ENVIRONMENTAL EFFECTS ON THE GROWTH OF *Philodendron* 'Wendlandii'

By

S. SWAPNA

THESIS

submitted in partial fulfilment of the
requirement for the degree of

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Faculty of Agriculture
Kerala Agricultural University

Department of Pomology & Floriculture
COLLEGE OF HORTICULTURE
VELLANIKKARA, THRISSUR - 680 654
Kerala, India

1996

DECLARATION

I hereby declare that the thesis entitled '**Environmental effects on the growth of *Philodendron* 'Wendlandii'** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, fellowship, associateship or other similar title of any other university or society.

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SWAPNA, S.

CERTIFICATE

Certified that the thesis entitled '**Environmental effects on the growth of *Philodendron* 'Wendlandii'** is a record of research work done independently by **Miss.Swapna, S.** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

Dr.C.K.Geetha
Chairperson
Advisory Committee
Assistant Professor
Dept. of Pomology and Floriculture
College of Horticulture

Vellanikkara
31 · 08 · 96

CERTIFICATE

We, the undersigned members of the Advisory Committee of **Miss.Swapna,S.**, a candidate for the degree of **Master of Science in Horticulture**, with major in **Pomology and Floriculture**, agree that the thesis entitled **'Environmental effects on the growth of *Philodendron* 'Wendlandii'** may be submitted by **Miss.Swapna,S.**, in partial fulfilment of the requirement, for the degree.

Dr.C.K.Geetha
Assistant Professor
Department of Pomology & Floriculture
College of Horticulture
Vellanikkara
(Chairperson)

Dr.P.K.Rajeevan
Professor and Head i/c
Dept. of Pomology & Floriculture
College of Horticulture
Vellanikkara
(Member)

Dr.P.K.Valsalakumari
Associate Professor
Dept. of Pomology & Floriculture
College of Horticulture
Vellanikkara
(Member)

Dr.E.K.Lalitha Bai
Assistant Professor
Department of Agricultural Meteorology
College of Horticulture
Vellanikkara
(Member)

EXTERNAL EXAMINER
(S. SATHIAMOORTHY)

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Introduction

INTRODUCTION

Urbanisation has fostered the trend of indoor gardening all over the world resulting in the increased demand for attractive foliage plants. The excellent ability of most of the foliage plants to adapt to low light intensities has enabled their use for interior decoration.

India has rich land resources spread over diverse agroclimatic zones that have potential to produce a wide variety of high value crops, including foliage plants. Most of the foliage plants in trade are native to the tropics which corroborates the possibility of their successful cultivation in many parts of the Country. However, the potential of foliage plant production on a commercial scale has not been exploited fully. The market for most of the foliage plants is year round and the increased demand for foliage plants both in the international and domestic market calls for considerable augmentation of local production (Swarup, 1993).

Among the foliage plants, Philodendrons are of great demand. These constitute a large group of attractive plants belonging to the family Araceae. The genus *Philodendron* consists of about 200 species, vining and self-heading ones, with great variation in leaf size, leaf margin and colour. The self-heading ones have recently gained much export value because they are easy to handle and less susceptible to transport losses. 'Wendlandii' is an export oriented variety of *Philodendron* which is self-heading, having bright green thick rosette of waxy, long obovate leaves, with thick midribs and short petioles.

Growth and quality of foliage plants depend upon genetic constitution and interactions with environmental factors. In *Philodendron* each plant has inherent characteristics such as colour, leaf shape, size and growth rate that determine its potential for consumer satisfaction but its ultimate quality is controlled by the environment under which the plants are grown.

Not much work has been done in our State to standardise the growing techniques including the light intensity requirements of foliage plants. Many tropical foliage plants have low light intensity requirements in their native habitats (Smith and Scarborough, 1981). Hence identification of the optimum light intensity for growth is important. Besides, optimisation of growing media, nutrient forms and doses are important in the production of quality plants.

In this context an experiment to evaluate the growth and performance of an export valued foliage plant under various growing conditions becomes relevant. The present study was thus undertaken to evaluate the growth and quality of *Philodendron* 'Wendlandii' in different media, containers and fertilizers at different shade levels and to identify the best environment.

Review of Literature

REVIEW OF LITERATURE

In this chapter attempts are made to review the literature pertaining to the environmental effects on foliage plants and few other horticultural crops.

The review is classified according to the treatments under study and their influence on various growth parameters.

2.1 Growing media and containers

Urbanisation has led to the trend of indoor gardening all over the world and thus to the increased demand for attractive foliage plants. Almost everyone has a room with a window and almost everyone can obtain a tin can or plastic carton and some soil or potting media, all that are required for growing an indoor or container garden. The shortage and lack of uniformity of quality top soil resulted in the development of artificial growing media. This innovation in the container culture was given impetus by increasing transportation costs percluding the use of soil for plants that had to be shipped long distances.

Light weight media were studied in many places resulting in different media like Cornell-Peatlite mixes (Boodley and Sheldrake, 1967). These media utilize peat moss or bark as the organic component and sand, vermiculite or perlite as the inorganic component. Currently there are many products that are commercially available to the consumer.

Certain foliage plants have specific soil or potting mixture requirement but most are grown in soil types or in potting mixtures having widely varying physical and chemical properties (Criley, 1973). Good potting mixtures should be retentive of sufficient water and fertilizers allowing excellent aeration (Joiner and Conover, 1965; Bunt, 1973; Spomer, 1975).

Trials conducted at the University of Florida concluded with recommendation of three potted foliage plant mixes. Among these a combination of 3 parts peat and 1 part sand was best in larger containers and good for shade house growing structures (Poole and Waters, 1972). Peat has also been recommended as a propagating medium for *Philodendron scandens oxycardium* (Conover and Poole, 1972).

A substrate for cultivating and propagating plants was described by Kochler (1973) which is made of chemically treated rockwool. This is less expensive, has low weight, 97 per cent pore volume, 3 per cent dry matter and rapid water uptake.

Brown and Emino (1981) reported that bulk density, moisture holding capacity, pH, initial nutrient level, aeration or soluble salt characteristics were not consistently related to growth respone in 6 commercial growing media. The growth of plants was highly variable among media.

Foliage plants, if grown in 100 per cent peat or sand, require precise cultural practices. Hence there is no single best growing medium for foliage plants and most potting mixtures are blends of two or more components formulated to combine physical and chemical properties to obtain better characteristics than one alone (Poole *et al.*, 1981).

Bik and Straver (1982) suggested that tree bark can be used as a good medium for foliage plants. According to Sartain and Ingram (1984) 1:1 mixture of pine bark and Canadian peat had better effect on shoot and root growth and dry weight of *Juniperus horizontalis* and *Rhododendron simsii*.

Based on the trials to find out a suitable substrate for *Anthurium andreanum* Turski *et al.* (1986) reported that a 2:1:1 mixture of peat, perlite and sphagnum moss was excellent. A new substrate called solite, which is an aggregate manufactured from montmorellonite clay, in combination with peat, in a 3:1 ratio produced good quality *Ficus benjamina* and *Dracaena marginata* plants (Conover and Poole, 1986).

Bazzochi *et al.* (1987) suggested that a mixture of peat and polysterene in 3:1 ratio resulted in better performance of *Syngonium podophyllum* compared to bark and cork media. Growth responses of braccoli, lettuce, marigold and tomato showed that mushroom compost can be a perfect peat substitute (Lohr and Coffey, 1987). Mixture of mushroom compost with Canadian peat in different combinations were tried. It was found that dry weight, height and quality ratings showed quadratic responses as the rate of compost in the growing mix increased.

Peat is by far the most widely used material for making potting mixes either by itself or in combination with other materials (Bunt, 1988). Gopalaswamiengar (1991) has recommended a soil mixture which can be used for growing *Philodendrons*. This contains 4 parts leaf mould, 2 parts sand, 1 part horse manure, 1 part charcoal, 1 part brick dust and 1 part sphagnum moss.

Growth index and top and root dry weights of *Pentas lanceolata* and *Ixora coccinea* were significantly better in coir based medium than sedge peat-based medium (Meerow, 1994a). It is suggested that coir-dust is an acceptable substitute for sphagnum or sedge peat in soilless container media, although nutritional regimes may need to be adjusted on a crop by crop basis. Meerow (1994b) suggested that 2:1:1 mix of peat, pine bark and wood shavings works well for short term palms. Slow growing palms benefit from a mix with higher sand fraction.

Hall and Smith (1994) reported that ornamental pot plants showed a higher marketable quality rating in perlite-based substrates than those grown in peat. Another study on perlite (Smith and Hall, 1994) showed that perlite-based mixes performed as well as peat for *Ficus elastica* and *Chrysanthemum* 'Bright Golden Anne'. Vermiculite addition enhanced the quality of *Ficus*. It was concluded that perlite-based potting mixes can be as simple to manage and as productive as peat-based mixes.

2.1.2 Containers

The importance of containers in indoor gardening is increasingly felt day by day. Aesthetic value and durability are the main criteria in choosing the container, apart from its growth promoting nature. However, not much research works have been undertaken in this regard.

Bunt (1988) has compared clay pots with plastic pots and enumerated the drawbacks of clay pots such as loss of water, reduction in temperature of the media due to evaporation loss and loss of nutrients due to flow of water from the medium into clay. According to Gopalaswamiengar (1991) foliage plants perform better in plastic containers compared to mud pots under indoor conditions. Typical root development in a plastic pot is similar to that in the ground. There is even distribution of roots whereas roots are confined to the periphery in earthern pots.

2.2 Fertilizer source and dose

Plant nutrients can be obtained from many sources and the methods used to obtain them vary from primitive to sophisticated. As in many other horticultural crops nutrients are given using soluble readily available fertilizers in foliage plants also. But of late, slow-release fertilizers are widely used in foliage plant industry since they disperse required amounts of nutrients for extended period of time.

As early as in 1959 Taylor *et al.* found the effects of various fertilizer levels on foliage plants and their interactions with light intensity. When fertilizer levels were increased from 90 to 180 or 360 mg/l in solution form, leaf colour of *Philodendron scandens oxycardium*, *Philodendron scandens* and *Epipremnum aureum* was improved with each increment and fertilizer enabled the plants to partially overcome the effects of higher light intensity, which decreased the foliage colour. Number of leaves were also increased for all cultivars when N level was increased from 90 to 180 or 360 mg/l.

Ball (1965) suggested a fertilizer rate for potted foliage plant production as 25 g of 25-0-21 or 30-4-8 (N-P-K) per 10 litres of water, applied every two weeks. A base potting medium application was recommended by Conover (1966) which consisted of 2-5 kg dolomite and 1-2 kg superphosphate/m^3, plus 80-130 g of 20-1-17 NPK per 100 litres of water applied every two weeks. According to

Conover and Poole (1975b) less fertilizer was required under shade to produce high quality *Dracaena* for interior uses.

Conover and Poole (1977a) determined the influences of various fertilizer levels on the growth and quality during production and maintanence in the interior environments. Increasing fertilizer levels had no effect on height, trunk caliper, but increased grade and foliage colour in *Ficus benjamina*. Collard *et al.* (1977) reported that superior quality *Ficus benjamina* plants with highest chlorophyll levels were obtained in the highest fertilizer levels. Different levels N and K_2O (7.5, 15.0 or 22.5 g/m^2/month) were studied in *Ficus benjamina* by Milks (1977) who reported that improvement in plant grade, growth index and chlorophyll level was present with increased fertilizer application, but had no effect on leaf or root carbohydrate levels. Best quality plants were those that received the two highest fertilizer levels.

Joiner *et al.* (1978) reported that best visual grade of *Dieffenbachia maculata* 'Baraquiniana' was obtained with NPK rates of 13.9-1.4-13.9 g/m^2/month, while maximum incremental growth rate occurred at 9.3-0.9-9.3 g NPK/m^2/month. Highest yield of *Aglaonema commutatum* 'Fransher' cuttings was obtained when plants were grown as standards (Conover *et al.*, 1978). A lower application rate decreased yield and fresh weight of cuttings while higher rates were unnecessary. Weekly applications of 12.5 to 37.5 mg N, 5 to 50 mg P and 25 to 50 mg K per 10 cm pot produced good growth of *Adiantum raddianum* (Poole and Conover, 1978). Tissue elemental composition of these ferns (per cent dry weight) was 1.9-2.3 N, 0.28-0.43 P and 2.3-2.8 K.

Nitrogen applications of 25, 50, 100, 200 and 300 mg/l were made to boston ferns grown in 15 cm pots in peat-perlite medium (Morgan and Hipp, 1979).

Dry weight, frond length and leaf area generally increased with N levels upto 200 mg/l but all parameters were reduced at 300 mg/l. Seager (1979) reported that NPK ratios 1.0:1.5:2.0 and supplemental doses of liquid fertilizer of 200:29:400 mg/l of N-P-K produced best quality plants of *Ficus elastica* 'Decora'. However, Poole and Conover (1979) reported that high fertilizer levels in *Ficus benjamina* increased leaf drop during dark storage.

Adjusting fertilizer levels to light intensities is one of the major and most important problems faced by foliage plant growers. Commercially, failure to properly balance fertilization with light intensity is one of the weakest links in production (Joiner, 1981). Optimum NPK ratio is 1:1:2 as a basal dressing for *Ficus elastica* 'Decora' plants grown in pine needle litter or peat. A similar ratio for top dressing was also recommended although specific levels were not provided (Joiner *et al.*, 1983).

Henny *et al.* (1988b) suggested that best fertilizer rate for *Aglaonema* 'Stripes' was 7.1 to 14.2 g of 19-3-10 NPK/150 mm pot every 3 months. In another study *Aglaonema* 'Silver Bay' plants were reported to have more shoots, better foliage quality and better overall plant grade when 6.6 g 19.0-2.6-10.0 NPK was supplied (Henny *et al.*, 1992a).

