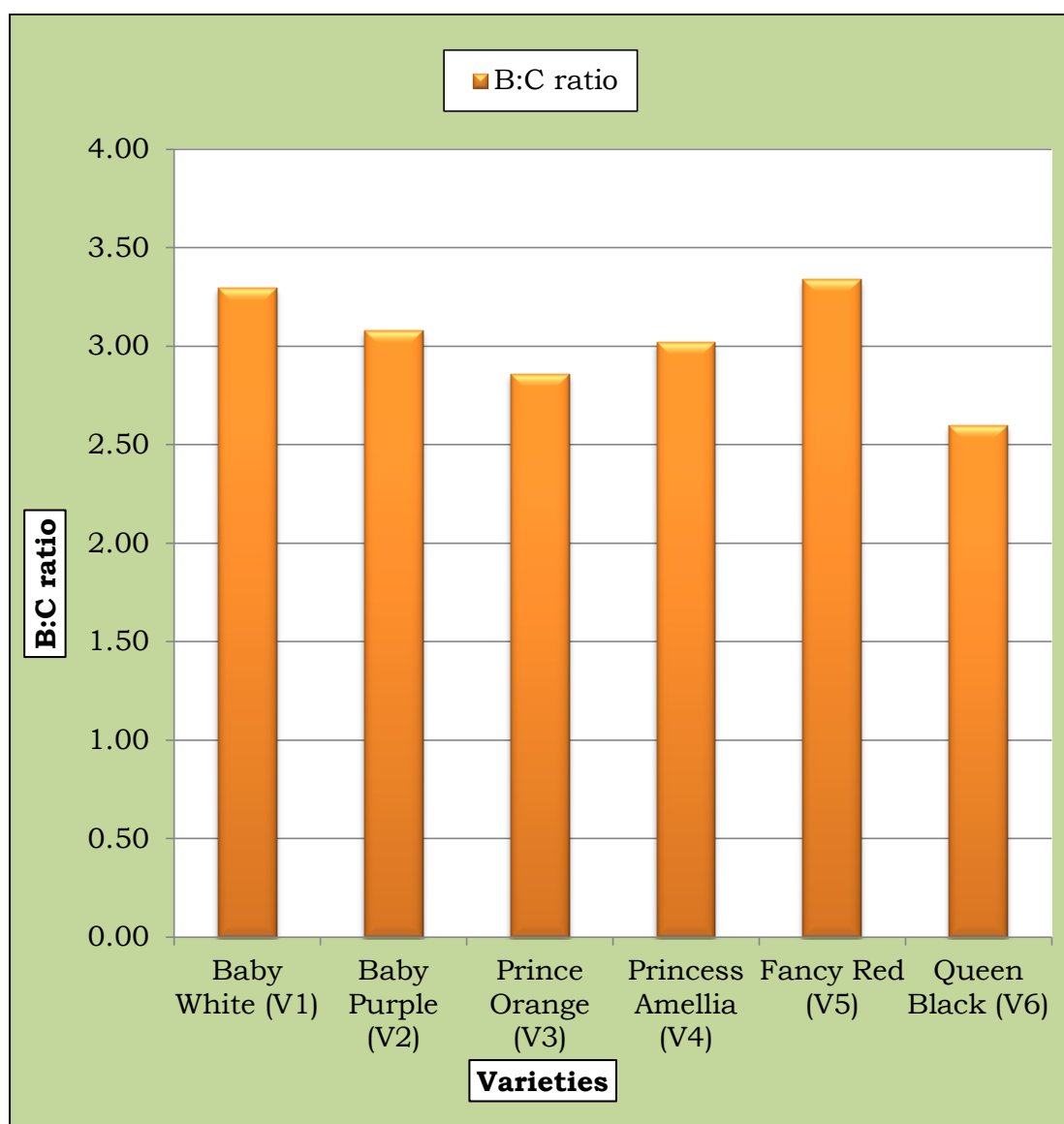


Fig. 16: Economics ratio of different anthurium varieties

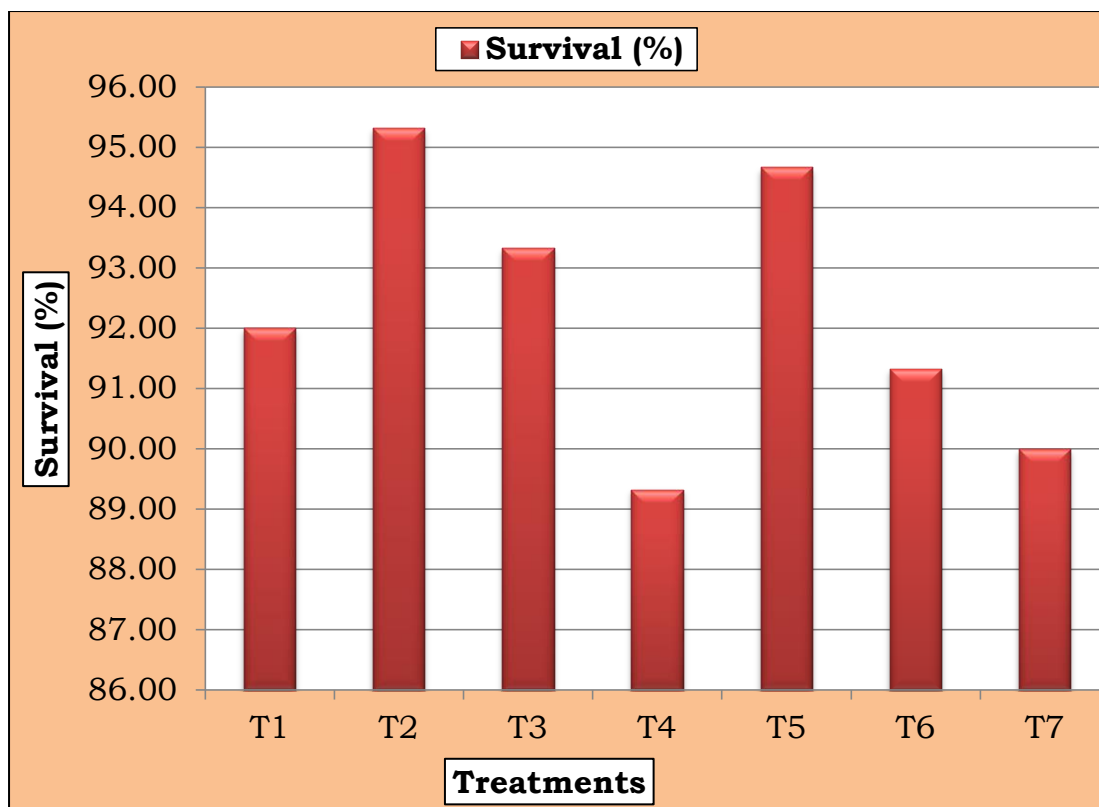


Fig. 17: Effect of growing media on survival percentage of anthurium cv. Tropical Red