Controlled-release fertilizers

The first use of slow-release fertilizers for foliage plants was reported by Waters and Llewellyn (1968). They found that 3 kg of Osmocote 14-6-12 per m^3 provided good growth of *Philodendron scandens oxycardium* for 4 months and resulted in tissue levels of 1.51 per cent N, 1.21 per cent P and 3.74 per cent K.

Langhans *et al.* (1972) first reported that Osmocote was equal to liquid fertilizer at similar rates for periods of 6 months. The results of the above experiments were substantiated when comparisons of Osmocote and liquid fertilizer sources on four foliage plants grown on four different media showed no clear-cut differences (Conover and Poole, 1977b).

However, there are also reports of better performance of liquid fertilizer compared to slow-release source. Comparisons of liquid fertilizers, Osmocote and urea formaldehyde-based fertilizer were attempted by Poole and Conover (1977) in which they found better effects of liquid fertilizer in the case of *Philodendron*. Another report by Conover and Sanders (1978) showed a comparison of liquid fertilizer, Osmocote and their combinations in *Chamaedorea, Howea* and *Philodendron*. Liquid fertilizer applied monthly produced slightly better plants than Osmocote 19-3-10 applied every 3 months.

Maynard and Lorenz (1979) reported that slow release fertilizers have become important in foliage industry. Gilliam *et al.* (1983) reported the effects of slow-release fertilizers on the growth and post production performance of Boston fern. The plant was grown with 3 rates of 2 slow-release fertilizers and with one rate of liquid fertilizer. Greatest fern dry weight occurred with ferns grown with liquid fertilization (20.0 N - 0.8 P - 16.6 K) or Osmocote (19.0 N - 2.5 P - 8.3 K) at a rate of 1.8 kg N/m^3.

Sartain and Ingram (1984) reported that plants grown in Osmocote fertilized media showed higher levels of soluble salts and extractable nutrients. They also reported that Osmocote produced maximum shoot growth in all the media.

According to Neumaier *et al.* (1987) the effect of controlled release fertilizers on various plant characters in *Hibiscus* was influenced by light levels. Most of the buds and flowers were produced with 200 ppm N and 12 g controlled release fertilizer. However, combinations of soluble fertilizer and controlled release fertilizer produced higher quality plant than either of them alone.

The effect of fertilizer level (1.2 to 41.3 g Osmocote 19.0 N - 2.6 P - 10.0 K per 15 cm pot) was tested in *Syngonium podophyllum* 'White Butterfly' (Chase and Poole, 1987). Optimum shoot growth was obtained for plants fertilized with 4.9 to 19.5 g Osmocote. Slight reduction in plant growth occurred at higher rates.

Henny *et al.* (1988a) compared the performance of 'Tropic Star' *Dieffenbachia* at 3 levels of Osmocote 19 N - 6 P - 12 K (2.2, 4.4 and 6.6 g, every 3 months). It was found that higher fertilizer rates increased all growth dimensions, except number of shoots and colour grade.

Knowles *et al.* (1993) studied the effect of slow-release nitrogen fertilizer on growth and quality of *Salvia farinacea*. The slow-release fertilization was compared to weekly fertigation at 100 mg N using ammonium nitrate. Fertigation resulted in shoot dry weight and shoot quality equal to highest values achieved with slow-release fertilizer.

2.3 Environmental factors

Microclimate is the key factor deciding the growth of any plant. Growth and quality of foliage plants depend on the interactions between environmental factors and genetic constitution of the plant. Factors like temperature, light intensity and humidity can limit the quality of foliage of the plants including colour, size, shape etc.

2.3.1 Temperature

Temperature needs of each foliage plant species should be determined, since some are tropical, others subtropical and others temperate in their requirements. Temperature affects growth rate of foliage plants as much as any other factor by influencing rates of photosynthesis and respiration (Hadfield, 1968).

Poole and Conover (1981) reported that temperature as high as 38°C and 44°C reduced the quality of *Calathea makoyana, Chamaedorea elegans, Dieffenbachia maculata* 'Perfection' and *Nephrolepis exaltata* 'Bostoniensis'. Best plant growth is observed in *Philodendron, Ficus* and *Epipremnum* at a maximum daily temperature of 95° F (35°C) (Conover and Poole, 1981).

According to Poole and Conover (1987) the optimum temperatures for plant grade, fresh weight and plant height of *Calathea* cv. Argentea, *Maranta leuconeura* and *Philodendron scandens* spp. *oxycardium* were 95° F. Zeislin *et al.* (1987) reported that exposure of *Ficus benjamina* plants to alternating night temperatures of 18°C and 12°C promoted growth compared to plants grown at constant temperature of 18°C. Optimal shoot growth of *Syngonium podophyllum* 'White Butterfly' was obtained at a maximum air temperature between 32°C and 41°C during summer and a minimum air temperature of 18.5°C and 21.0°C during winter (Chase and Poole, 1987).

Mortensen (1988) reported that growth rates of *Ficus benjamina, F. elastica* and *Syngonium podophyllum* increased steadily upto 27°C, but for *Nephrolepis exaltata* and *Dieffenbachia sp.* the optimum temperature appeared to be 24°C.

2.3.2 Light

Foliage plants are used extensively for interior decoration because of their excellent ability to adapt to low light intensities. Optimum photoperiod as well as light intensities are required to produce top quality plants. *Philodendron, Peperomia, Ficus, Begonia* and similar jungle plants can be grown with fair success in the interior of rooms that are lighted with floor-to-ceiling windows, but should not be attempted in the poorly lighted interiors unless supplementary lighting can be provided.

Porter (1937) reported that tomato plants showed increased vegetative growth as measured by fresh and dry weights, with a decrease in light intensity. An increase in length and breadth of leaves of tobacco under shaded conditions is also reported by Panikar *et al.* (1969).

Conover and Poole (1975b) recorded chlorophyll levels of 0.055 mg/cm^2 in leaves of sungrown *Dracaena marginata* and 0.081 and 0.100 mg/cm^2, respectively, in those grown under 40 and 80 per cent shade for 6 months. According to Milks (1977) chlorophyll content increased in plants placed under low-light interior environment, but was greatest in plants grown under 63 per cent shade, increasing from 0.027 to 0.081 mg/cm^2. It was observed by Priessel *et al.* (1980) that *Codiaeum variegatum* var. Pictum showed reduced chlorophyll and carotenoid contents with increased light intensity.

Johnson *et al.* (1979) reported 53 per cent increase in stomatal density in leaves of sun-grown *Ficus benjamina* compared to those grown under 47 per cent shade.

Dracaena sanderiana plants grown at five shade intensities were analysed for N, P and K and found that the leaf nutrient content, except that at high light intensity increased the content of K, especially in younger leaves (Rodriguez *et al.*, 1973).

Conover and Poole (1974) reported that *Philodendron scandens oxycardium* produced larger leaves and greater stem caliper under 40 per cent shade than under 80 per cent shade. It is also reported that foliage plant groups exhibit certain quality problems in addition to colour differences when incorrect light levels are received. Conover and Poole (1975a) reported that *Aglaonema* and *Dieffenbachia* leaves assume a nearly vertical position when grown under excessive light, which reduces quality, since surfaces of leaves cannot be viewed from the side.

According to Uematsu and Yomita (1980), in *Asparagus densifolius* cv. Meyers, strong light resulted in the production of yellow and stunted foliage. Hence shading with cheese cloth was recommended.

According to Johnson *et al.* (1982) high light intensities interacted with effects of ethephon during acclimatization of *Ficus benjamina*. High shoot/root ratios, reduced leaf area and heavy leaf fall during interior phase occurred in ethephon treated plants, especially plants which where in full sun. Thomas and

Teobe (1983) observed that plant height, stem diameter, internodal length, leaf area and foliar dry weight were all greatest with 20 per cent shading. A study conducted to find the suitability of some foliage and flowering plants for indoor gardening (Aasha, 1986) showed that light requirements of *Chlorophytum* and *Dieffenbachia* was between 20 and 50 per cent of incident light whereas plants like *Aralia, Cordyline* and *Maranta* required 50-75 per cent light. Chase and Poole (1987) reported that *Syngonium* plants grown in 80 per cent shade had fewer leaves, taller shoots, whiter colour and had lower quality grades, lower fresh weight of shoots, higher per cent of plants with healthy appearing roots and larger leaves than those grown under 47 per cent shade. According to Neumaier *et al.* (1987) optimum condition for growth of high quality hibiscus plants was found to be at 50 per cent shade.

Henny *et al.* (1988b) found that *Aglaonema* 'Stripes' showed darker green leaves when grown under 125 μmol $s^{-1}m^{-2}$ light, even though not much influence of light was found on the overall quality.

Broschat *et al.* (1989) reported that *Ptychosperma elegans* palms grown under shade for 6 months showed greater plant height and better colour. However, Son and Yeam (1989) reported higher light intensities to produce maximum average leaf areas in plants like *Begonia, Pilia* and *Peperomia*.

Aglaonema costatum, Philodendron erubescens and *Chlorophytum comosum* responded best to light intensity of 4000-5000 lux with respect to height of plants, number of leaves and size of leaves (Sharma *et al.*, 1992). Best quality plants of *Dieffenbachia* 'Star White' was produced at lower irradiance of 200-500 μ mol m^{-2} (Henny *et al.* 1992b).

Materials and Methods

MATERIALS AND METHODS

The present studies on the environmental effects on the growth of *Philodendron* 'Wendlandii' were carried out at the Department of Pomology and Floriculture, College of Horticulture, Vellanikkara from August 1995 to July 1996. The materials used and the methods adapted for the investigation are described in this chapter.

3.1 Location of the site

Vellanikkara is situated at 10° 31' N latitude and 76° 3' E longitude with an altitude of 22.25 m above MSL. The area enjoys a typical humid tropical climate.

The weather data during the period under study are given in Appendix-I.

3.2 Planting material

Philodendron is a herbaceous plant belonging to the family Araceae. 'Wendlandii' is one of its variety which is self-heading, having bright green, thick rosette of waxy green, long obovate leaves, with thick mid ribs on short petioles and red spathe (Plate 1).

3.3 Treatments

3.3.1 Growing media

Two different media compared in the study were, potting mixture as suggested by Gopalaswamiengar (1991) and peat (Plate 2).

Plate 1. Plants of *Philodendron* 'Wendlandii'

3.3.1.1 Potting mixture

Potting mixture was prepared by mixing 2 parts of organic matter (which includes 1 part dried cowdung and 1 part leaf mould), 1 part top soil and 1 part sand. The mixture was filled upto 3/4th volume in the pots.

3.3.1.2 Peat

Agro peat, a commercial peat mix, was used. This is a 100 per cent organic growing medium and soil conditioner which improves soil structure and fertility. It is light in weight. It consists of composted coconut husk fibre and encourages increased action of bacteria to produce natural humus.

3.3.2 Containers

Two types of containers, namely, mud pots and plastic pots, of size 6 inches were used in the study.

3.3.3 Fertilizers

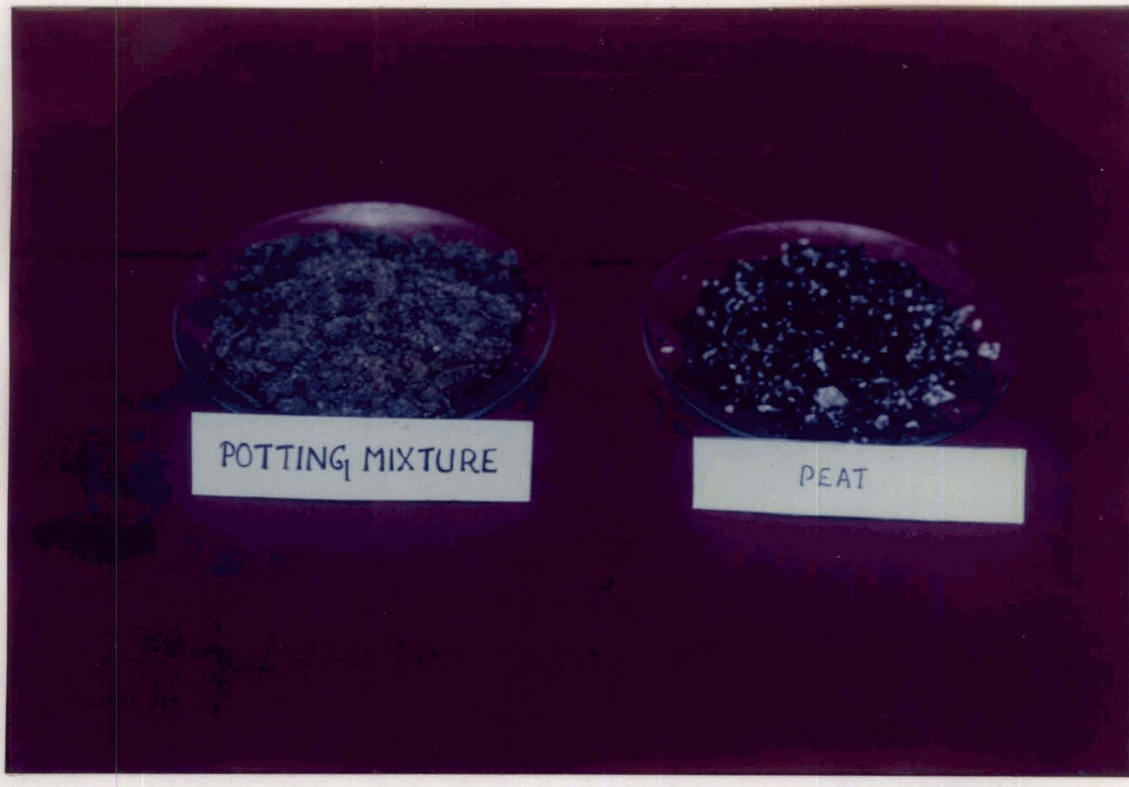
The two forms of fertilizer studied were the soluble form and the controlled release form of NPK 17:17:17 complex. Each of these forms was tried at two levels, viz., 12 g and 24 g per pot per year (Plate 3). Thus there were five treatments including the control (no fertilizer).