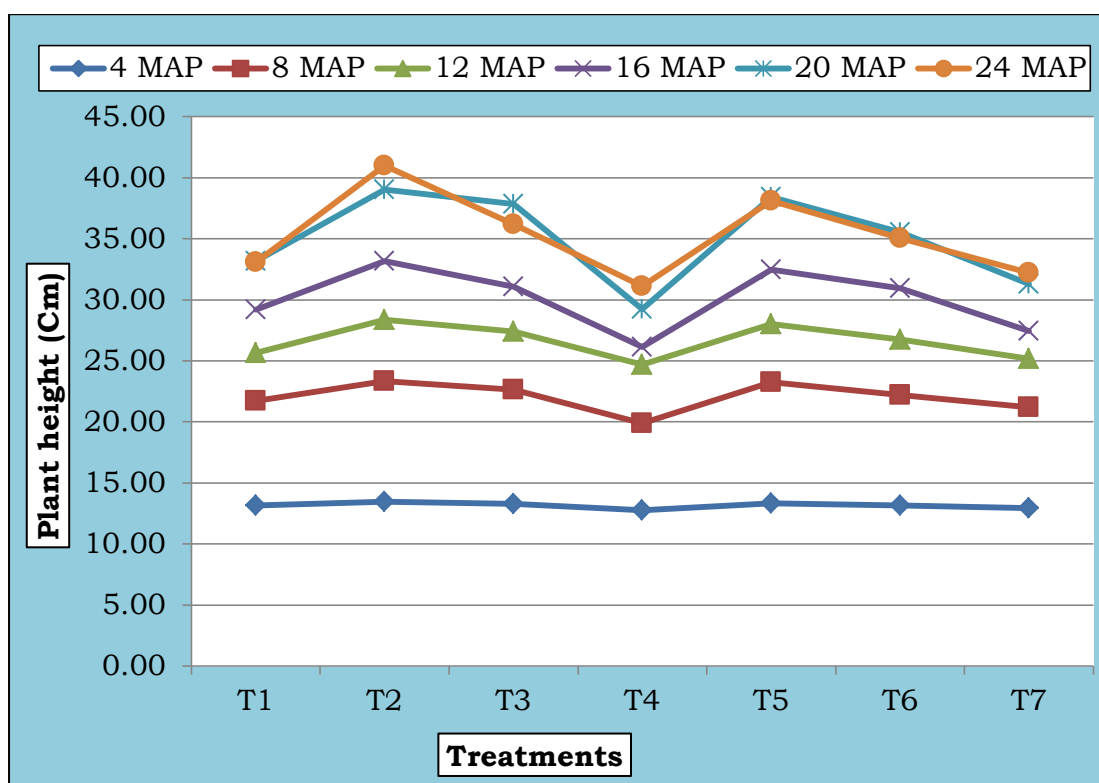


Fig. 18: Effect of growing media on plant height of anthurium cv. Tropical Red

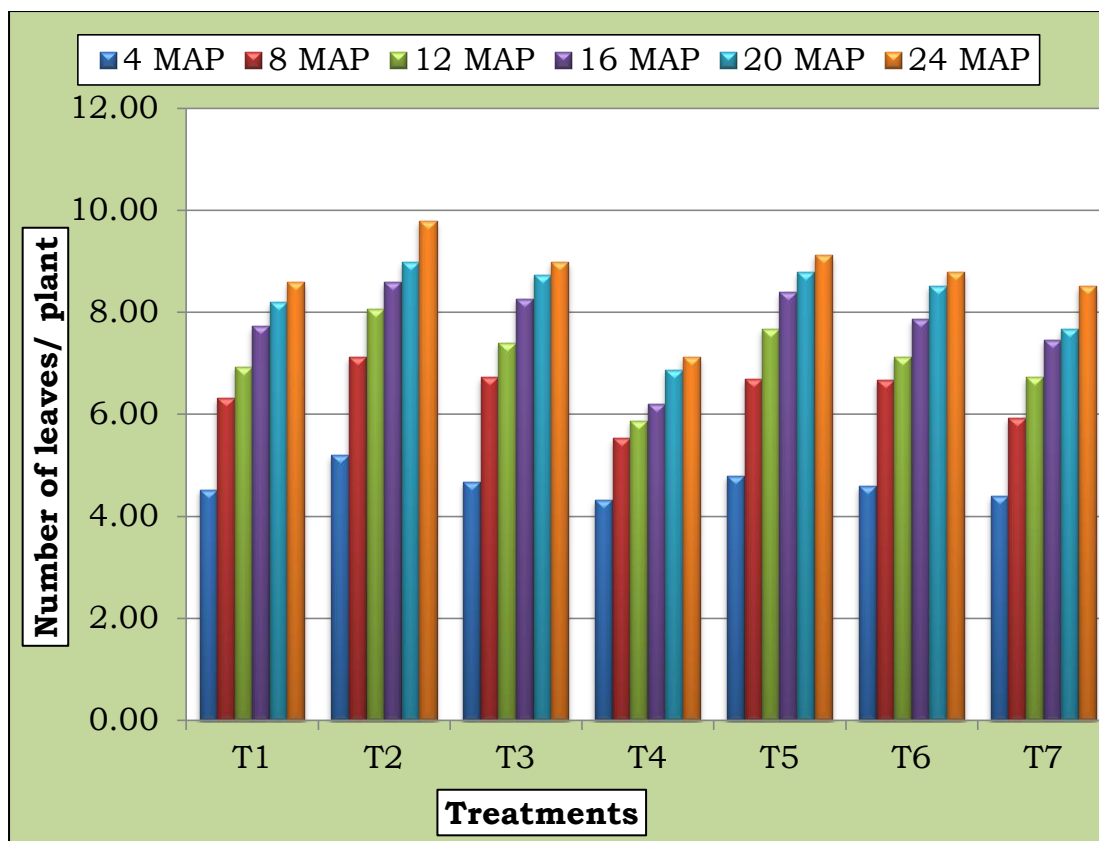


Fig. 19: Effect of growing media on number of leaves per plant of anthurium cv. Tropical Red

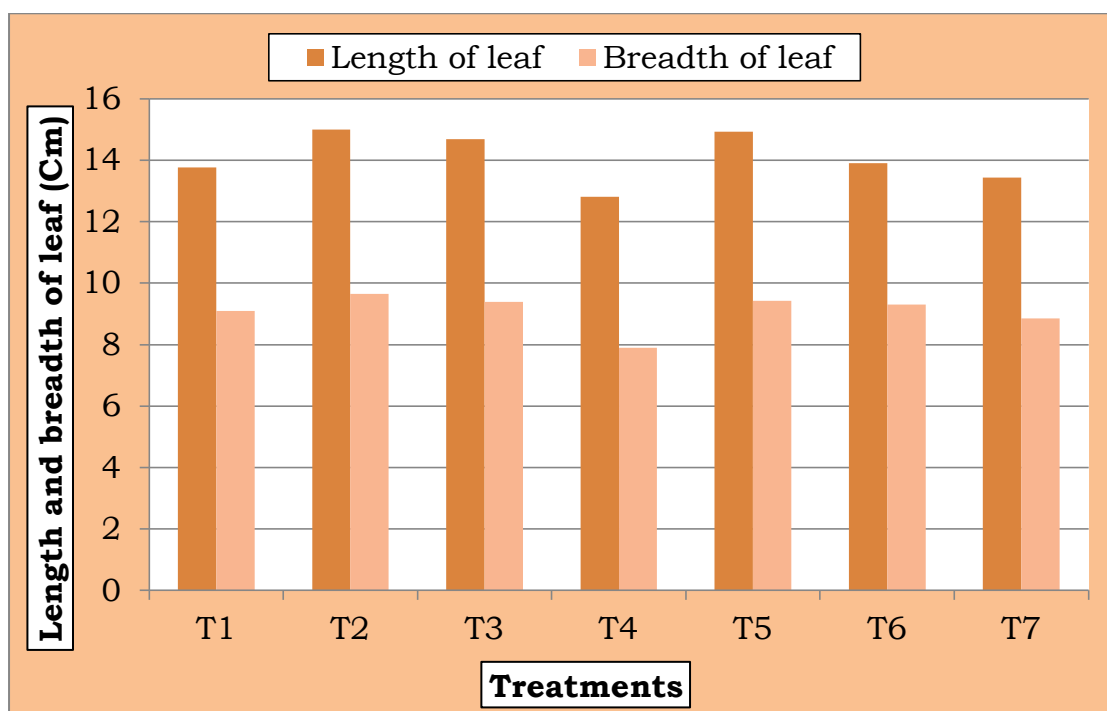


Fig. 20: Effect of growing media length and breadth of leaf of anthurium cv. Tropical Red

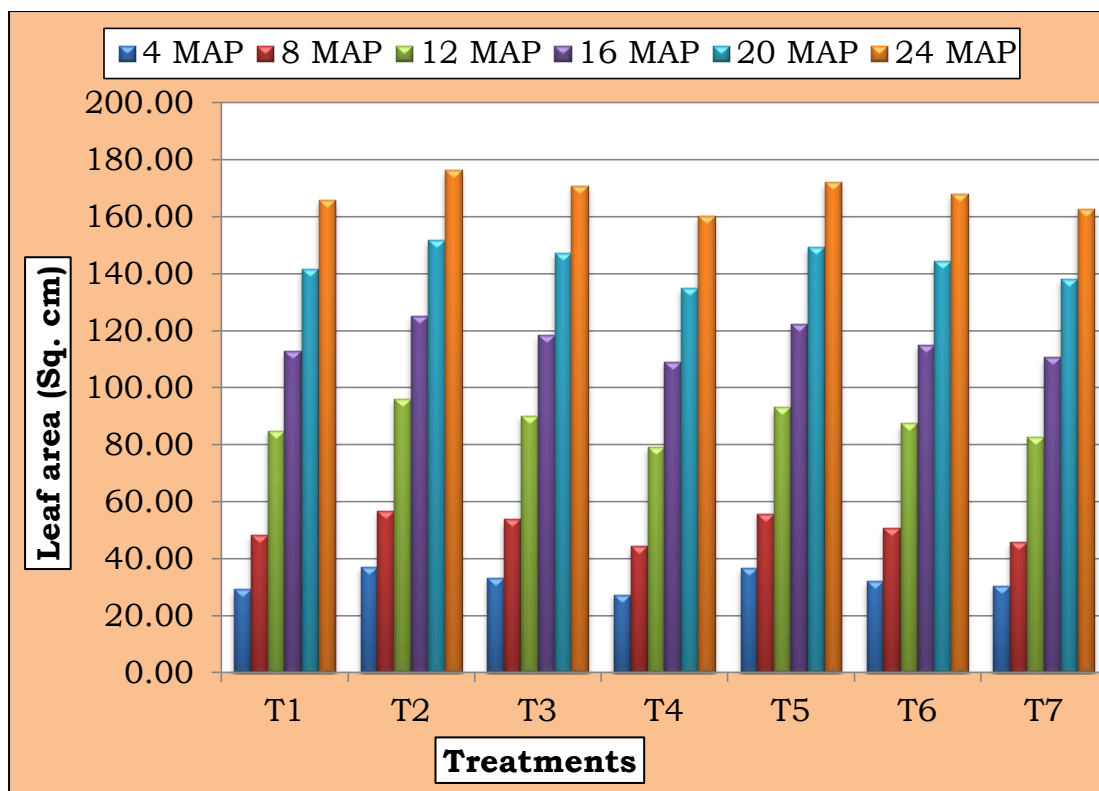


Fig. 21: Effect of growing media on leaf area of anthurium cv. Tropical Red

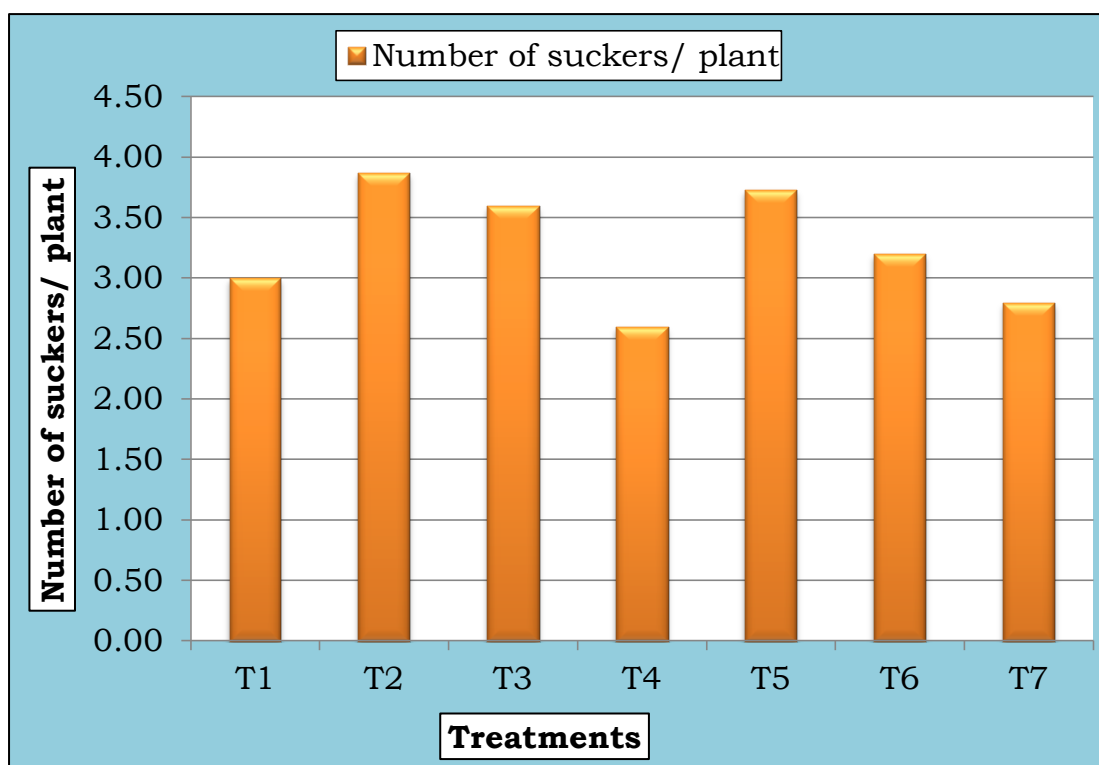


Fig. 22: Effect of growing media on number of suckers per plant of anthurium cv. Tropical Red

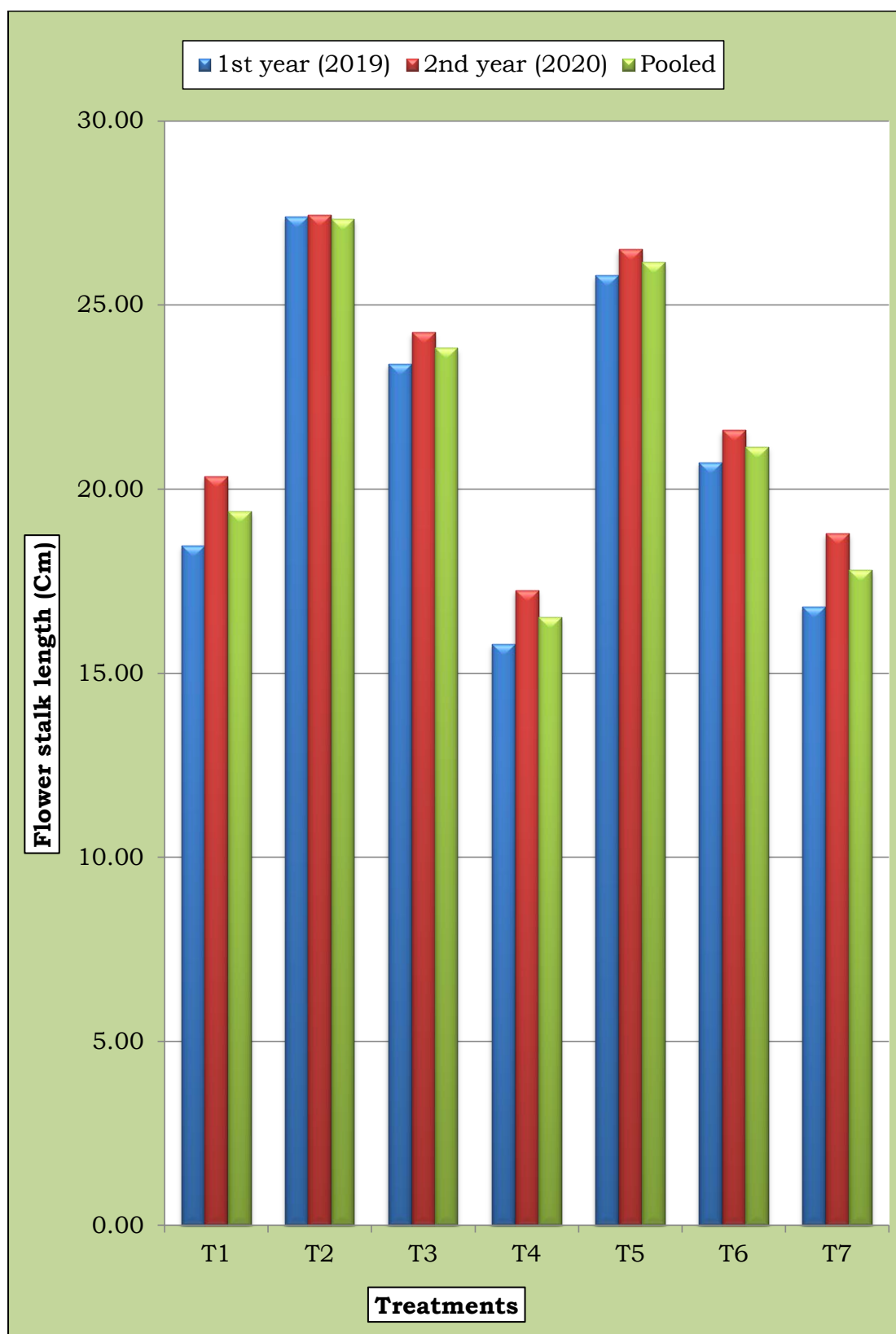


Fig. 23: Effect of growing media on flower stalk length of anthurium cv. Tropical Red

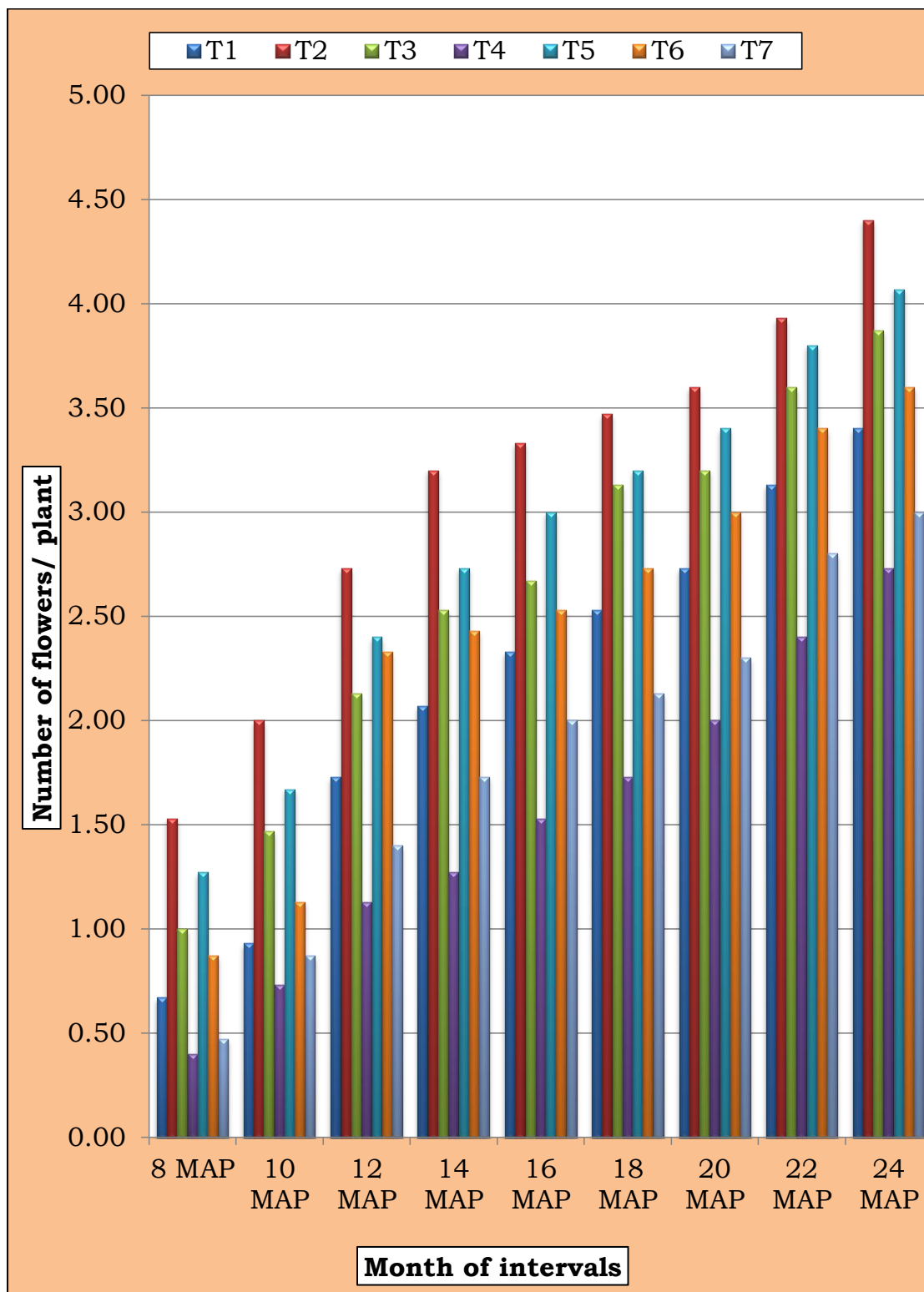


Fig. 24: Effect of growing media on number of flowers produced per plant of anthurium cv. Tropical Red at bimonth intervals