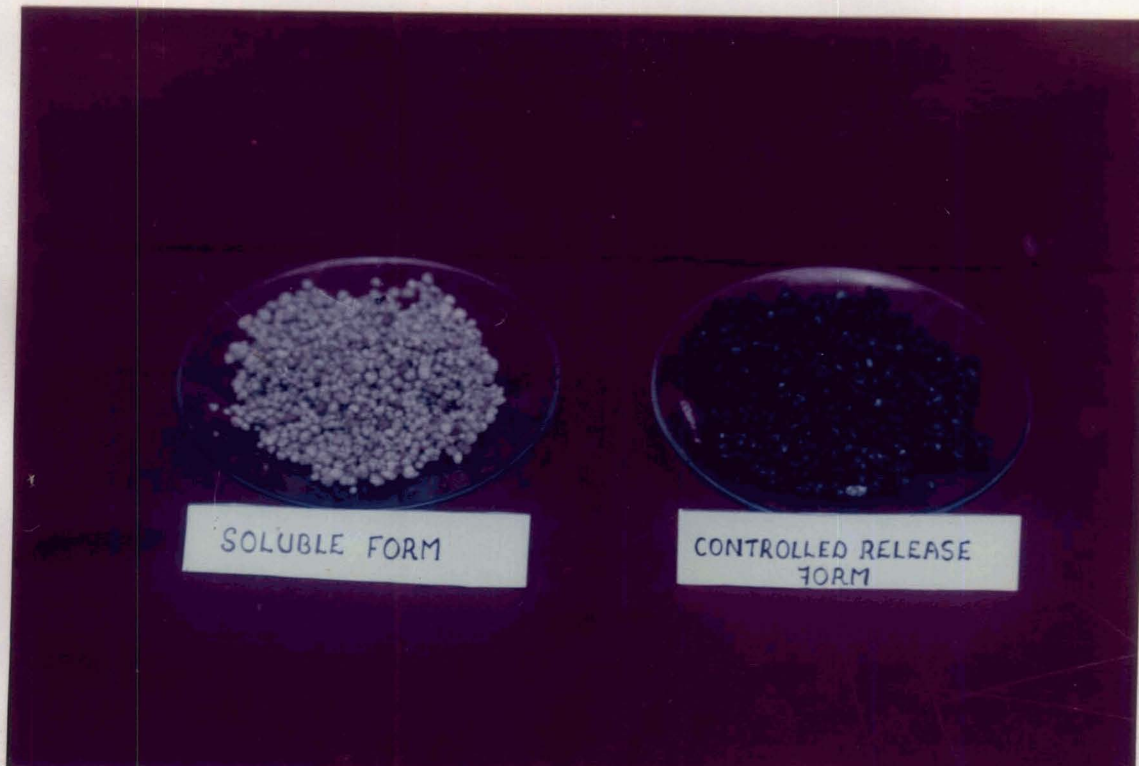
3.3.3.1 Soluble form

The entire dose of fertilizer was given in 12 equal splits at monthly intervals ie. 1 g/plant/month and 2 g/plant/month for two different levels. For this 12 g and 24 g of 17:17:17 complex were weighed out separately and dissolved in

Plate 2. Types of media used for the experiment

Plate 3. Forms of fertilizer (NPK 17:17:17 complex) used for the experiment


POTTING MIXTURE
PEAT


SOLUBLE FORM
CONTROLLED RELEASE
FORM

1.2 l and 2.4 l of water, respectively. Each of these solutions was applied @ 100 ml and 200 ml, respectively, per pot per month for the respective treatments.

3.3.3.2 Controlled release form

A controlled release form of fertilizer was prepared by coating the 17:17:17 complex with Bitumin. Fifty millilitre of bitumin was used to coat 1 kg of the fertilizer uniformly. Half the dose of the fertilizer, ie., 6 g and 12 g per pot for the two treatments, was applied as basal dressing at the beginning of the experiment and the remaining half of the dose was applied 6 months after planting.

The experiment was laid out in factorial RBD with 20 treatments and 2 replications under three shade levels, viz., 25, 50 and 75 per cent. The shade was regulated in three separate shade structures using agro-shade nets. The roof and sides of the structures were covered using the specific shade nets (Plate 4).

Each treatment consisted of 10 plants which were grown for one year. Temperature, relative humidity and light inside the shade houses were recorded at intervals (Appendix-II).

3.4 Observations on growth parameters

3.4.1 Physico-chemical characteristics of the media

3.4.1.1 Physical constants

Moisture content and physical constants of the media like apparent specific gravity, absolute specific gravity and maximum water holding capacity were calculated according to Keen-Razkowski Box measurements (Piper, 1966). The calculations are as follows:

Plate 4. Structures used for regulating shade levels (from left to right: 75%, 50% and 25%)

$$\text{Apparent specific gravity} = \frac{b-a}{v}$$

$$\text{Absolute specific gravity} = \frac{(c-a)}{v-(d-e)}$$

$$\text{Maximum water holding capacity} = \frac{(c-a) - (b-a) \times 100}{(b-a)}$$

where

a = weight of box + filter paper

b = weight of box + air dried soil

c = weight of box + wet saturated soil

d = weight of box + wet residual soil (after removal of wet expanded soil)

e = weight of box + residual soil dried at 105 °C

v = internal volume of the box

3.4.1.2 Chemical characters of the media

Samples of the two growing media were taken for chemical analyses. The total nitrogen, available phosphorus, available potassium and organic carbon contents were estimated using microkjeldahl, colorimetrically (Chlorostannous reduced molybdophosphoric blue colour method), flame photometrically and by Walkey and Black method (Jackson, 1958) respectively.

3.4.2 Growth parameters

Individual plant observations were recorded with respect to characters such as plant height, number of leaves, size of leaves and number of lateral shoots at three months interval.

3.4.2.1 Plant height

The height of the plant in a pot was measured from soil surface upto the tip of the tallest growing leaf using a measuring scale and the mean was expressed in centimeters.

3.4.2.2 Number of leaves

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

3.4.2.3 Total leaf area

The length of the leaf lamina from the base to the tip and breadth at the centre were measured. The leaf area of individual leaf was calculated as the product of the length and breadth and a factor 0.562, which was worked out for the crop. The average leaf area was worked out, taking the average length and breadth of the leaves of five different sizes in a plant. This was multiplied by the number of leaves to get the total leaf area and was expressed in cm^2.

3.4.2.4 Number of side shoots

The total number of side shoots in each plant was counted and recorded at two different stages of growth and average number was worked out.

3.4.2.5 Number of roots

The number of primary and secondary roots in a plant was counted and recorded 12 months after planting.

3.4.2.6 Fresh weight and dry weight of plant

The plants were uprooted after the experiment and cleaned free of dirt. They were separated into shoot and root and dried in hot air oven at 70 $\pm$ 2°C till constant weights were obtained and expressed in grams/plant.

3.4.3 Chlorophyll content

Chlorophyll 'a', 'b' and total chlorophyll content of the leaves for different treatments under three different shade levels were estimated by spectro-photometric method as suggested by Stanes and Hadley (1965). Fully developed, youngest leaves were used for the estimation, as follows.

One gram of the representative sample, collected from two plants per treatment was taken in a mortar in the presence of excess acetone. A pinch of calcium carbonate was added to prevent pheophytin formation and the contents were ground well and filtered through Whatman No.1 filter paper. The brei was washed repeatedly with fresh acetone (80%) until the washing was colourless. The extract and washings were then made upto 100 ml. The optical density (A) of an aliquot was measured using Spectronic-20 at wave length of 546 and 663 nm. The contents of chlorophyll 'a', 'b' and total chlorophyll (mg g^{-1} fresh weight) were then estimated using the following relationships.

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

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

Total chlorophyll [Chlorophyll (a+b)] = $8.05\ A_{663} + 20.20\ A_{645}$

3.4.4 Uptake studies

3.4.4.1 Nutrient concentration

The shoot portion of the samples were analysed for N, P and K after the experiment.

The dried plant samples were ground and chemically analysed for macronutrients as detailed below.

Nitrogen was determined by digesting 0.1 g of the sample in 2 ml concentrated sulphuric acid using hydrogen peroxide and N was estimated in the digest calorimetrically using Nessler's reagent (Wolf, 1982). The colour was read in a spectrophotometer (Spectronic-20) at a wave length of 410 nm.

Diacid extracts were prepared by digesting 1 g of the sample with 15 ml of 2:1 concentrated nitric acid - perchloric acid mixture (Johnson and Ulrich, 1959) and was made upto 100 ml. Aliquots from this solutions were taken for the analyses of P and K.

Phosphorus was determined calorimetrically by the Vanadomolybdo phosphoric yellow colour method (Jackson, 1958). The yellow colour was read in a spectrophotometer (Spectronic-20) at a wave length of 470 nm. Potassium was estimated using a flame photometer (EEL).

For all the chemical analyses, analytically pure grades of chemicals and glass distilled water were used.

3.4.4.2 Nutrient uptake

Nutrient uptake was computed from the values of concentration of the nutrients and the dry weight of parts sampled.

3.4.5 Plant quality

Leaf colour grading and plant quality grading was done as suggested by Neumaier *et al.* (1987). Colour of leaves under different shade levels were visually observed and graded as light green (1), medium green (3) and dark green (5). Plant quality rating was done based on fullness and growth habit as poor (1) (unfit for sale), good (3) and excellent (5).

3.5 Statistical analysis

The recorded data were statistically analysed following the methods suggested by Panse and Sukhatme (1985).

Results

RESULTS

Results of the experiments conducted to assess the effect of environment on the growth of *Philodendron* 'Wendlandii' are presented in this chapter.

4.1 Physico-chemical characteristics of the media

Physical constants and chemical properties of peat and potting mixture are presented in Table 1.

4.2 Growth parameters

Growth characters, viz., plant height, number of leaves and total leaf area, as influenced by different treatments and shade levels at four stages of growth; three months, six months, nine months and 12 months after planting, are presented separately hereunder.

4.2.1 Three months after planting

4.2.1.1 Effect of treatments

Data on the influence of various treatments on the growth parameters are given in Table 2.

Plant height showed no significant variation under 25 and 50 per cent shade levels in either of the growing media. However, under 75 per cent shade, plants of 13.41 cm were produced by potting mixture, which was significantly superior to peat. Similar effects were produced by containers also. Height of plants increased upto 13.75 cm under 75 per cent shade level when mud pots were used,

Table 1. Physico-chemical characteristics of the media

	Peat	Potting mixture
A. Physical characteristics		
Moisture percentage	8.63	7.90
Apparent density	0.62	1.41
Specific gravity	0.90	2.10
Maximum water holding capacity (%)	69.90	26.20
B. Chemical characters		
Organic carbon (%)	22.30	0.72
Total nitrogen (%)	0.12	0.23
Available phosphorus (kg/ha)	0.24	12.80
Available potassium (kg/ha)	1.06	120.20

Table 2. Growth parameters of *Philodendron* 'Wendlandii' as influenced by media, containers and fertilizers at different shade levels (3 months after planting)

Treatments	Growth parameters								
	25% shade			50% shade			75% shade		
	Plant height (cm)	Number of leaves	Total leaf area (cm^2)	Plant height (cm)	Number of leaves	Total leaf area (cm^2)	Plant height (cm)	Number of leaves	Total leaf area (cm^2)
Media									
Potting mixture	15.84	7.24	113.99	14.62	7.68	131.39	13.41	6.43	127.24
Peat	15.09	8.36	170.32	14.86	12.23	230.99	12.52	8.60	131.38
SEm±	0.415	0.071	1.571	0.449	0.402	11.906	0.156	0.178	5.212
CD (0.05)	NS	0.174	3.84	NS	0.98	29.12	0.38	0.428	NS
Containers									
Plastic pot	15.88	7.58	133.27	14.49	9.11	152.15	12.18	6.60	99.42
Mud pot	15.05	8.01	151.04	14.99	10.80	210.25	13.75	8.43	159.14
SEm±	0.415	0.071	1.571	0.449	0.402	11.906	0.156	0.178	5.212
CD (0.05)	NS	0.174	3.84	NS	0.98	29.12	0.38	0.428	12.74
Fertilizers									
SF @ 12 g/pl/yr	13.65	8.34	179.78	14.61	9.26	196.79	14.4	7.84	148.73
SF @ 24 g/pl/yr	16.43	7.03	136.65	15.66	11.71	258.48	15.48	7.52	171.12
CF @ 12 g/pl/yr	17.20	8.69	166.25	15.20	9.81	161.58	12.04	7.45	99.67
CF @ 24 g/pl/yr	15.24	8.98	166.02	15.26	11.66	203.74	14.20	9.05	184.49
Control	14.80	5.94	62.07	12.95	7.32	85.39	8.71	5.71	42.39
SEm±	0.651	0.113	2.484	0.710	0.636	18.828	0.247	0.281	8.24
CD (0.05)	1.605	0.275	6.06	NS	1.56	46.04	0.85	0.68	20.15

which was significantly higher than plastic pots (12.18 cm). Controlled release fertilizer @ 12 g/pl/yr was superior and produced a height of 17.20 cm at 25 per cent shade, but soluble fertilizer @ 24 g/pl/yr was on par with this. Soluble fertilizer @ 24 g/pl/yr produced taller plants of height 15.48 cm and proved to be superior under 75 per cent shade. Height did not vary considerably with fertilizers at 50 per cent shade level.

Number of leaves increased upto 8.36, 12.23 and 8.60 at 25, 50 and 75 per cent shade levels, respectively, when grown in peat. Mud pots produced plants with 8.01, 10.80 and 8.43 leaves, which were significantly superior to plants grown in plastic pots. Controlled release fertilizer when applied @ 24 g/pl/yr gave 8.98, 11.66 and 9.05 leaves, respectively, under increasing shade levels.

Total leaf area was significantly higher in peat as compared to that in potting mixture, under 25 and 50 per cent shade, but media had no significant influence on size of leaves under 75 per cent shade. Plants grown in mud pots gave larger leaves of sizes 151.04 cm^2, 210.25 cm^2 and 159.14 cm^2, respectively, with increased shade levels. Controlled release fertilizer @ 24 g/pl/yr was superior under 75 per cent shade. At 25 per cent shade level soluble fertilizer at lower concentration recorded the leaf size of 179.78 cm^2 and at 50 per cent shade higher concentration gave better leaf size of 258.48 cm^2.

4.2.1.2 Combination of treaments

Data showing the combined effect of treatments on growth parameters under different shade levels are given in Table 3.

Table 3. Growth parameters of *Philodendron* 'Wendlandii' as influenced by combinations of media, containers and fertilizers at different shade levels (3 months after planting)

Treatments	Growth parameters								
	25% shade			50% shade			75% shade		
	Plant height (cm)	Number of leaves	Total leaf area (cm^2)	Plant height (cm)	Number of leaves	Total leaf area (cm^2	Plant height (cm)	Number of leaves	Total leaf area (cm^2)
Pm + Pp + SF_1	14.48	7.03	142.23	14.65	7.60	168.74	16.00	5.30	131.39
Pm + Pp + SF_2	14.35	5.55	121.39	14.50	7.70	157.05	18.55	5.30	180.70
Pm + Pp + CF_1	18.15	8.25	96.64	16.35	8.00	146.52	9.40	5.33	31.20
Pm + Pp + CF_2	16.00	9.05	143.36	15.55	8.50	166.57	15.65	7.40	191.93
Pm + Pp + NF	17.05	5.90	42.97	11.25	6.00	88.22	7.35	5.70	36.93
Pm + Mp + SF_1	11.63	8.65	162.12	14.30	8.00	100.89	14.50	7.90	179.08
Pm + Mp + SF_2	20.60	7.75	141.53	15.35	8.88	156.48	15.25	7.38	177.50
Pm + Mp + CF_1	18.20	7.35	97.44	13.90	8.60	113.03	11.55	5.60	54.42
Pm + Mp + CF_2	15.30	7.08	131.45	16.40	7.05	148.99	15.75	8.80	235.21
Pm + Mp + NF	12.63	5.75	60.75	13.95	6.45	73.48	10.10	5.60	54.47
Pt + Pp + SF_1	13.80	9.75	213.08	16.85	9.95	195.72	11.30	8.25	96.51
Pt + Pp + SF_2	15.05	6.95	138.66	14.65	13.28	208.36	12.73	7.38	115.52
Pt + Pp + CF_1	15.70	8.75	162.15	14.60	8.08	119.18	11.55	8.05	96.75
Pt + Pp + CF_2	18.03	8.58	187.15	15.05	12.00	164.14	10.80	7.78	69.74
Pt + Pp + NF	16.20	6.00	85.04	11.93	9.98	112.98	8.50	5.55	43.96
Pt + Mp + SF_1	14.70	7.95	201.67	13.15	11.50	321.81	15.80	9.93	187.95
Pt + Mp + SF_2	15.73	7.85	145.02	18.15	17.00	512.01	15.40	10.03	210.77
Pt + Mp + CF_1	16.75	10.40	308.75	15.95	14.58	267.59	15.65	10.83	216.33
Pt + Mp + CF_2	11.65	11.23	202.12	14.03	19.10	335.27	14.60	12.23	241.08
Pt + Mp + NF	13.33	6.13	59.52	14.75	6.86	72.91	8.90	6.00	34.64
SEm±	1.313	0.2251	4.968	1.421	1.272	37.650	0.494	0.561	16.48
CD (0.05)	NS	0.55	12.15	NS	3.11	NS	1.21	1.37	40.29

Note: Pt = Peat; Pm = Potting mixture; Mp = Mud pot; Pp = Plastic pot; SF_1 = Soluble form @ 12 g/plant/year
SF_2 = Soluble form @ 24 g/plant/year; CF_1 = Controlled release form @ 12 g/plant/year
CF_2 = Controlled release form @ 24 g/plant/year; NF = No fertilizer

Under 75 per cent shade level a combination of potting mixture, plastic pot and the higher concentration of soluble fertilizer produced tallest plants (18.55 cm). But treatment combinations did not influence the height of plants significantly under lower levels of shade.

Number of leaves was maximum under 25, 50 and 75 per cent shade when a combination of peat, mud pot and the higher concentration of controlled release fertilizer was used.

Total leaf area of the plants varied considerably with treatment combinations. Under 25 per cent shade peat + mud pot + lower level of controlled release fertilizer proved to be superior (308.75 cm^2). A combination of peat, mud pot and controlled release fertilizer (higher concentration) produced larger leaves under 75 per cent shade. Treatment combinations did not exert significant differences in leaf area under 50 per cent shade.

4.2.2 Six months after planting

4.2.2.1 Effect of treatments

Data showing the effect of treatments on growth parameters at six months after planting are given in Table 4.

Media did not significantly influence the height of plants at 25 per cent shade. Taller plants were produced in peat at 50 per cent shade, whereas height significantly increased in potting mixture at 75 per cent shade level. Peat was significantly superior to potting mixture with respect to number of leaves in all the shade levels (15.76, 21.15 and 16.57 leaves, respectively, with incresing shade

Table 4. Growth parameters of *Philodendron* 'Wendlandii' as influenced by media, containers and fertilizers at different shade levels (6 months after planting)

Treatments	Growth parameters								
	25% shade			50% shade			75% shade		
	Plant height (cm)	Number of leaves	Total leaf area (cm^2)	Plant height (cm)	Number of leaves	Total leaf area (cm^2)	Plant height (cm)	Number of leaves	Total leaf area (cm^2)
Media									
Potting mixture	17.28	10.84	226.41	16.15	12.10	317.41	14.19	10.47	258.46
Peat	14.01	15.76	488.14	18.21	21.15	725.44	13.92	16.57	357.65
SEm±	0.325	0.194	7.348	0.339	0.828	34.06	0.366	0.178	7.89
CD (0.05)	NS	0.48	17.97	0.83	2.01	83.28	0.89	0.43	19.29
Containers									
Plastic pot	17.48	11.54	309.04	15.97	14.71	390.45	12.83	12.46	248.54
Mud pot	16.81	15.07	400.51	18.39	18.54	652.40	15.29	14.59	367.56
SEm±	0.325	0.194	7.348	0.399	0.823	34.06	0.366	0.178	7.89
CD (0.05)	NS	0.48	17.97	0.83	2.01	83.28	0.89	0.43	19.29
Fertilizers									
SF @ 12 g/plant/year	15.01	13.64	421.95	18.18	17.94	615.66	14.46	14.13	353.47
SF @ 24 g/plant/year	18.74	13.61	353.39	17.94	20.10	714.06	16.71	15.25	426.83
CF @ 12 g/plant/year	19.14	16.14	499.16	17.88	16.21	504.94	13.76	14.33	264.17
CF @ 24 g/plant/year	17.04	15.39	393.05	18.39	19.17	628.62	16.03	16.63	432.64
Control (NF)	15.81	7.73	106.33	13.51	9.69	143.85	9.34	7.28	63.16
SEm±	0.513	0.307	11.618	0.535	1.302	53.86	0.579	0.281	12.48
CD (0.05)	1.25	0.67	28.38	1.31	3.18	131.69	1.42	0.69	30.51

SF - Soluble form; CF - Controlled release form; NF - No fertilizer

levels). Total leaf area was significantly higher in peat as compared to potting mixture under all shade levels.

Effect of containers on the height of plants was not significant at 25 per cent shade level. However, taller plants (18.39 cm and 15.29 cm) were produced in mud pots at 50 per cent and 75 per cent shade levels, respectively. Number of leaves and total leaf area were significantly different in mud pot under varying shade levels. The number of leaves produced was 15.07, 18.54 and 14.59 and the leaf area 400.51 cm^2, 652.40 cm^2 and 367.56 cm^2 in mud pots at 25, 50, 75 per cent shade levels, respectively.

Plant height showed considerable variation with the form of fertilizer and the dose. Taller plants were produced at 25 per cent shade when controlled release fertilizer at the lower concentration was applied. The height was 18.39 cm at 50 per cent shade when the higher level of controlled release fertilizer was given. At 75 per cent shade soluble fertilizer at higher dose produced taller plants of height 16.71 cm. Controlled release fertilizer at higher concentration performed on par with this.

Number of leaves and total leaf area were significantly higher with the lower dose of controlled release fertilizer at 25 per cent shade level (16.14 and 499.16 cm^2, respectively). At 50 per cent shade level 20.10 leaves and 714.06 cm^2 area were produced by the higher dose of soluble fertilizer. Controlled release fertilizer at its higher dose was on par with this. This treatment under 75 per cent shade, produced plants with significantly higher number of leaves and leaf area (16.63 and 432.64 cm^2, respectively). Comparable size of leaves (426.83 cm^2) was produced with soluble fertilizer at the higher rate.

4.2.2.2 Combination of treatments

Data on the effect of treatment combinations on growth parameters are given in Table 5.

Plant height was significantly superior (22.18 cm) under 25 per cent shade when treatment combination of potting mixture, mud pot and the higher level of soluble fertilizer was provided. However under 50 per cent shade, combination of peat, mud pot and the lower level of controlled release fertilizer or the higher level of soluble fertilizer produced taller plants. Treatment combinations did not have significant influence on plant height at 75 per cent shade.

Significantly higher values for the number of leaves (24.95) and total leaf area (973.09 cm^2) were obtained at 25 per cent shade with a combination of peat, mud pot and the lower dose of controlled release fertilizer. Under 50 and 75 per cent shade levels significantly higher number of leaves and leaf area (35.65 cm, 1126.79 cm^2 and 25.75 cm, 747.59 cm^2, respectively) were observed when plants were grown in a combination of peat, mud pot and the higher level of controlled release fertilizer.

4.2.3 Nine months after planting

4.2.3.1 Effect of treatments

Data on the effect of treatments on growth parameters recorded at nine months after planting are given in Table 6.

Plant height did not vary significantly with media under 25 per cent shade. However, under 50 per cent shade peat produced significantly taller plants

Table 5. Growth parameters of *Philodendron* 'Wendlandii' as influenced by combinations of media, containers and fertilizers at different shade levels (6 months after planting)

Treatments	Growth parameters								
	25% shade			50% shade			75% shade		
	Plant height (cm)	Number of leaves	Total leaf area (cm^2)	Plant height (cm)	Number of leaves	Total leaf area (cm^2)	Plant height (cm)	Number of leaves	Total leaf area (cm^2)
Pm + Pp + SF_1	15.78	10.85	267.10	15.30	14.75	399.22	11.90	10.88	316.96
Pm + Pp + SF_2	16.08	7.78	237.39	15.65	13.85	378.68	21.35	12.63	562.88
Pm + Pp + CF_1	19.03	12.98	219.93	18.95	11.88	380.79	10.63	11.20	90.13
Pm + Pp + CF_2	17.53	14.70	264.00	18.00	14.95	571.42	16.55	13.85	393.02
Pm + Pp + NF	18.40	7.78	65.76	11.55	8.70	121.32	7.93	7.05	57.08
Pm + Mp + SF_1	12.80	13.95	346.12	15.00	12.98	220.94	15.20	10.08	246.09
Pm + Mp + SF_2	22.18	11.58	229.56	17.70	13.23	381.28	15.90	12.80	325.62
Pm + Mp + CF_1	20.40	12.48	315.66	14.50	11.33	149.31	13.53	8.75	133.45
Pm + Mp + CF_2	16.43	9.40	208.78	19.95	10.40	417.59	18.08	10.68	385.91
Pm + Mp + NF	14.18	7.43	109.87	14.85	8.93	153.59	10.93	6.80	73.93
Pt + Pp + SF_1	15.20	12.75	444.58	20.25	18.45	631.05	12.40	14.48	224.99
Pt + Pp + SF_2	17.73	12.23	413.19	15.95	20.75	485.62	14.00	14.38	331.06
Pt + Pp + CF_1	18.35	14.15	487.94	15.60	16.08	352.54	12.50	16.40	241.99
Pt + Pp + CF_2	20.28	14.95	559.36	16.08	15.68	398.67	12.20	16.25	204.05
Pt + Pp + NF	16.48	7.70	131.12	12.38	12.03	185.21	8.83	7.48	63.79
Pt + Mp + SF_1	16.25	17.53	630.01	22.15	25.60	1211.44	18.35	21.10	626.33
Pt + Mp + SF_2	19.00	22.85	533.48	22.45	32.58	1610.66	15.60	21.20	487.74
Pt + Mp + CF_1	18.80	24.95	973.09	22.45	25.60	1137.16	18.40	20.98	591.12
Pt + Mp + CF_2	13.93	22.50	540.05	19.55	35.65	1126.79	17.30	25.75	747.59
Pt + Mp + NF	14.18	8.03	118.57	15.25	9.13	115.27	9.68	7.78	57.83
SEm±	1.026	0.615	23.241	1.071	2.604	107.720	1.159	0.561	24.95
CD(0.05)	2.51	1.50	56.82	2.62	6.37	263.38	NS	1.37	61.00