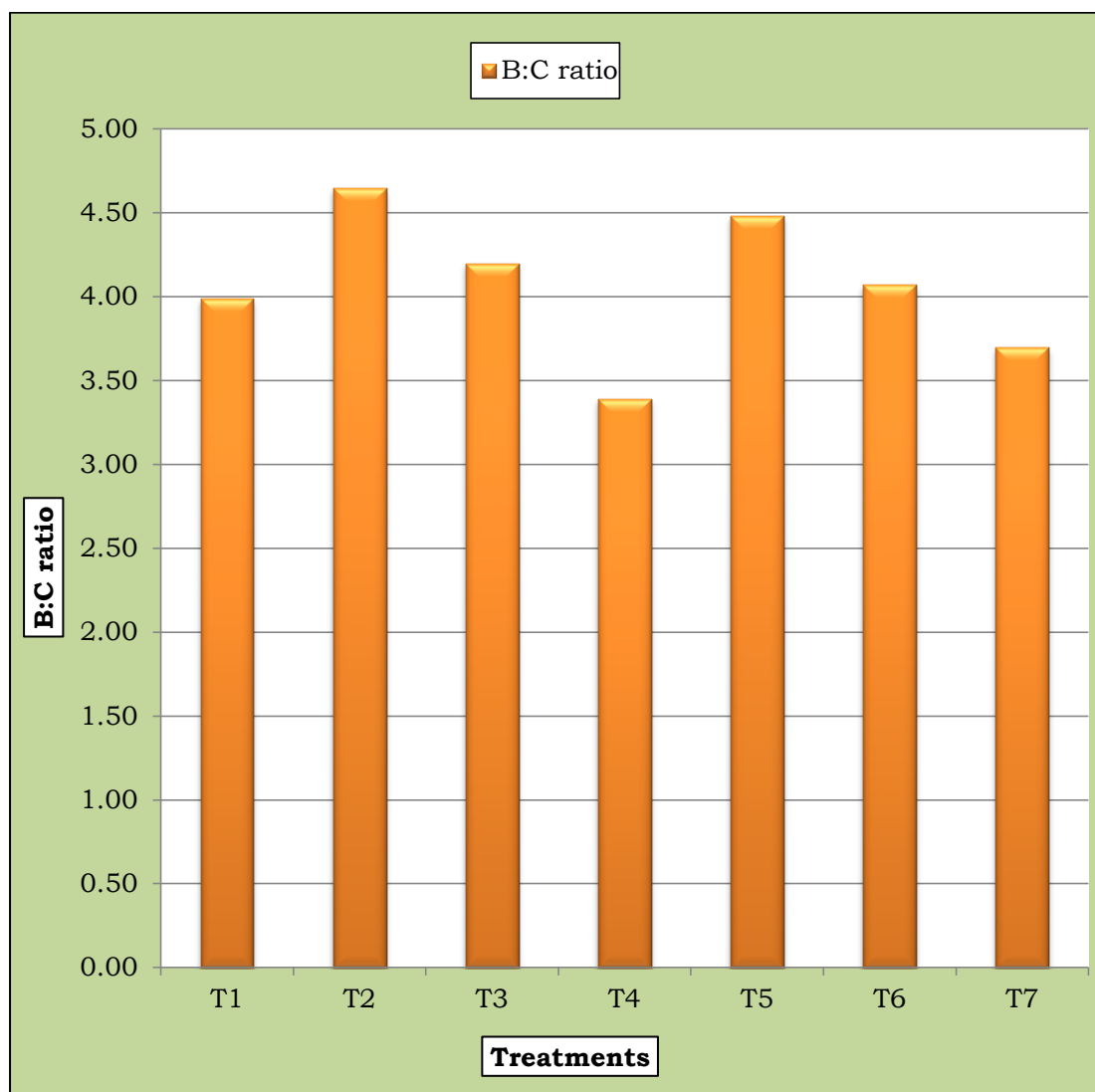


Fig. 25: Economics of different media combinations in anthurium cv. Tropical Red

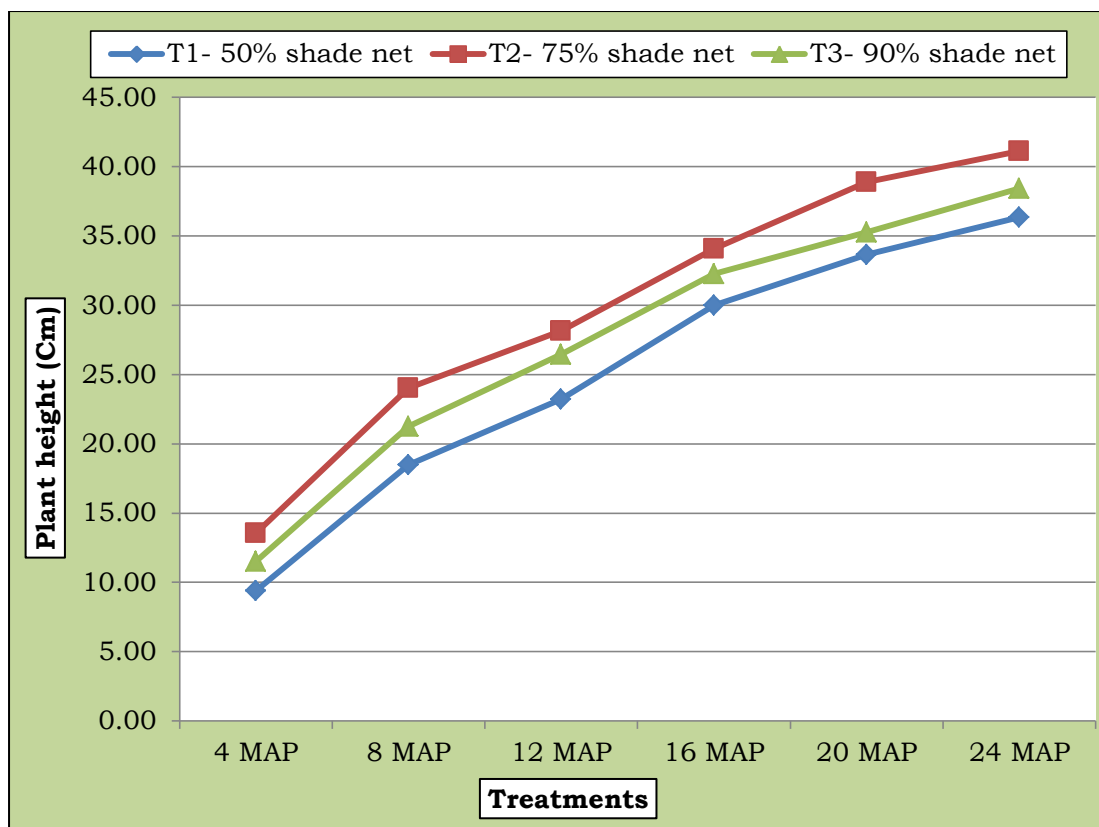


Fig. 26: Effect of shade levels on plant height of anthurium cv. Tropical Red

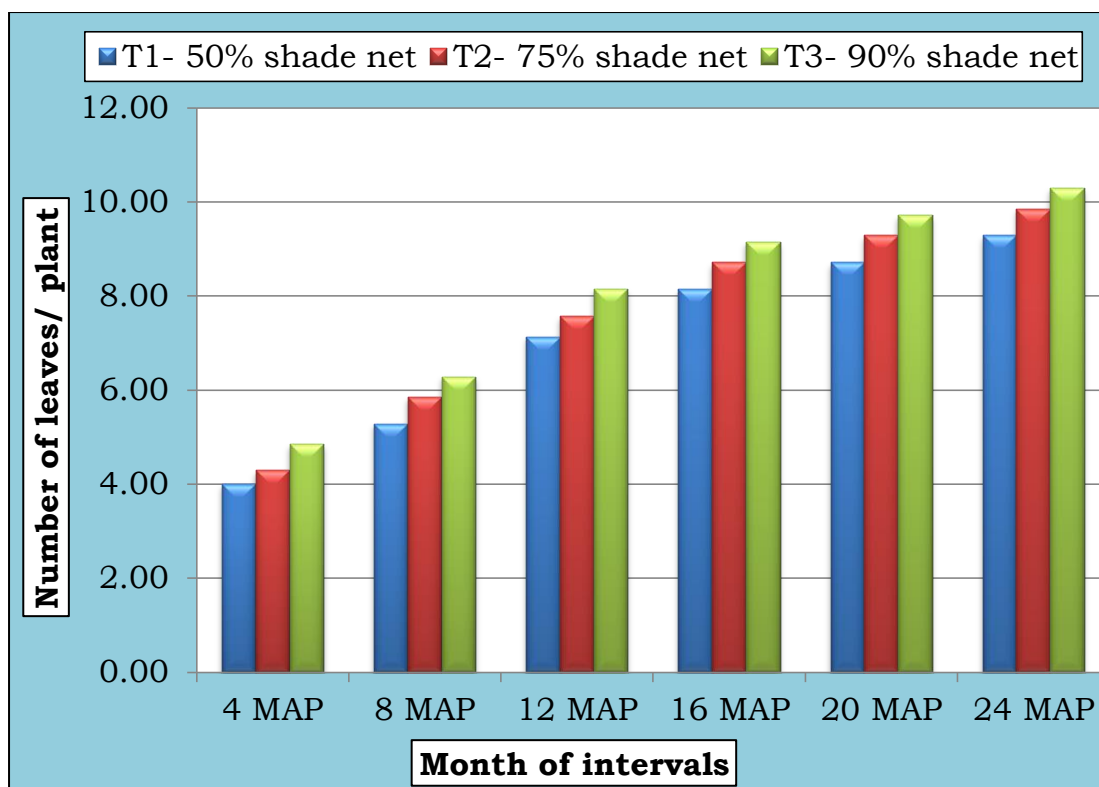


Fig. 27: Effect of shade levels on number of leaves per plant of anthurium cv. Tropical Red

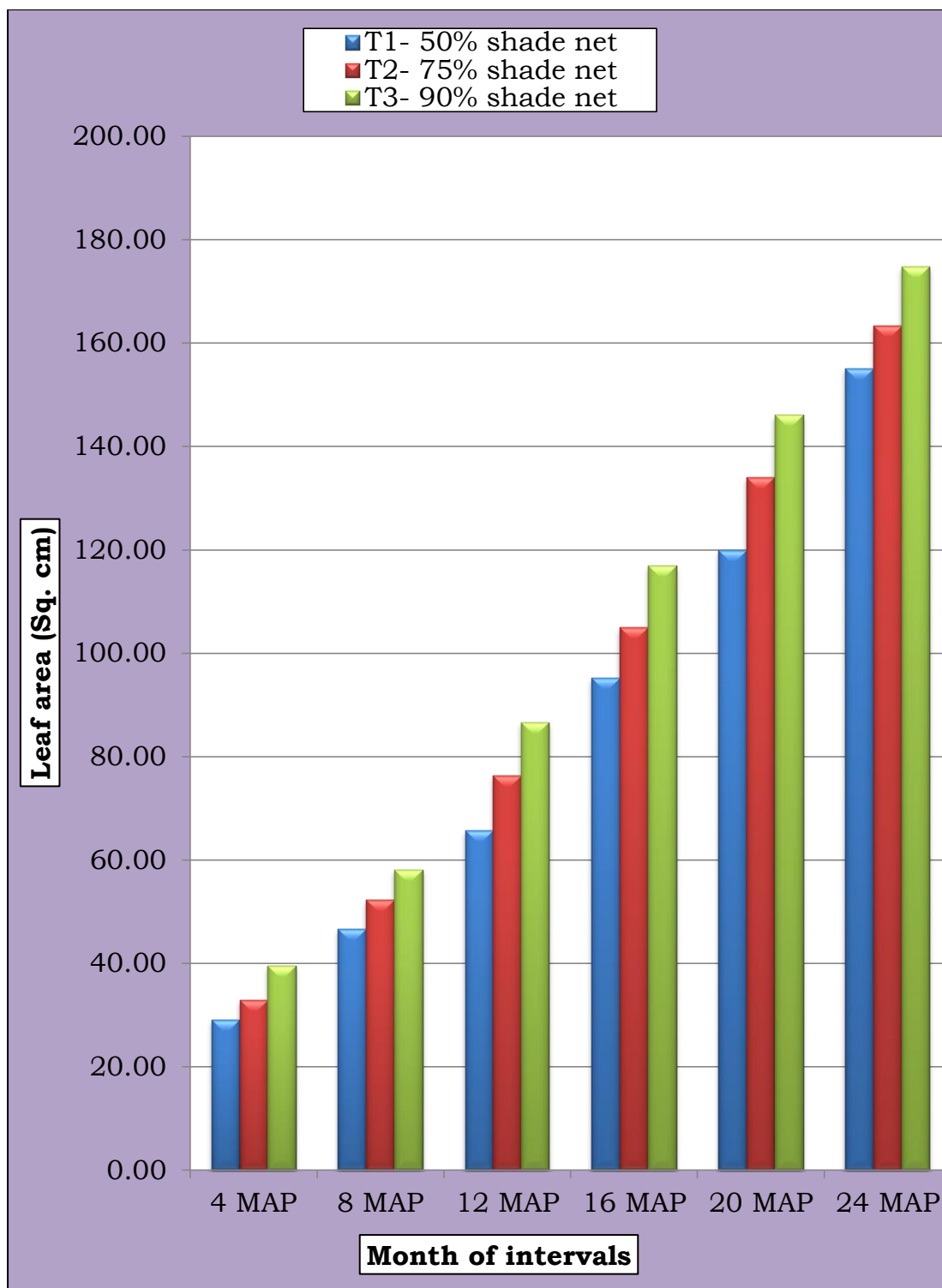


Fig. 28: Effect of shade levels on leaf area of anthurium cv. Tropical Red

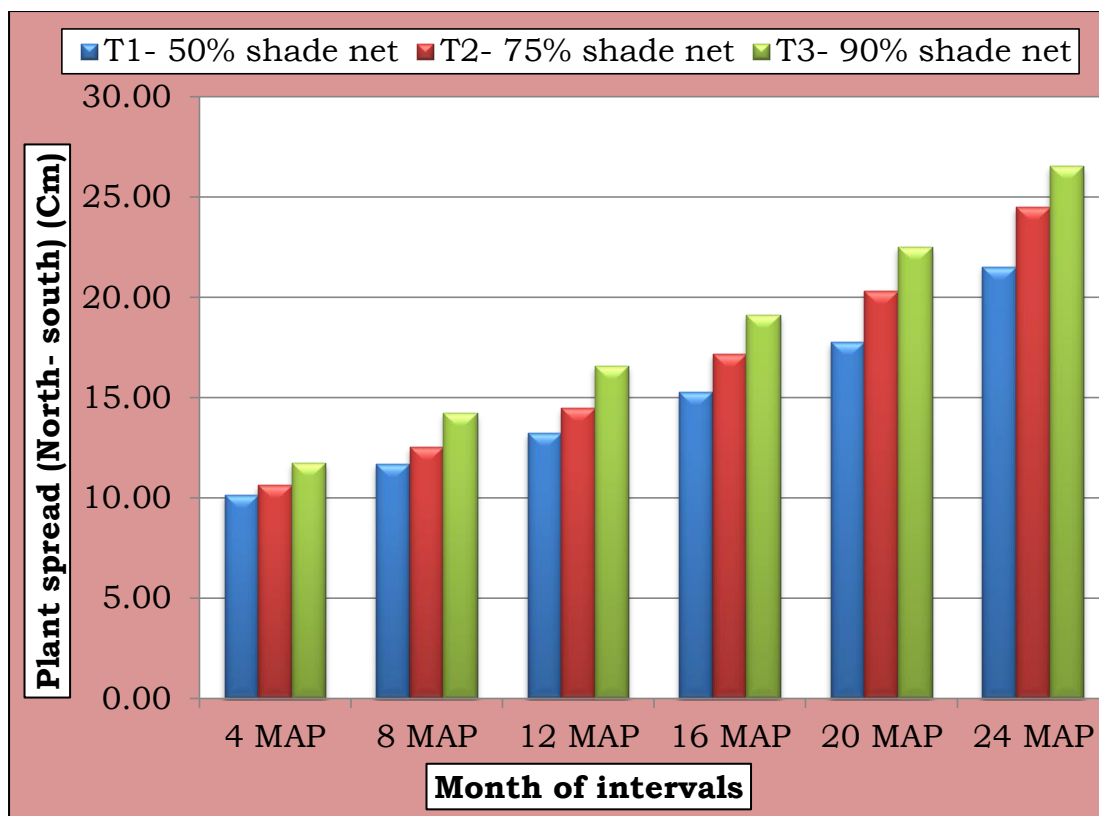


Fig. 29: Effect of shade levels on plant spread (North- south) of anthurium cv. Tropical Red

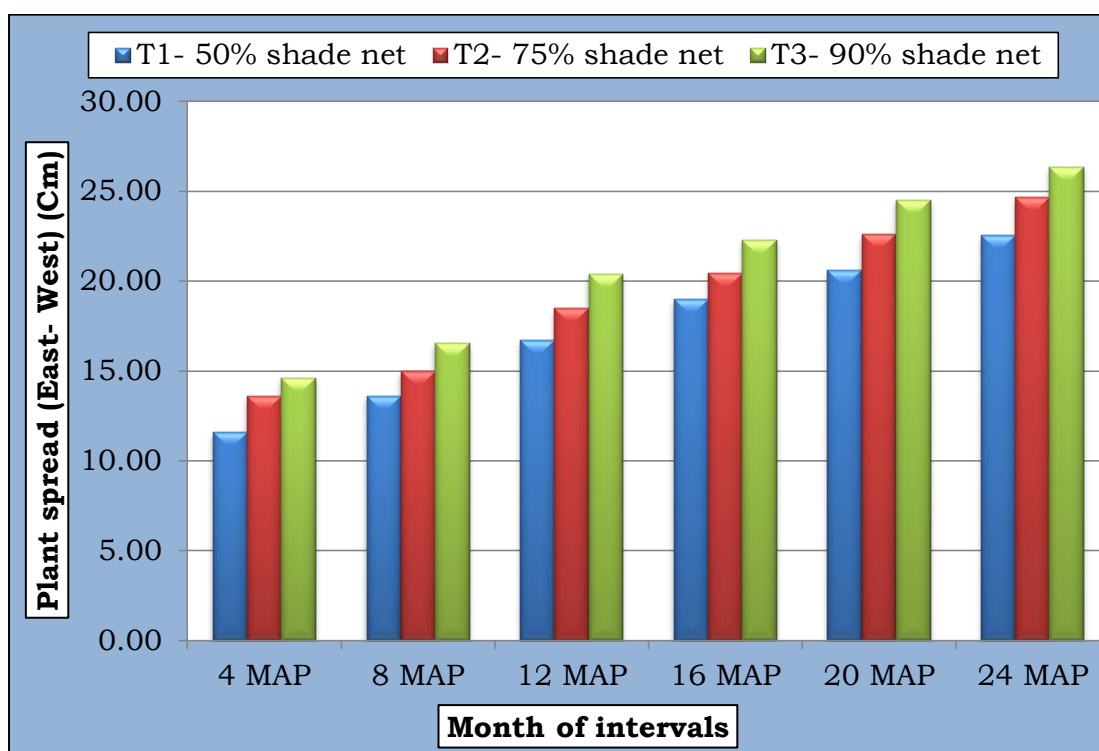


Fig. 30: Effect of shade levels on plant spread (East-West) of anthurium cv. Tropical Red