Note: Pt - Peat; Pm - Pitting mixture; Mp - Mud pot; Pp - Plastic pot; SF_1 - Soluble form @ 12 g/plant/year
SF_2 - Soluble form 24 g/plant/year; CF_1 - Controlled release from @ 12 g/plant/year
CF_2 - Controlled release form @ 24 g/plant/year; NF - No fertilizer

Table 6. Growth parameters of *Philodendron* 'Wendlandii' as influenced by media, containers and fertilizers at different shade levels (9 months after planting)

Treatments	Growth parameters								
	25% shade			50% shade			75% shade		
	Plant height (cm)	Number of leaves	Total leaf area (cm^2)	Plant height (cm)	Number of leaves	Total leaf area (cm^2)	Plant height (cm)	Number of leaves	Total leaf area (cm^2)
Media									
Potting mixture	18.36	13.84	331.00	17.79	16.49	559.00	16.25	14.62	444.28
Peat	18.71	22.99	982.00	20.84	30.88	1491.00	14.91	24.80	665.58
SEm±	0.161	0.365	24.677	0.422	1.379	78.389	0.207	0.200	13.47
CD (0.05)	NS	0.89	60.32	1.03	3.37	191.7	0.51	0.49	32.93
Containers									
Plastic pot	18.45	15.92	639.00	17.27	19.93	665.00	14.52	18.01	442.11
Mud pot	18.62	20.91	674.00	21.36	27.45	1385.00	16.64	21.42	667.00
SEm±	0.161	0.365	24.677	0.422	1.379	78.389	0.207	0.200	13.47
CD (0.05)	NS	0.89	NS	1.03	3.37	191.7	0.51	0.49	32.93
Fertilizers									
SF @ 12 g/plant/year	16.55	19.59	759.00	20.74	26.77	1216.00	17.13	21.33	688.00
SF @ 24 g/plant/year	20.59	19.31	633.00	20.60	28.53	1323.00	17.91	22.60	731.00
CF @ 12 g/plant/year	20.58	21.84	867.00	20.60	23.78	1042.00	14.92	21.17	488.00
CF @ 24 g/plant/year	18.42	21.54	855.00	20.85	27.45	1342.00	18.09	24.28	772.00
Control (NF)	16.54	9.79	170.00	13.98	11.91	199.00	9.85	9.18	94.00
SEm±	0.254	0.577	39.017	0.667	2.180	128.940	0.328	0.316	21.29
CD (0.05)	0.62	1.39	95.40	1.63	5.30	303.03	0.80	0.77	52.05

SF - Soluble form; CF - Controlled release form; NF - No fertilizer

(20.84 cm) and potting mixture performed better to produce plants of height 16.25 cm at 75 per cent shade. Number of leaves and total leaf area showed significant increase in peat under all the shade levels.

Containers did not influence growth parameters at 25 per cent shade. However, taller plants with larger sized leaves were produced at 50 and 75 per cent shade when plants were grown in mud pots. Number of leaves also confirmed the significant superiority of mud pots. Plants showed 27.45 and 21.42 leaves and 1385 cm^2, 667 cm^2 leaf area when grown in mud pots under 50 and 75 per cent shade levels, respectively.

Controlled release fertilizer at its lower dose produced considerable increase in all growth parameters under all shade levels. Height was as much as 20.94 cm and 18.09 cm, number of leaves 27.45 and 24.28, total leaf area of 1342 cm^2 and 772 cm^2, respectively, at 50 and 75 per cent shade levels.

4.2.3.2 Combination of treatments

Data pertaining to the effect of combination of treatments on growth parameters under different shade levels are presented in Table 7.

Height of palnts showed significant increase when grown in a combination of mud pot and the higher level of soluble fertilizer under 25 per cent shade. At 50 per cent shade peat + mud pot + higher level of soluble fertilizer produced significantly taller plants (29.5 cm). Controlled release fertilizer at the lower level in the same combination produced a height of 28.80 cm which was on par with this. Under all the shade levels maximum number of leaves (35.40, 56.70 and 39.80 leaves, respectively, with increasing shade levels) with significantly larger size was

Table 7. Growth parameters of *Philodendron* 'Wendlandii' as influenced by combinations of media, containers and fertilizers at different shade levels (9 months after planting)

Treatments	Growth parameters								
	25% shade			50% shade			75% shade		
	Plant height (cm)	Number of leaves	Total leaf area (cm^2)	Plant height (cm)	Number of leaves	Total leaf area (cm^2)	Plant height (cm)	Number of leaves	Total leaf area (cm^2)
Pm + Pp + SF_1	17.20	14.70	471.00	16.80	20.30	711.00	19.00	15.8	546.00
Pm + Pp + SF_2	16.90	9.70	290.00	16.80	20.50	722.00	24.40	18.80	1058.00
Pm + Pp + CF_1	20.10	17.10	315.00	21.90	18.40	818.00	12.48	15.40	212.00
Pm + Pp + CF_2	18.70	17.70	366.00	20.10	17.60	853.00	17.25	20.70	624.00
Pm + Pp + NF	18.70	10.30	110.00	11.70	11.20	173.00	8.20	8.30	81.00
Pm + Mp + SF_1	13.60	17.70	462.00	17.00	18.60	383.00	15.50	16.10	416.00
Pm + Mp + SF_2	20.60	13.30	263.00	19.60	19.10	718.00	16.50	17.80	484.00
Pm + Mp + CF_1	21.90	16.50	538.00	15.40	14.60	241.00	15.00	12.70	287.00
Pm + Mp + CF_2	17.10	11.30	310.00	23.50	14.10	762.00	22.70	13.10	633.00
Pn + Mp + NF	14.90	10.20	18.80	15.80	10.70	206.00	11.50	7.60	95.00
Pt + Pp + SF_1	16.20	18.50	939.00	23.50	26.90	1128.00	13.30	21.30	398.00
Pt + Pp + SF_2	18.00	19.50	973.00	16.60	25.40	676.00	14.70	22.30	570.00
Pt + pp + CF_1	19.30	20.50	1066.00	16.40	23.80	564.00	13.10	23.70	397.00
Pt + Pp + CF_2	22.20	21.80	1637.00	16.90	21.40	756.00	13.90	23.60	430.00
Pt + Pp + NF	17.30	9.40	226.00	12.70	13.90	246.00	2.10	10.30	100.00
Pt + Mp + SF_1	19.20	27.50	1165.00	26.20	41.30	2642.00	20.70	32.20	1393.00
Pt + Mp + SF_2	22.90	34.70	1008.00	29.50	49.10	3177.00	16.10	31.60	810.00
Pt + Mp + CF_1	21.00	33.30	1549.00	28.80	38.40	2547.00	19.20	32.80	1055.00
Pt + Mp + CF_2	15.70	35.40	1106.00	22.30	56.80	2999.00	18.60	39.80	1399.00
Pt + Mp + NF	15.40	9.30	156.00	15.80	11.90	171.00	10.70	10.60	99.00
SEm±	0.509	1.154	78.030	1.330	4.361	247.890	0.655	0.633	42.59
CD (0.05)	1.25	2.82	190.78	3.26	NS	606.09	1.60	1.55	104.13

Note: Pt - Peat; Pm - Potting mixture; Mp - Mud pot; Pp - Plastic pot; SF_1 - Soluble form @ 12 g/plant/year
SF_2 - Soluble form @ 24 g/plant/year; CF_1 - Controlled release form @ 12 g/plant/year

produced when grown in a combination of peat, mud pot and the higher level of controlled release fertilizer.

4.2.4 Twelve months after planting

4.2.4.1 Effect of treatments

Data on the effect of treatments on growth parameters at 12 months after planting are given in Tables 8, 10 and 12.

The plants were significantly taller (22.32 cm and 23.49 cm, respectively) under 25 and 50 per cent shade, when grown in peat. On the other hand, potting mixture produced taller plants at 75 per cent shade. Among the containers mud pots influence plant height more compared to plastic pots under all shade levels (24.15 cm, 24.15 cm and 18.39 cm, respectively with increasing shade). Controlled release fertilizer @ 24 g/pl/yr gave more plant height (22.76 cm, 28.77 cm and 20.22 cm, respectively under 25, 50 and 75 per cent shades). More number of leaves (26.9, 33.6 and 31.3, repsectively) with larger leaf area (1511.3 cm^2, 2234.8 cm^2 and 1018.8 cm^2, respectively) was produced in peat under all the shade levels. Under increased shade levels side shoots were more (16.5 and 16.0) in peat under 25 and 50 per cent shade levels, whereas potting mixture performed better, producing 13.1 shoots under 75 per cent shade. Number of roots were significantly more (23.2, 22.0 and 23.2, respectively) when grown in peat under increasing shade levels. Among the containers, plastic pots had plants with more roots under 25 and 75 per cent shade levels whereas mud pots produced more roots under 50 per cent shade (21.3, 21.4 and 21.5 roots, respectively). Number of roots were significantly influenced by the form and dose of fertilizer under 25 and 75 per cent shade levels. Controlled release fertilizer at higher concentration produced maximum number of roots (21.5 and 21.7, respectively), but was on par with all other treatments, except the control.

Dry matter content was significantly higher in the case of peat and mud pot under all the three shade levels. Among the different fertilizer treatments controlled release form at the higher concentration accumulated maximum dry matter at 50 and 75 per cent shades (38.51 g and 28.24 g, respectively). Lower dose of controlled release form and higher dose of soluble form were on par with this at 50 per cent shade level.

4.2.4.2 Combination of treatments

Data on the effect of treatment combinations on growth parameters are given in Tables 9, 11 and 13.

Tallest plants were produced in a combination of peat, mud pot and soluble fertilizer (at the higher concentration) under 25 and 50 per cent shade levels. Controlled release form with peat and mud pot produced height on par with this. Under 75 per cent shade peat + mud pot + controlled release fertilizer (lower concentration) produced significant increase in height (29.00 cm).

Maximum number of leaves were produced in a combination of peat, mud pot and the higher level of controlled release fertilizer under all the shade levels. Maximum leaf area (3098.1 cm^2) under 25 per cent shade was produced when a combination of peat, plastic pot and the higher level of controlled release fertilizer was used. Largest leaf size (4421.7 cm^2) was produced in peat + mud pot + the lower concentration of controlled release fertilizer under 50 per cent shade. Controlled release fertilizer at a higher concentration when substituted in the above

Table 8. Growth of parameters of *Philodendron* 'Wendlandii' as influenced by media, containers and fertilizers at 25 per cent shade (12 months after planting)

Treatments	Growth parameters							
	Plant height (cm)	Number of leaves	Total leaf area (cm^2)	Number of side shoots	Number of roots	Dry matter yield (g/plant)		
						Root	Aerial part	Total
Media								
Potting mixture	19.51	16.6	496.70	12.7	15.3	7.68	18.94	26.62
Peat	22.32	26.9	1511.30	16.5	23.2	9.14	34.23	53.38
SEm±	0.138	0.36	42.25	0.05	0.474	0.331	1.160	0.45
CD (0.05)	0.34	0.90	102.30	0.12	1.16	0.81	2.84	1.10
Containers								
Plastic pot	18.76	19.1	1021.40	15.3	21.3	7.77	20.60	28.37
Mud pot	24.15	24.3	986.60	14.0	17.0	9.04	32.56	41.60
SEm±	0.513	0.36	42.25	0.05	0.474	0.331	1.160	0.52
CD (0.05)	1.25	0.90	NS	0.12	1.16	0.81	2.84	1.27
SF @ 12 g/pl/year	19.26	22.7	1052.10	16.0	20.4	8.78	24.24	33.02
SF @ 24 g/pl/year	23.01	21.9	922.70	16.0	20.4	9.52	27.49	37.01
CF @ 12 g/pl/year	22.33	26.6	1337.20	15.5	20.5	8.25	27.49	35.74
CF @ 24 g/pl/year	22.76	26.0	1462.90	15.3	21.5	9.27	28.36	37.63
Control (NF)	17.22	11.4	239.3	10.4	12.8	6.23	15.34	21.57
SEm±	0.218	0.580	6.681	0.080	0.730	1.280	1.840	1.01
CD (0.05)	0.53	1.42	163.3	0.22	1.78	0.52	4.89	NS

SF - Soluble form CF - Controlled release form NF - No fertilizer

Table 9. Growth parameters of *Philodendron* 'Wendlandii' as influenced by combinations of media, containers and fertilizers at 25 per cent shade (12 months after planting)

Treatments	Growth parameters							
	Plant height (cm)	Number of leaves	Total leaf area (cm^2)	Number of side shoots	Number of roots	Dry matter yield (g/plant)		
						Root	Aerial part	Total
Pm + Pp + SF_1	19.55	17.3	599.4	16.4	20.2	8.30	37.65	45.95
Pm + Pp + SF_2	17.65	11.1	396.7	16.7	19.8	10.70	13.87	24.57
Pm + Pp + CF_1	21.03	21.2	548.0	11.6	14.8	7.51	17.41	24.92
Pm + Pp + CF_2	21.25	22.5	564.8	10.7	12.3	8.02	19.98	28.00
Pm + Pp + NF	19.20	11.8	146.7	8.6	9.4	5.81	16.12	21.93
Pm + Mp + SF_1	15.05	20.9	761.7	13.2	16.2	7.25	16.35	23.60
Pm + Mp + SF_2	25.75	16.1	422.2	12.6	13.3	7.56	17.81	25.37
Pm + Mp + CF_1	22.85	20.1	833.8	14.3	18.3	7.10	16.58	23.68
Pm + Mp + CF_2	17.50	13.4	459.4	12.4	15.1	8.40	18.51	26.91
Pm + Mp + NF	15.30	11.3	234.8	10.8	13.1	6.83	15.12	21.95
Pt + Pp + SF_1	18.25	22.5	1390.1	18.8	27.3	8.31	22.97	31.28
Pt + Pp + SF_2	19.65	21.9	1439.3	19.4	28.2	8.36	25.15	33.51
Pt + Pp + CF_1	21.80	25.6	1705.4	19.2	29.3	7.90	21.15	29.05
Pt + Pp + CF_2	24.08	26.7	3098.1	21.3	37.1	7.43	16.47	23.90
Pt + Pp + NF	18.43	11.1	326.0	10.1	15.6	6.03	15.25	21.28
Pt + Mp + SF_1	24.20	30.0	1481.1	15.6	18.1	11.24	60.00	71.24
Pt + Mp + SF_2	29.00	28.5	1432.5	15.2	20.5	12.06	53.12	65.18
Pt + Mp + CF_1	23.65	39.7	2261.5	19.6	20.3	10.50	54.81	65.31
Pt + Mp + CF_2	28.20	41.3	2729.3	16.7	22.0	13.24	58.48	71.72
Pt + Mp + NF	15.95	11.3	249.9	12.0	13.5	6.26	14.88	21.94
SEm±	0.436	1.15	133.61	0.16	1.46	1.040	3.670	1.310
CD (0.05)	1.31	2.80	326.7	0.39	3.57	NS	8.97	3.20

Note: Pt - Peat; Pm - Potting mixture; Mp - Mud pot; Pp - Plastic pot; SF_1 - Soluble form @ 12 g/plant/year
SF_2 - Soluble form @ 24 g/plant/year; CF_1 - Controlled release form @ 12 g/plant/year
CF_2 - Controlled release form @ 24 g/plant/year; NF - No fertilizer

Table 10. Growth parameters of *Philodendron* 'Wendlendii' as influenced by media, containers and fertilizers at 50 per cent shade (12 months after planting)

Treatments	Growth parameters							
	Plant height (cm)	Number of leaves	Total leaf area (cm^2)	Number of side shoots	Number of roots	Dry matter yield (g/plant)		
						Root	Aerial part	Total
Media								
Potting mixture	19.42	18.1	849.7	14.3	18.2	7.53	19.71	27.44
Peat	23.49	33.6	2234.8	16.0	22.0	12.52	28.53	41.05
SEm±	0.513	1.39	125.81	0.04	0.823	0.713	1.248	1.248
CD (0.05)	1.25	3.4	307.6	0.1	2.01	1.74	3.05	3.05
Containers								
Plastic pot	18.76	21.8	1068.9	14.4	18.7	7.60	18.57	26.17
Mud pot	24.15	29.9	2015.4	15.0	21.5	12.45	29.67	42.12
SEm±	0.513	1.39	125.81	0.04	0.823	0.713	1.248	1.248
CD (0.05)	1.25	3.4	307.6	0.10	2.01	1.74	3.05	3.05
SF @ 12 g/plant/year	19.31	28.7	1716.4	14.5	19.8	9.33	23.92	33.25
SF @ 24 g/plant/year	19.53	30.9	1751.1	14.1	21.9	14.69	25.06	36.75
CF @ 12 g/plant/year	18.22	27.0	1928.0	14.3	22.2	10.31	26.19	36.50
CF @ 24 g/plant/year	28.77	30.1	2034.1	17.8	22.5	8.93	29.58	38.51
Control (NF)	14.51	12.6	281.7	11.9	14.0	6.85	15.85	22.70
SEm±	0.726	2.19	198.92	0.05	1.30	1.128	1.973	3.200
CD (0.05)	1.78	5.4	486.4	0.1	NS	2.76	4.82	7.82

SF - Soluble form; CF - Controlled release form; NF - No fertilizer

Table 11. Growth parameters of *Philodendron* 'Wendlandii' as influenced by combinations of media, containers and fertilizers at 50 per cent shade (12 months after planting)

Treatments	Growth parameters							
	Plant height (cm)	Number of leaves	Total leaf area (cm^2)	Number of side shoots	Number of roots	Dry matter yield (g/plant)		
						Root	Aerial part	Total
Pm + Pp + SF_1	17.50	21.0	943.3	13.8	18.0	6.41	17.94	24.35
Pm + Pp + SF_2	17.19	22.0	1174.6	13.9	19.6	7.98	18.01	25.99
Pm + Pp + CF_1	27.34	22.3	1398.5	18.7	22.5	8.86	27.35	36.21
Pm + Pp + CF_2	21.83	20.4	1105.8	16.1	19.0	8.21	24.70	32.91
Pm + Pp + NF	12.70	12.3	806.9	9.9	13.2	6.45	14.48	20.93
Pm + Mp + SF_1	17.63	20.5	496.4	12.4	13.5	12.01	20.07	32.08
Pm + Mp + SF_2	21.49	20.5	961.7	14.9	20.1	5.06	23.09	28.15
Pm + Mp + CF_1	15.95	15.9	606.3	11.7	17.5	7.60	16.51	24.11
Pm + Mp + CF_2	26.50	15.1	1249.5	19.6	25.6	7.08	22.05	29.13
Pm + Mp + NF	16.08	11.4	253.8	12.1	13.1	5.62	12.95	18.57
Pt + Pp + SF_1	26.08	29.1	1472.3	17.9	21.8	7.25	15.50	22.75
Pt + Pp + SF_2	17.43	28.0	1328.4	13.7	19.4	8.20	19.13	27.33
Pt + Pp + CF_1	16.94	26.1	1285.2	12.8	18.8	7.09	16.86	23.95
Pt + Pp + CF_2	17.42	23.1	1367.6	14.1	19.9	8.74	17.85	26.59
Pt + Pp + NF	13.23	14.2	306.2	13.1	15.4	6.78	13.90	20.68
Pt + Mp + SF_1	31.03	44.2	3953.6	20.5	26.2	11.66	42.18	53.84
Pt + Mp + SF_2	35.93	53.1	3539.6	21.2	28.8	37.54	40.00	77.54
Pt + Mp + CF_1	35.33	43.6	4421.7	19.1	30.1	17.67	44.03	61.70
Pt + Mp + CF_2	35.53	62.0	4413.6	15.2	25.4	11.72	53.73	65.45
Pt + Mp + NF	16.04	12.8	259.8	12.9	14.5	8.56	22.09	30.65
SEm±	1.623	4.39	397.83	0.12	2.60	2.256	3.95	3.26
CD (0.05)	3.97	10.7	972.7	0.29	NS	5.52	9.66	7.98

Note: Pt - Peat; Pm - Pitting mixture; Mp - Mud pot; Pp - Plastic pot; SF_1 - Soluble form @ 12 g/plant/year
SF_2 - Soluble form 24 g/plant/year; CF_1 - Controlled release from @ 12 g/plant/year
CF_2 - Controlled release form @ 24 g/plant/year; NF - No fertilizer

Table 12. Growth parameters of *Philodendron* 'Wendlandii' as influenced by media, containers and fertilizers at 75 per cent shade (12 months after planting)

Treatments	Growth parameters							
	Plant height (cm)	Number of leaves	Total leaf area (cm^2)	Number of side shoots	Number of roots	Dry matter (g/plant)		
						Root	Aerial part	Total
Media								
Potting mixture	18.00	17.6	673.8	13.1	15.3	7.24	17.48	24.72
Peat	16.21	31.3	1018.8	11.9	23.2	7.43	17.73	27.16
SEm±	0.315	0.36	28.05	0.06	0.47	0.115	0.385	0.413
CD (0.05)	0.77	0.9	68.6	0.2	1.16	NS	0.94	1.01
Containers								
Plastic pot	15.80	22.1	668.5	11.9	21.4	7.16	15.34	22.50
Mud pot	18.39	26.9	1023.3	13.1	17.1	7.51	17.88	25.39
SEm±	0.315	0.36	28.05	0.06	0.473	0.115	0.383	0.413
CD (0.05)	0.77	0.9	68.6	0.2	1.16	NS	0.94	1.01
SF @ 12 g/plant/year	18.61	26.3	1046.4	14.1	20.4	6.75	15.30	22.05
SF @ 24 g/plant/year	19.61	27.7	1104.8	15.3	20.6	7.54	16.43	23.97
CF @ 12 g/plant/year	16.41	27.2	785.0	11.2	20.7	7.36	18.06	25.42
CF @ 24 g/plant/year	20.22	30.5	1146.1	14.1	21.7	8.34	19.90	28.24
Contron (NF)	10.73	10.6	149.2	8.2	12.9	6.68	13.35	20.03
SEm±	0.598	0.57	44.35	0.10	0.748	0.211	1.478	1.252
CD (0.05)	1.21	1.4	108.4	0.2	1.83	0.52	0.60	3.06

SF - Soluble form; CF - Controlled release form; NF - No fertilizer

Table 13. Growth parameters of *Philodendron* 'Wendlandii' as influenced by combinations of media, containers and fertilizers at 75 per cent shade level (12 months after planting)

Treatments	Growth parameters							
	Plant height (cm)	Number of leaves	Total leaf area (cm^2)	Number of side shoots	Number of roots	Dry matter yield (g/plant)		
						Root	Aerial part	Total
Pm + Pp + SF_1	20.25	20.7	903.3	15.9	20.3	7.15	16.50	23.65
Pm + Pp + SF_2	28.25	21.4	1608.8	19.5	19.9	8.52	17.27	25.79
Pm + Pp + CF_1	13.88	20.1	414.1	8.3	14.6	7.14	16.70	23.84
Pm + Pp + CF_2	18.50	25.1	790.0	14.9	12.5	7.13	16.49	23.62
Pm + Pp + NF	8.63	9.9	103.2	7.9	9.5	6.72	11.69	18.41
Pm + Mp + SF_1	16.25	18.3	557.2	13.8	16.2	6.12	14.88	21.00
Pm + Mp + SF_2	17.63	20.9	659.1	13.9	13.3	6.98	16.76	23.74
Pm + Mp + CF_1	16.88	14.8	412.3	11.3	18.4	7.68	23.87	31.55
Pm + Mp + CF_2	27.25	16.5	1135.0	16.6	15.3	7.97	24.97	32.94
Pm + Mp + NF	12.25	8.8	146.7	9.0	13.3	6.94	15.70	22.64
Pt + Pp + SF_1	14.75	25.6	631.2	10.8	27.3	6.86	13.34	20.20
Pt + Pp + SF_2	15.38	27.0	870.2	13.3	28.5	7.52	16.64	24.16
Pt + Pp + CF_1	15.88	29.6	521.1	10.3	29.4	6.70	14.51	21.21
Pt + Pp + CF_2	15.25	29.5	701.1	9.8	37.2	7.37	17.07	24.44
Pt + Pp + NF	9.25	11.8	142.1	8.4	15.6	6.48	13.16	19.64
Pt + Mp + SF_1	23.25	40.5	2093.8	15.6	18.1	6.87	16.47	23.34
Pt + Mp + SF_2	17.13	41.7	1281.2	13.4	20.7	7.14	15.02	22.16
Pt + Mp + CF_1	29.00	44.5	1784.4	14.9	20.4	7.93	17.17	25.10
Pt + Mp + CF_2	19.75	50.8	1958.3	19.9	22.0	10.891	21.072	31.96
Pt + Mp + NF	12.50	11.9	204.7	7.7	13.5	6.59	12.86	19.45
SEm±	0.996	1.13	88.69	0.202	1.49	2.32	1.15	1.21
CD (0.05)	2.44	2.8	216.6	0.49	NS	NS	NS	NS

Note: Pt - Peat; Pm - Pitting mixture; Mp - Mud pot; Pp - Plastic pot; SF_1 - Soluble form @ 12 g/plant/year
SF_2 - Soluble form 24 g/plant/year; CF_1 - Controlled release from @ 12 g/plant/year
CF_2 - Controlled release form @ 24 g/plant/year; NF - No fertilizer

combination also produced leaf area on par with this. Best combination with respect to leaf area under 75 per cent shade was peat + mud pot + soluble fertilizer at the lower rate (2093.8 cm^2). Controlled release form at the higher rate in the same combination produced comparable leaf area.

Number of side shoots varied significantly with treatment combinations. Maximum number of side shoots (21.3) was produced in a combination of peat + plastic pot + the higher level of controlled release fertilizer at 25 per cent shade level. Under 50 per cent shade peat + mud pot + soluble fertilizer at higher dose gave significantly higher number of side shoots (21.2) whereas controlled release form at a higher dose when substituted in the above combination proved to be superior producing 19.9 side shoots under 75 per cent shade.

Significant influence of treatment combinations on number of roots was observed only at 25 per cent shade. Combination of peat, plastic pot and controlled release fertilizer at higher rate produced significantly more number of roots (37.1).

Dry matter yield varied significantly with treatment combinations at 25 and 50 per cent shade. The dry matter yield was 71.72 g in peat + mud pot + the higher concentration of controlled release fertilizer at 25 per cent shades which was significantly superior to other treatment combinations. Under 50 per cent shade, soluble fertilizer @ 24 g/pl/yr when substituted in the above combination produced maximum dry weight (77.54 g).

4.3 Chlorophyll content

Data on effects of treatments on chlorophyll content are given in Table 14.