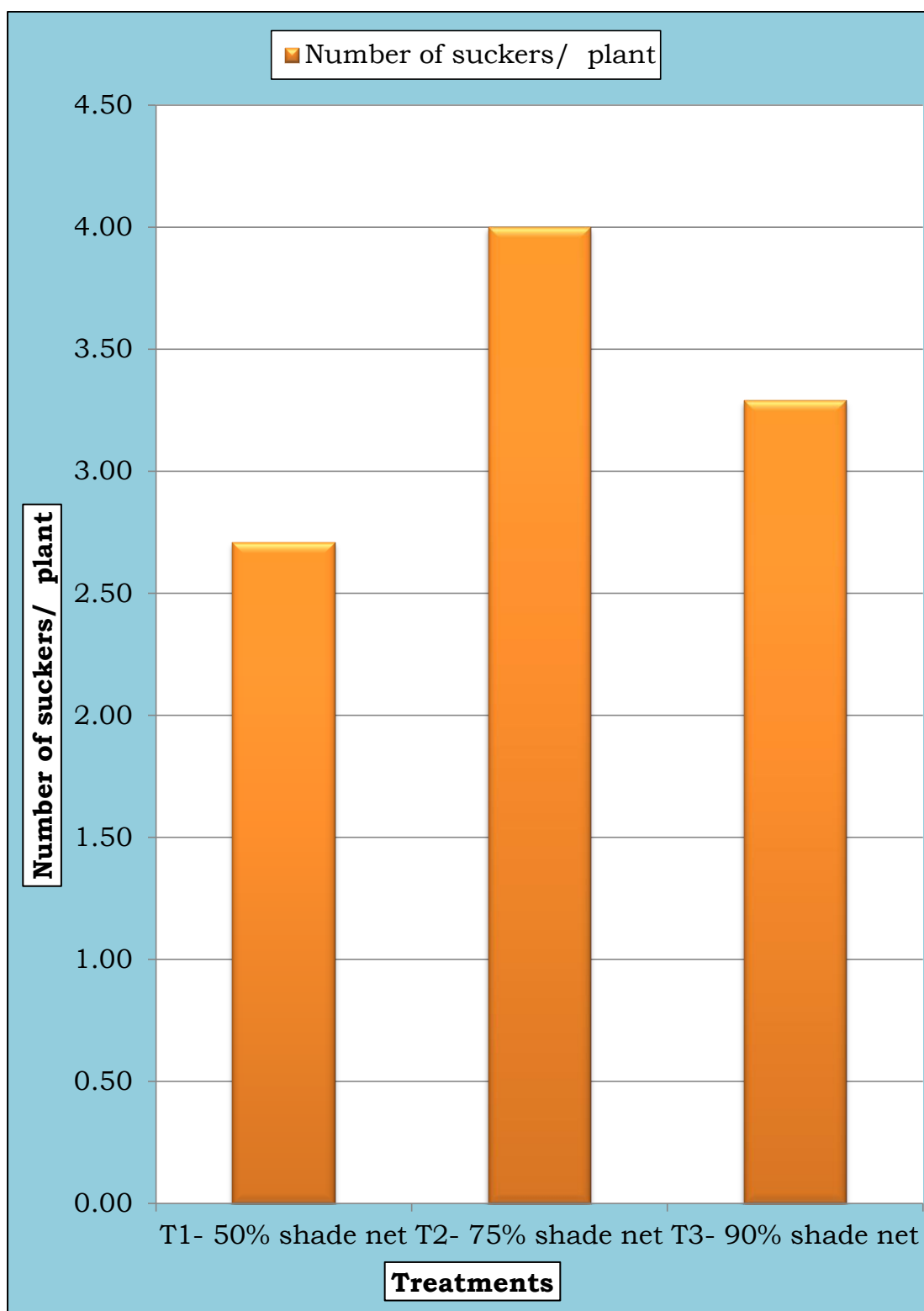


Fig. 31: Effect of shade levels on number of suckers per plant of anthurium cv. Tropical Red

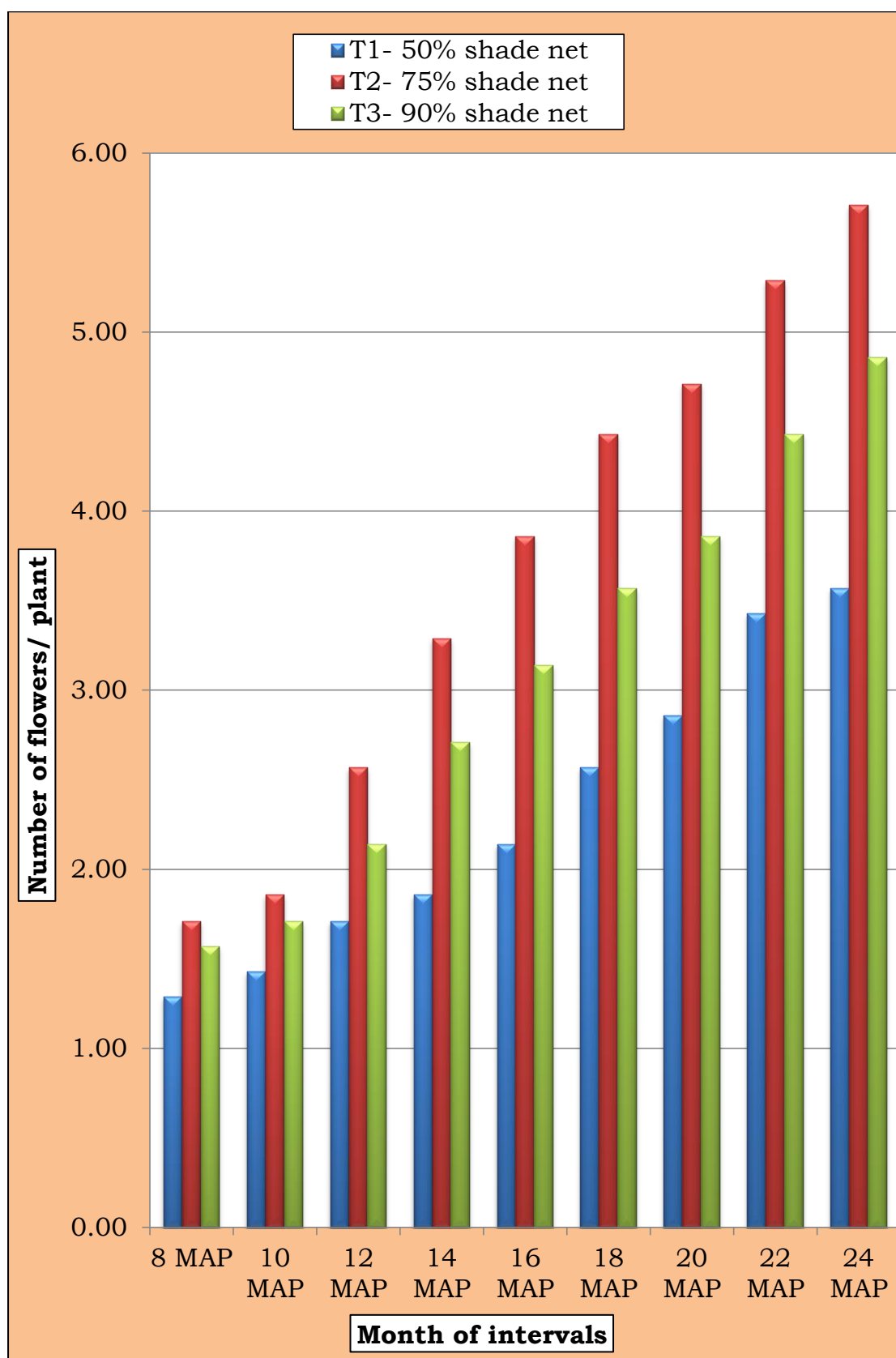


Fig. 32: Effect of shade levels on number of flowers per plant of anthurium cv. Tropical Red at bimonth intervals