Table 14. Chlorophyll contents of the leaf of *Philodendron* 'Wendlandii' as influenced by media, containers and fertilizers at different shade levels

Treatments	Chlorophyll content (mg/g of fresh weight)								
	25% shade			50% shade			75% shade		
	Chl a	Chl b	Total chl	Chl a	Chl b	Total chl	Chl a	Chl b	Total chl
Media									
Potting mixture	1.32	1.16	2.49	4.43	3.95	8.38	5.04	4.64	9.68
Peat	1.15	1.07	2.22	3.77	3.50	7.27	4.88	4.45	9.34
SEm±	0.059	0.047	0.035	0.097	0.083	0.090	0.048	0.065	0.302
CD (0.05)	NS	NS	NS	0.23	0.20	0.23	0.11	NS	NS
Containers									
Plastic pot	1.07	0.98	2.05	4.34	3.91	8.25	4.92	4.49	9.41
Mud pot	1.41	1.25	2.66	3.86	3.54	74.00	5.01	4.59	9.61
SEm±	0.059	0.047	0.035	0.097	0.090	0.048	0.066	0.302	0.642
CD (0.05)	0.14	0.11	0.11	0.23	0.20	0.23	NS	NS	NS
Fertilizers									
SF @ 12 g/plant/year	1.32	1.19	2.51	4.33	4.13	8.46	5.08	4.65	9.73
SF @ 24 g/plant/year	1.10	1.03	2.13	4.01	3.57	7.58	5.00	4.65	9.66
CF @ 12 g/plant/year	1.15	1.08	2.23	3.94	3.55	7.49	4.85	4.48	9.34
CF @ 24 g/plant/year	1.28	1.10	2.38	4.23	3.88	8.11	4.97	4.41	9.38
Control (NF)	1.34	1.18	2.52	4.01	3.66	7.67	4.91	4.52	9.43
SEm±	0.093	0.074	0.081	0.154	0.131	0.218	0.075	0.105	0.113
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

SF - Soluble form; CF - Controlled release form; NF - No fertilizer

The content chlorophyll 'a', 'b' and the total showed significant increase when grown in potting mixture (4.43, 3.95 and 8.38 mg g^{-1}, respectively) under 50 per cent shade. Media had no influence on chlorophyll content under the other two shade levels.

Mud pot was found to be better at 25 per cent shade and plastic pots under 50 per cent shade, with respect to chlorophyll content. Fertilizer forms and rates produced no significant influence at any of the three shade levels. Combination of treatments were also not significant in the case of chlorophyll.

4.4 Nutrient content and uptake

Data on treatment effect on nutrient content and uptake are given in Tables 15 and 16, respectively.

Concentration of N, P and K were not significantly influenced by the treatments under any of the shade levels. However, uptake of nutrients showed considerable variations depending on the treatments. Nitrogen uptake was significantly higher when plants were grown in peat (0.72 and 0.65 g/plant, respectively) under 25 and 50 per cent shade levels. Phosphorus uptake significantly increased under all shade levels when grown in peat, 106.0, 97.0 and 58.0 mg/plant, respectively, with increase in shade levels. Potassium uptake increased upto 0.99 and 0.88 g/plant under 25 and 50 per cent shade levels in peat, respectively, which was significantly superior over potting mixture.

Nitrogen, phosphorus and potassium uptake was significantly superior when plants were fertilized with the higher concentration of controlled release form under all the shade levels (Table 16). Combination effect was not significant.

Table 16. Uptake of major nutrients in *Philodendron* 'Wendlandii' has influenced by media, and fertilizer at different shade levels (12 months after planting)

Treatments	Nutrient uptake*								
	25% shade			50% shade			75% shade		
	N	P	K	N	P	K	N	P	K
Media									
Potting mixture	0.34	51.0	0.40	0.37	63.0	0.57	0.31	59.2	0.49
Peat	0.72	106.0	0.99	0.65	97.0	0.88	0.36	58.0	0.47
SEm±	0.107	6.094	0.088	0.113	0.170	0.070	0.061	0.046	0.100
CD (0.05)	0.26	14.89	0.22	0.28	0.42	0.17	0.15	0.11	NS
Fertilizers									
SF @ 12 g/plant/year	0.36	45.9	0.63	0.21	30.6	0.62	0.23	30.6	0.38
SF @ 24 g/plant/year	0.58	71.5	0.83	0.36	50.8	0.77	0.38	49.2	0.49
CF @ 12 g/plant/year	0.66	82.5	0.72	0.45	89.0	0.70	0.49	57.9	0.49
CF @ 24 g/plant/year	0.77	90.9	0.88	0.54	103.3	0.90	0.49	69.7	0.60
Control (NF)	0.21	15.3	0.18	0.19	15.9	0.19	0.20	26.7	0.16
SEm±	0.058	0.041	0.044	0.041	0.052	0.010	0.026	0.031	0.019
CD (0.05)	0.14	0.10	0.11	0.10	0.127	0.03	0.063	0.075	0.046

* N and K expressed as g/plant
P expressed as mg/plant

SF - Soluble form; CF - Controlled release form; NF - No fertilizer

Table 15. Concentration of major nutrients in the aerial portion of *Philodendron* 'Wendlandii' as influenced by media and fertilizers at different shade levels (12 months after palnting)

Treatments	Nutrient concentration (%)								
	25% shade			50% shade			75% shade		
	N	P	K	N	P	K	N	P	K
Media									
Potting mixture	1.8	0.27	2.6	1.9	0.34	2.8	1.8	0.27	2.6
Peat	2.1	0.31	2.9	2.3	0.37	3.0	2.1	0.31	2.9
SEm±	0.012	0.024	0.110	0.211	0.173	0.141	0.146	0.146	0.171
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Fertilizers									
SF @ 12 g/plant/year	1.5	0.19	2.6	1.4	0.20	2.6	1.5	0.20	2.5
SF @ 24 g/plant/year	2.1	0.26	3.0	2.2	0.31	3.1	2.3	0.30	3.0
CF @ 12 g/plant/year	2.4	0.30	2.6	2.5	0.34	2.7	2.7	0.32	2.7
CF @ 24 g/plant/year	2.7	0.32	3.1	2.7	0.35	3.1	2.5	0.35	3.0
Control (NF)	1.4	0.10	1.2	1.4	0.10	1.2	1.5	0.20	1.2
SEm±	0.042	0.037	0.040	0.070	0.103	0.118	0.113	0.117	0.217
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

SF - Soluble form; CF - Controlled release form; NF - No fertilizer

4.5 Plant quality

Data on foliar colour and plant quality rating as influenced by treatments are given in Table 17.

Foliar colour rating showed that treatments did not significantly influence colour of plants within a shade level. Plant quality rating based on growth showed that combination of peat and mud pots produced best quality plants with the score ranging from 4.2 to 4.5 (Plate 5).

4.6 Influence of shade

Data on the influence of shade levels on growth and quality of plants are presented in Table 18.

The tallest plants of height 15.35 cm at three months after planting were produced under 25 per cent shade. But 50 per cent shade proved to be significantly superior during later stages of growth, producing a height of 17.05 cm, 19.15 cm and 21.50 cm, respectively at six, nine and twelve months after planting.

Number of leaves were significantly higher upto 9 months after planting when grown under 50 per cent shade. But at 12 months, 75 per cent shade produced plants with the highest number of leaves (25.5).

Total leaf area was significantly superior under 50 per cent shade at all the stages of planting, ie., 180.6 cm^2, 518.4 cm^2, 1017.6 cm^2 and 1538.7 cm^2, respectively, at three, six, nine and twelve months after planting.

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Table 17. Plant quality of *Philodendron* 'Wendlandii' as influenced by media, containers and fertilizers at different shade levels

Treatments	25% shade		50% shade		75% shade	
	Foliar colour rating	Plant quality rating	Foliar colour rating	Plant quality rating	Foliar colour rating	Plant quality rating
Pm + Pp + SF_1	1.1	2.5	3.6	2.7	3.6	2.5
Pm + Pp + SF_2	1.1	2.6	3.7	2.7	3.6	2.7
Pm + Pp + CF_1	1.1	2.6	3.7	2.8	3.7	2.8
Pm + Pp + CF_2	1.0	2.6	3.7	2.9	3.7	2.8
Pm + Pp + NF	1.0	2.2	3.5	2.2	3.4	2.1
Pm + Mp + SF_1	1.0	2.8	3.5	2.9	3.6	2.6
Pm + Mp + SF_2	1.0	3.1	3.6	3.3	3.6	2.7
Pm + Mp + CF_1	1.1	3.0	3.6	2.9	3.6	2.7
Pm + Mp + CF_2	1.1	3.2	3.7	3.1	3.7	2.8
Pm + Mp + NF	1.0	2.1	3.5	2.2	3.4	2.1
Pt + Pp + SF_1	1.1	3.2	3.7	3.7	3.6	3.6
Pt + Pp + SF_2	1.2	3.5	3.9	3.9	4.0	3.7
Pt + Pp + CF_1	1.3	3.5	4.1	3.8	4.1	3.7
Pt + Pp + CF_2	1.3	3.7	4.0	3.9	4.0	3.9
Pt + Pp + NF	1.0	3.0	3.7	4.2	3.7	3.1
Pt + Mp + SF_1	1.2	4.5	3.8	4.5	3.8	4.2
Pt + Mp + SF_2	1.3	4.5	4.0	4.5	4.0	4.3
Pt + Mp + CF_1	1.2	4.4	4.0	4.4	4.1	4.2
Pt + Mp + CF_2	1.3	4.5	3.9	4.5	4.0	4.2
Pt + Mp + NF	1.1	3.0	3.6	4.1	3.6	4.0

Note: Pt - Peat; Pm - Potting mixture; Mp - Mud pot; Pp - Plastic pot
SF_1 - Solube form @ 12 g/plant/year; SF_2 - Soluble form @ 24 g/plant/year
CF_1 - Controlled release form @ 12 g/plant/year; CF_2 - Controlled release form @ 24 g/plant/year
NF - No fertilizer

Table 18. Growth and quality of *Philodendron* 'Wendlandii' as influenced by shade levels

Characters	25% shade	50% shade	75% shade	SEm±	CD(0.05)
Plant height (cm)					
3 months after planting	15.35	14.92	13.11	0.402	0.98
6 months after planting	16.99	17.05	14.52	0.426	1.04
9 months after planting	18.40	19.15	15.81	0.403	0.98
12 months after planting	20.57	21.50	17.31	0.217	0.68
Number of leaves					
3 months after planting	7.6	9.6	7.6	0.432	1.05
6 months after planting	12.3	15.5	14.4	0.278	0.53
9 months after planting	17.5	22.6	21.5	0.602	1.46
12 months after planting	21.5	23.5	25.5	0.756	1.83
Total leaf area (cm^2)					
3 months after planting	142.5	180.6	132.9	2.993	7.29
6 months after planting	358.7	518.4	314.0	5.117	15.52
9 months after planting	663.5	1017.6	559.3	9.120	22.25
12 months after planting	1010.4	1538.7	1126.2	14.680	35.62
Chlorophyll (mg g^{-1} fresh weight)					
Chl a	1.20	3.96	4.92	0.124	0.29
Chl b	1.27	3.62	4.51	0.160	0.39
Total	2.34	7.60	9.57	0.219	0.53
Foliar colour rating	1.1	3.7	3.8	-	-
Plant quality rating	3.2	3.5	3.2	-	-

Chlorophyll 'a', 'b' and total chlorophyll were the highest in the case of plants grown under 75 per cent shade (4.92, 4.51 and 9.57 mg g^{-1}, respectively). However, 50 per cent shade produced chlorophyll content on par with this and was significantly superior to 25 per cent shade level.

Foliar colour rating was more under 50 and 75 per cent shade levels (3.7 and 3.8, respectively) which was higher than 25 per cent shade with a score of 1.1 (Plate 6).

Plant quality rating was higher in the case of 50 per cent shade level (3.5) as compared to 25 and 75 per cent shade levels which gave plants with score of 3.2.

Plate 5. Plant quality rating as influenced by media and containers (from left to right: Plastic pot + Potting mixture, Plastic pot + peat, Mud pot + potting mixture, Mud pot + peat)

Plate 6. Foliar colour in *Philodendron* 'Wendlandii' grown under different shade levels (from left to right: 25%, 50% and 75%)

Discussion

DISCUSSION

The results generated from the studies conducted to evaluate the influence of media, containers and fertilizers under different shade levels on *Philodendron* 'Wendlandii' are briefly discussed.

The performance of any plant depends upon the interaction between its genetic constitution and the environmental factors. Every plant has its inherent characters which ultimately makes it suitable for commercial exploitation. However, the environment under which it is grown largely determines the realisation of the genetic potential. Thus it becomes the primary requisite to evaluate the plant under the available agro-ecosystem.

In the present study an export oriented variety of *Philodendron* was evaluated manipulating the essential environmental situations, viz., media, containers, nutrients and light.

Media are supposed to provide the support and supply system for plants, especially in the case of terrestrial plants. Different types of media have been used for plants taking into account their ability to sustain plants by providing moisture, nutrients and appropriate physical conditions. In the case of export oriented plants, the density or weight of the medium also assumes considerable relevance. Taking into account these factors, two different media, one the commonly used potting mixture and the other peat, the medium generally recommended for propagating and growing high value crop plants, were used in the present study.

Containers also play an important role in crop production, especially in the case of high value crops, since they are grown under protected cultivation systems instead of open fields. Here, the size, material, durability, cost, availability etc., are considered as factors determining the choice of the container. The two types of containers commonly used for growing ornamental plants are the mud pots and the plastic pots. Though mud pots are valued for their desirable characters like low cost, easy availability etc. (Gopalaswamiengar, 1991), there are also certain undesirable qualities like confinement of roots to the periphery, faster depletion of moisture and lowering of temperature in the medium due to evaporative cooling, less durability, difficulty in transporting etc. On the other hand, though plastic containes are costlier, they are preferred for raising export oriented high value crops in view of their light weight, durability, aesthetic value and soil temperature maintenance in the medium (Bunt, 1988). Both mud pot and plastic pots were used in the present study to evaluate their influence on plant growth.