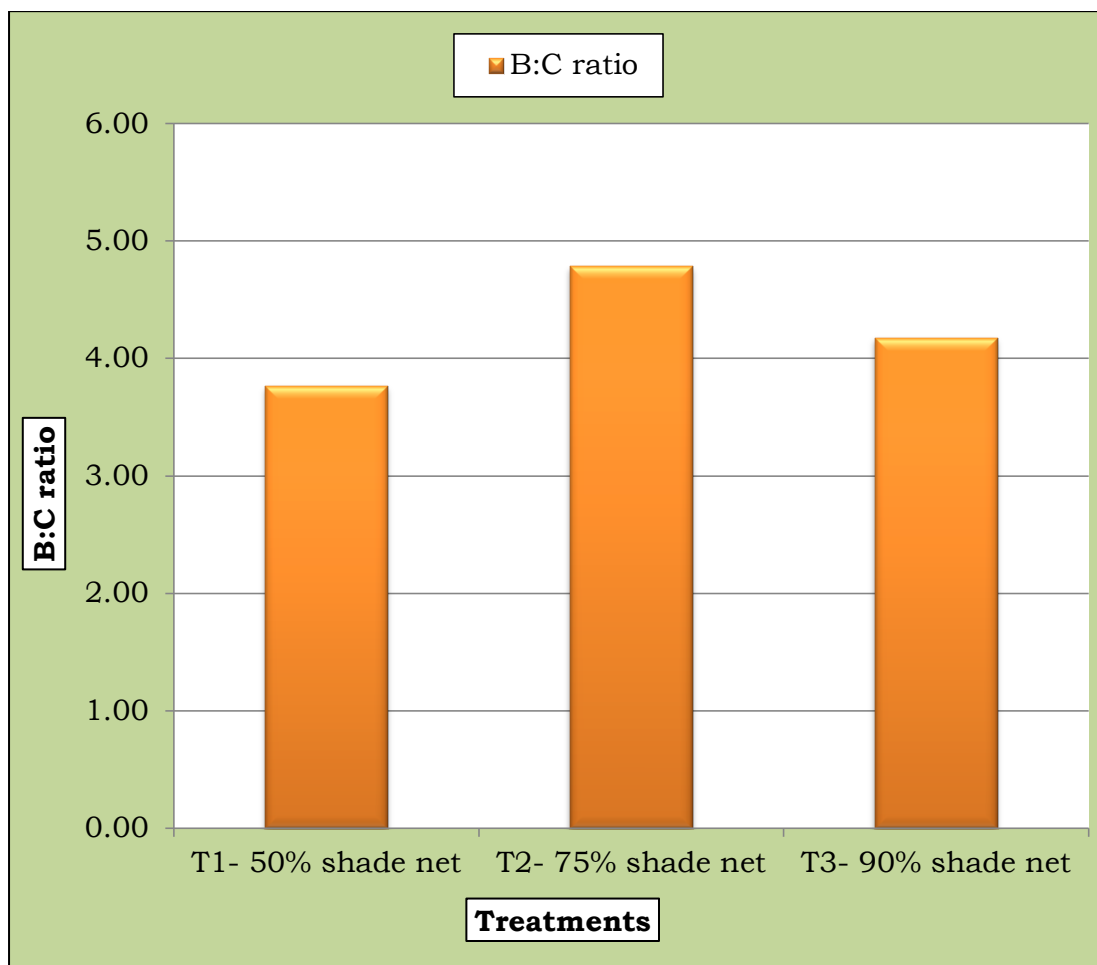


Fig. 33: Economics of different shade levels in anthurium cv. Tropical Red

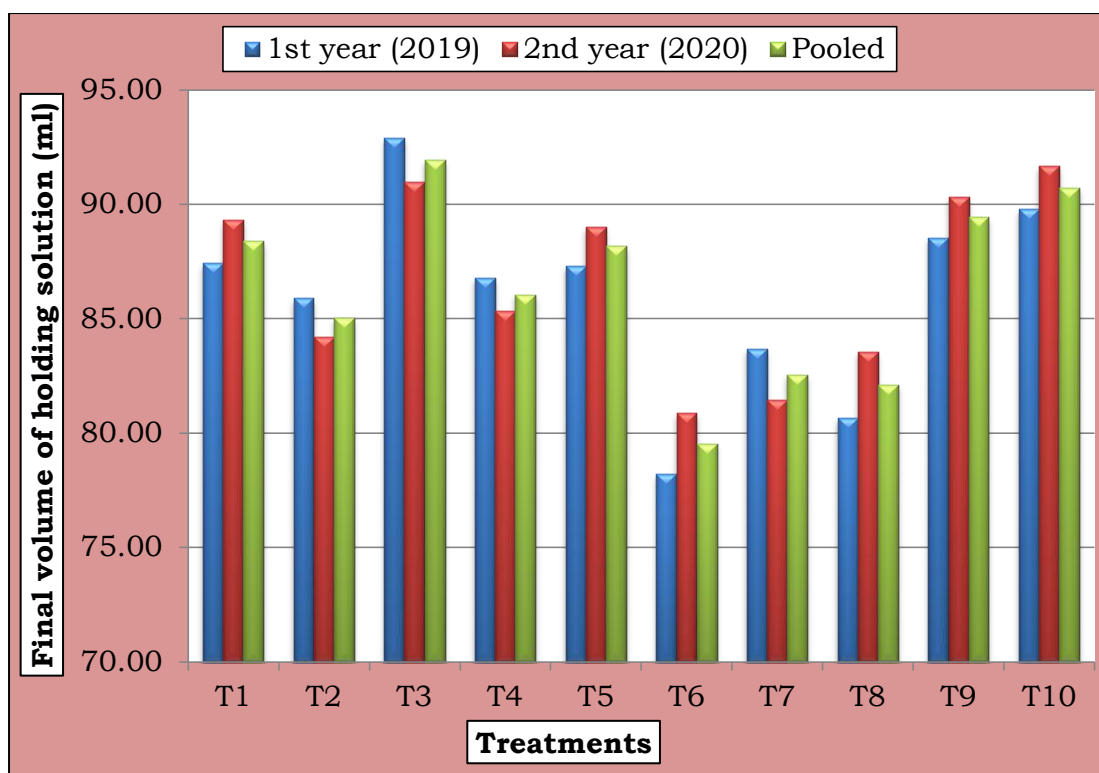


Fig. 34: Final volume of holding solutions in vase life studies

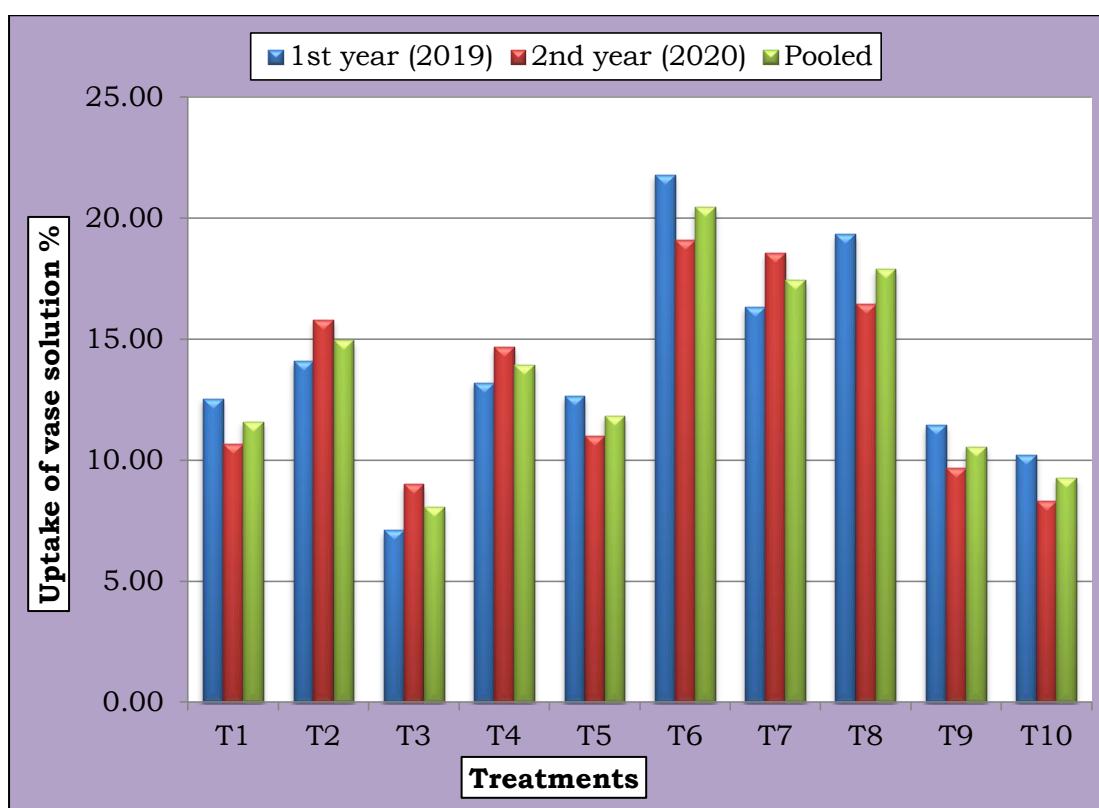


Fig. 35: Effect of different treatments on uptake of vase solutions in anthurium cv. Tropical Red

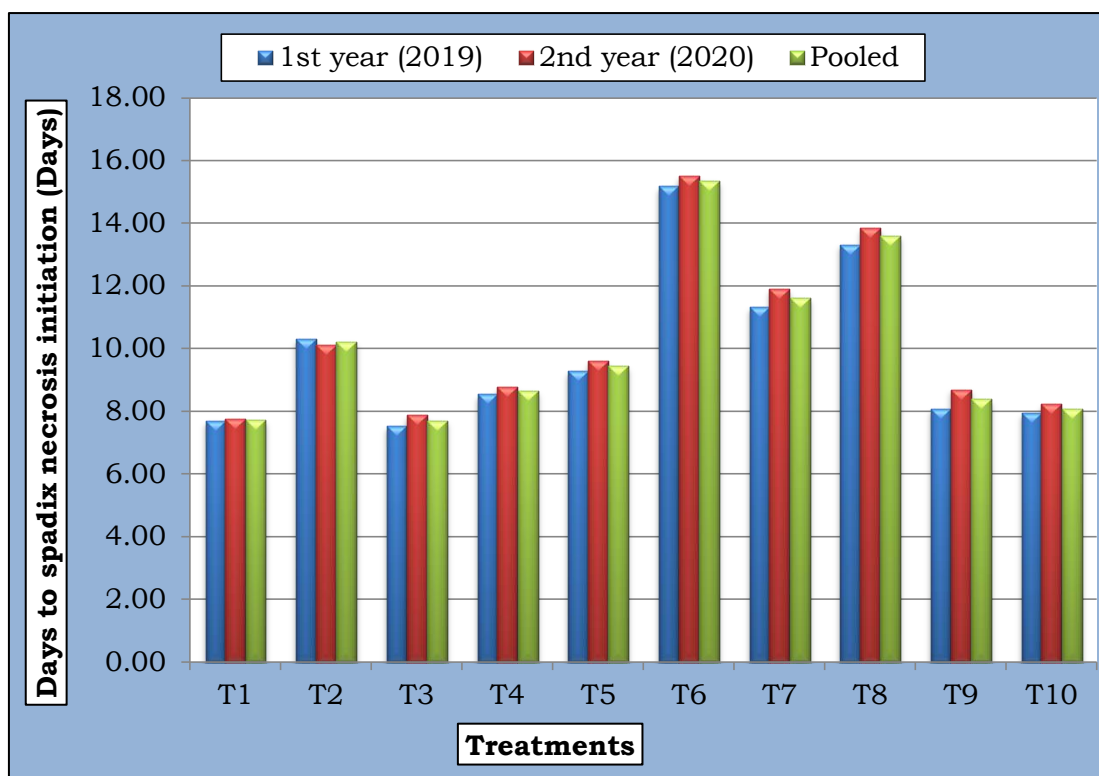


Fig. 36: Effect of holding solutions on days to spadix necrosis initiation in anthurium cv. Tropical Red

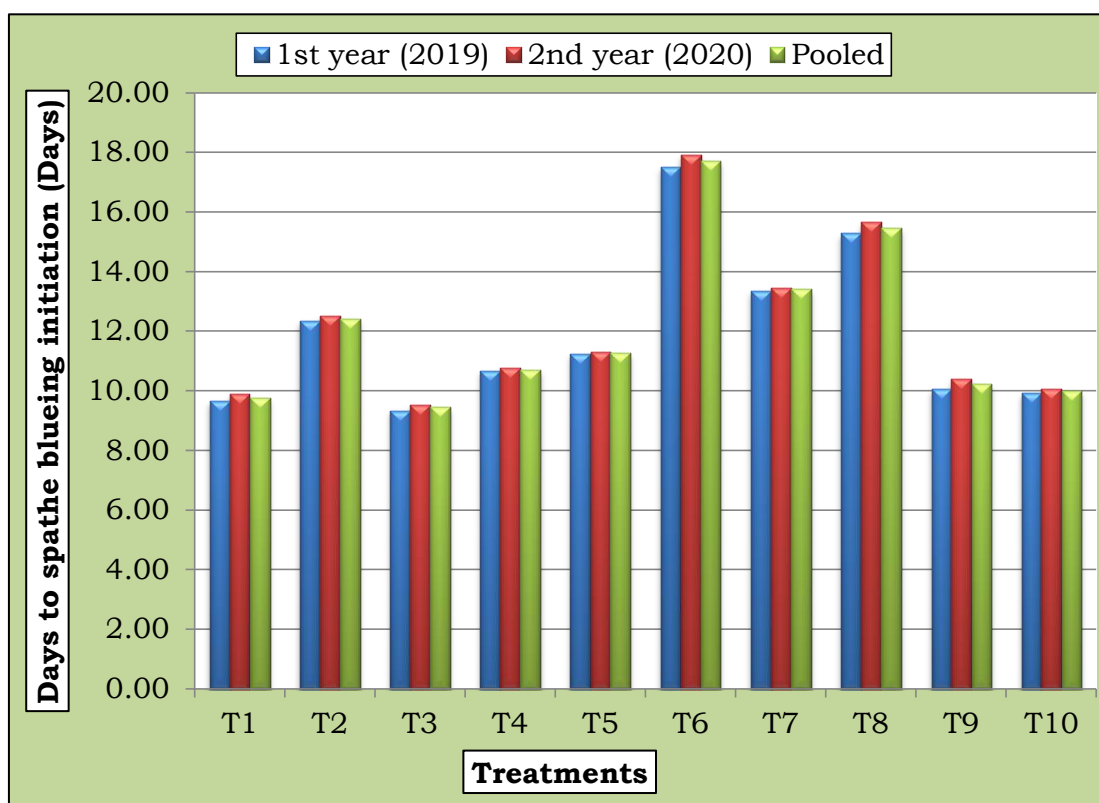


Fig. 37: Effect of holding solutions on days to spathe blueing initiation in anthurium cv. Tropical Red

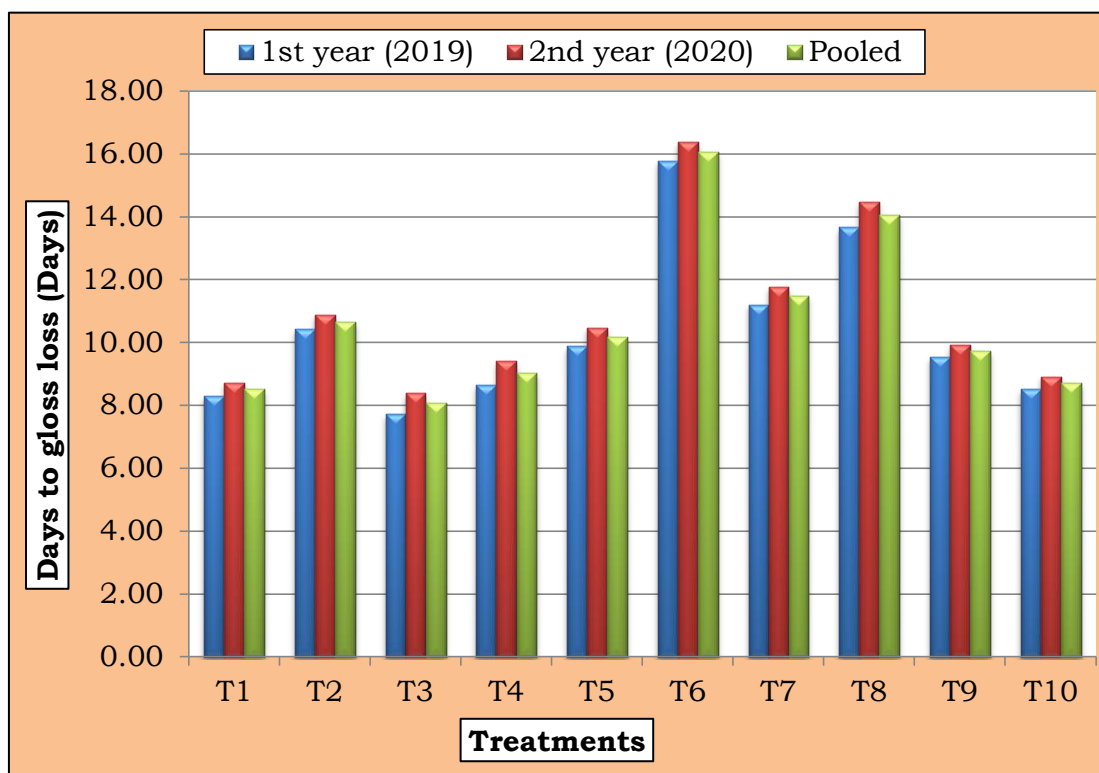


Fig. 38: Effect of holding solutions on days to gloss loss of anthurium cv. Tropical Red

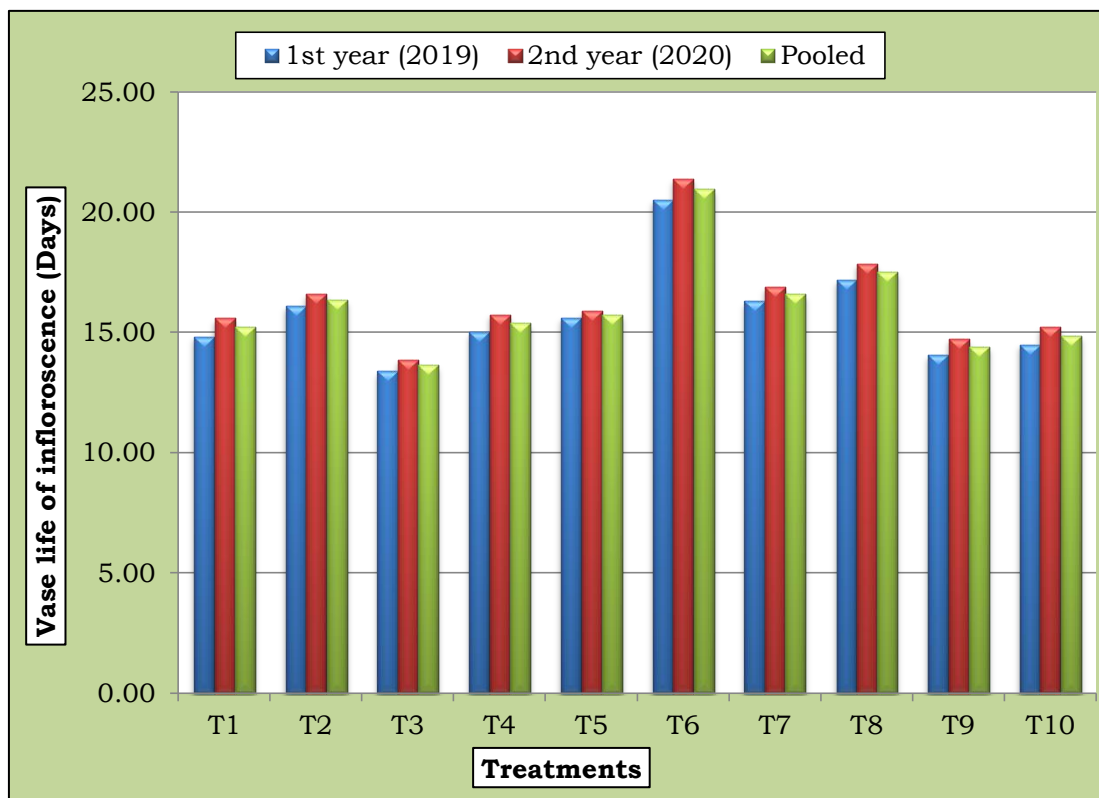


Fig. 39: Effect of holding solutions on vase life of inflorescence of anthurium cv. Tropical Red

Treatment details:

- T₁**- Coconut husk + charcoal (3:1)
- T₂**- Sand + FYM + coconut husk + brick pieces + charcoal (1:1:1:1:1)
- T₃**- Cocopeat + coconut husk + brick pieces + charcoal (1:1:1:1)
- T₄**- Cocopeat + wood shavings + FYM + brick pieces + charcoal (2:1:1:1:1)
- T₅**- Brick pieces + wood shavings + sand + FYM + coconut husk + charcoal (1:1:1:1:1:1)
- T₆**- Saw dust + wood shavings + sand + FYM + brick pieces + charcoal (2:1:1:1:1:1)
- T₇**- Sand + coddung clumps + coconut husk + wood shaving + charcoal+ earthen crocks + brick pieces + cocopeat (2:1:2:1:0.5:0.5:1:1)

Treatment details:

T₁- Tapwater

T₂- Tapwater + Bavistin 0.2%

T₃- Distilled water

T₄-8 HQC 200ppm

T₅- 8 HQC 400ppm

T₆- BA 25 ppm

T₇- BA 50 ppm

T₈- Triadimefon 30 ppm

T₉- AgNo₃ 10 ppm

T₁₀- AgNo₃ 20 ppm