The requirement of major nutrients in a balanced form need not be emphasised for raising crop plants. Fertilizers are commonly supplied in soluble form in the production of ornamentals, in view of their easy availability. As slow and steady growth rate is preferred in foliage plants, controlled release form of fertilizers are generally preferred because of their less dissolution rates in tune with the crop requirement. Besides, leaching loss of fertilizer nutrients is also relatively less in the case slow release fertilizers. It has an added advantage that frequency of application can be reduced (Joiner *et al.*, 1981). Comparison of the readily available soluble form and controlled release form of fertilizer at two levels was carried out in the present study to arrive at the form and rate suitable for *Philodendron* 'Wendlandii'.

Many tropical foliage plants have low light intensity requirements in their native habitat. Light thus act as a key factor which influences the growth and quality of foliage plants since most of them are grown indoors. Apart from determining the photosynthetic efficiency, light intensity also affects the colour of foliage which decides the aesthetic appeal of the plant. Proper light intensity during production is important as this reduces acclimatization problems when placed indoors (Fonteno *et al.*, 1977). Hence the present study also took into account the suitable range of shade to be given to produce plants for indoor decorations.

The overall quality of a foliage plant is best determined by height, number and size of leaves and number of side shoots produced, which in turn contribute to the general appearance of the plant. All the environmental factors mentioned above were found to influence the quality of plants in the present study.

At the early stage of growth, height was not significantly influenced by the growing media. But at 6, 9 and 12 months after planting superiority of peat over potting mixture with respect to plant height was evident. This could be because the treatmental effects were manifested only when the plants were grown for a longer period and habituation occurred. This is in conformity with the conclusions of Bunt (1988).

Among the containers tried, mud pots produced taller plants than those in plastic pots. Controlled release fertilizer also produced similar effect. This is in line with the results reported by Henny *et al.* (1988a), in which 'Tropic star' Dieffenbachia showed increased height with the application of osmocote 19 N-16 P-12 K.

Plant height showed varying responses with shade levels while 25 per cent shade produced maximum height 3 months after planting. On the other hand, 50 per cent shade was better at 6, 9 and 12 months after planting. Height produced was least under 75 per cent shade. This was on similar lines with result Naumaier *et al.* (1987) in which 50 per cent shade was found to be optimum with respect to plant height of *Hibiscus*.

Plants with more number of leaves and leaf area are preferred as the plants a bushy nature. Peat exhibit grown plants showed superiority in terms of number of leaves and leaf area. These results confirm the increased number of leaves and leaf size in *Ficus benjamina* and *Dracaena marginata* reported by Convoer and Poole (1986). Mud pots were superior to plastic pots with respect to number of leaves and area, irrespective of the shade levels. Controlled release fertilizer at both the concentrations tried was superior with respect to number of leaves at 25 per cent shade, but soluble fertilizer @ 24 g/pl/yr proved to be better at 50 per cent shade level. Similar result was reported in *Philodendron* by Poole and Conover (1977). Liquid fertilizer was found to produce more leaves and leaf area in *Chamaedorea, Howea* and *Philodendron* Conover and Sanders (1978). At 25 and 50 per cent shade levels total leaf area was found to be more when controlled release fertilizer was applied. Waters and Llewelly (1968) have reported that osmocote 14N-6P-12K per m^3 provided larger sized leaves in *Philodendron scandens oxycardium*.

Conover and Poole (1974) reported significant increase in leaf size in *Philodendron scandens oxycardium* at 40 per cent shade. The present study also gave supporting results. Fifty per cent shade was found better in terms of leaf area at all the stages of growth, namely, 3, 6, 9 and 12 months after planting.

Number of side shoots, which contribute to the number of leaves and dense growth pattern, is desirable in the case of foliage plants. Peat produced maximum side shoots at 25 and 50 per cent shade levels. Controlled release fertilizer proved to be better in terms of side shoot at 25 and 75 per cent shade, whereas soluble fertilizer was better under 50 per cent shade.

Dry matter accumulation was more in the case of peat. Conover and Poole (1972) have recommended peat for *Philodendron* as plants showed more dry weight when grown in peat. Controlled release fertilizer @ 24 g/pl/yr produced maximum dry weight at 50 and 75 per cent shade levels. Similar results were reported by Gilliam *et al.* (1983) in Boston fern.

Nutrient uptake was higher in plants grown in peat and fertilized using controlled release fertilizer @ 24 g/pl/yr. Sartain and Ingram (1984) reported similar results in which more extractable nutrients were found in osmocote fertilized plants. Supporting results by waters and Llewellyn (1968) showed that plants fertilized with osmocote 14N-6P-12K per m^3 produced tissue levels of 1.51 per cent N, 1.21 per cent P and 3.74 per cent K.

Chlorophyll content was higher when grown in potting mixture and plastic pots under 50 per cent shade level. Fertilizer form and dose had little influence on chlorophyll content. Chlorophyll content was found to increase proportionally with shade level although 50 per cent shade was found to be on par with 75 per cent shade. Such relationship between shade and chlorophyll content was reported in Dracaena (Conover and Poole, 1975b) and *Codiaeum variegatum* var. Pictum (Priessel *et al.*, 1980).

Visual evaluation of colour of foliage and plant quality suggested that combination of peat and mud pot produced superior quality plants within each shade level. Among the shade levels provided, 50 per cent was found to be optimum.

The foregoing discussions on the results generated from the present study indicated that there were consistent differences in growth and quality of *Philodendron* 'Wendlandii' with regard to the media, containers and fertilizer forms. Peat was found to be better for growth of the plant compared to potting mixture. The porous nature and higher water holding capacity of peat could be the reasons attributing to its superiority. It has been observed that number of roots were more in peat irrespective of the shade levels. This could be a possible factor for better uptake of the applied nutrients which in turn enhanced the overall growth. The better performance of plants in peat suggests the possibility of using this medium for growing foliage plants, inspite of its higher cost, compared to locally available media, especially in the case of large scale production. Its light weight is advantageous for transportation to distant places.

Mud pots were found to provide better conditions for plant growth. Even though there is less retention of water in the medium due to evaporation losses, the humid conditions in Kerala can make good the deleterious impacts of reduction in soil water content. Moreover, the reduction in soil temperature due to evaporative cooling, will be advantageous in the tropical conditions. The higher water retention capacity of peat can compensate the water loss in the case of mud pots and hence this combination can be beneficial for plant growth.

Soluble fertilizers and controlled release fertilizers were found to be on par in producing certain growth parameters. But controlled release fertilizers can be preferred because only lesser number of applications are needed which reduces the cost of production.

Shade level of 50 per cent was found preferred by *Philodendron* 'Wendlandii' which recommends its use for interior decoration. Since a comparable quality was observed in the case of 75 per cent shade as well, the specific shade intensity can be between 50 and 75 per cent. A future research in this aspect will be helpful.

Environmental factors concluded from the present study cannot be considered exhaustive as there are further factors enhancing plant growth which are to be standardised under our conditions. An assessment of the irrigation level and its frequency is essential because regular and profuse watering is not possible while growing plants indoors.

Studies on other varieties of *Philodendron* are imperative to arrive at conclusive results.

Summary

SUMMARY

Studies on the environmental effects on the growth of *Philodendron* 'Wendlandii' were carried out at the Department of Pomology and Floriculture, College of Horticulture, Vellanikkara from August 1995 to July 1996. The main objective of the trial was to evaluate the growth and quality of *Philodendron* 'Wendlandii' in different media, containers and fertilizers at three shade levels, viz., 25, 50 and 75 per cent and to identify the best environment. The salient findings of the study are summarised here.

Influence of media, containers and fertilizer forms and levels on growth parameters under the three shade levels was clearly evident at different stages of growth.

At 3 months after planting, the height of the plants was significantly better in potting mixture at 75 per cent shade. But peat proved to be superior in terms of number of leaves and total leaf area at 25 and 50 per cent shade levels. Mud pots produced plants which were significantly superior with respect to all growth parameters under all the three shade levels.

At 75 per cent shade, combination of peat mud pot and soluble fertilizer at higher level was superior in terms of number of leaves whereas peat + mud pot + controlled release fertilizer was superior at 25 and 50 per cent shade levels.

After 6 months of planting, a treatment combination of peat, mud pot and controlled release fertilizer could improve all the growth parameters at all the given shade levels. Soluble fertilizer @ 24 g/pl/yr substituted in the above

combination improved the height of plants at 25 per cent shade. This effect continued to be evident upto 12 months after planting.

Number of side shoots was more when plants were fertilized using controlled release fertilizer at 25 and 75 per cent shade level. However, at 50 per cent shade, soluble fertilizer considerably increased in the number of side shoots.

Number of roots did not show significant variation with treatments under 50 and 75 per cent shade levels. Dry matter yield was significantly higher when the plants were grown in peat + mud pot + controlled release form @ 24 g/pl/yr. Not much difference was noticed with regard to treatment combinations under 75 per cent shade.

None of the treatment combinations significantly influenced the chlorophyll content with each shade level. Concentration of N, P and K in the plants were not subjected to variations when different treatments were provided. However, uptake of major nutrients such as N, P and K was significantly different among media and fertilizers. Plants grown in peat and fertilized using controlled release fertilizer @ 24 g/pl/yr recorded maximum uptake of all the three nutrients.

Among the shade levels evaluated, 50 per cent shade was superior producing plants with better plant height, number of leaves and leaf area. Foliar colour rating and plant quality rating showed that 50 per cent shade was better compared to other levels.

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* Originals not seen

Appendices

APPENDIX-I
Weather data of the experimental site

Year	Month	Total rainfall (mm)	Mean relative humidity (%)	Mean sunshine (hrs)	Mean temperature (°C)	
					Maximum	Minimum
1995	August	448.7	86	3.7	30.6	23.7
	September	282.9	82	6.1	30.1	23.5
	October	110.4	78	8.3	33.2	23.2
	November	88.4	80	6.5	31.3	22.5
	December	0.0	57	10.3	32.5	21.3
1996	January	0.0	53	9.4	33.1	22.4
	February	0.0	53	9.9	34.7	23.4
	March	0.0	60	9.3	36.4	24.3
	April	152.0	73	8.3	34.6	25.0
	May	95.4	77	7.7	32.8	25.2
	June	400.3	85	4.7	30.5	23.8

APPENDIX-II

Environmental parameters recorded under different shade levels (from 6thmonth of planting)

Month	25% shade			50% shade			75% shade		
	Tempera-ture (°C)	Relative humidity	Light intensity	Tempera-ture (°C)	Relative humidity	Light intensity	Tempera-ture (°C)	Relative humdity	Light intensity
1996									
January	33.1	55	49200	33.8	58	41400	34.1	61	24000
February	35.2	54	50840	35.7	57	42780	36.0	59	24800
March	36.8	62	57400	37.2	63	48300	37.8	65	28000
April	35.0	74	58220	35.3	76	48990	36.0	78	28400
May	33.7	79	56580	34.0	80	47610	35.2	81	27600
June	30.8	86	55760	31.2	87	46080	32.0	88	27200
July	28.9	85	54940	29.4	86	46230	29.9	87	26800

APPENDIX-III

Analysis of variance for the growth parameters in *Philodendron* 'Wendlandii' as influenced by media, containers and fertilizers at 25 per cent shade

Characters	Media	Container	Fertilizer	
	Treatment mean squares	Treatment mean squares	Treatment mean squares	Error mean squares
(degree of freedom)	1	1	4	19
3 months after planting				
Plant height	5.56	6.89	15.45*	3.45
Number of leaves	12.64**	1.87**	13.05**	0.10
Total leaf area	31725.60**	3156.90**	18018.10**	49.36
6 months after planting				
Plant height	0.68	4.49	25.86**	2.11
Number of leaves	242.36**	124.82**	87.24**	0.76
Total leaf area	659099.70**	8368.10**	1771.70**	1079.90
9 months after planting				
Plant height	1.21	0.29	32.61**	0.52
Number of leaves	836.68**	249.75**	195.95**	2.67
Total leaf area	423969.81**	12419.20*	662559.40**	12178.90
12 months after planting				
Plant height	78.85**	27.46**	52.30**	0.38
Number of leaves	1059.77**	260.97**	300.96**	2.62
Total leaf area	10294075.10**	12139.40*	1831682.10*	3572.20
Number of side shoots	144.59**	16.97**	46.07**	0.05
Number of roots	638.40**	184.90**	101.36**	4.27
Dry weight of roots	21.13**	16.09**	13.73**	2.19
Dry weight of aerial part	2337.40**	1431.01**	379.64**	26.93

* Significant at five per cent level
** Significant at one per cent level

APPENDIX-IV

Analysis of variance for the growth parameters in *Philodendron* 'Wendlandii' as influenced by media, containers and fertilizers at 50 per cent shade

Character	Media	Containers	Fertilizers	
	Treatment mean squares	Treatment mean squares	Treatment mean squares	Error mean squares
(degree of freedom)	1	1	4	19
3 months after planting				
Plant height	0.57	2.55	8.96	4.04
Number of leaves	207.25**	28.65**	26.91**	3.24
Total leaf area	99199.90**	3375.66**	32571.93**	2835.80
6 Months after planting				
Plant height	42.64**	58.32**	34.03**	2.29
Number of leaves	819.03**	147.07**	137.01**	13.56
Total leaf area	1648871.00**	686178.20**	400626.30**	23206.20
9 months after planting				
Plant height	93.13**	166.75**	71.13**	33.56
Number of leaves	2070.72	564.90**	371.74**	38.02
Total leaf area	8683011.30**	5184133.00**	1818533.00**	122897.00
12 months after planting				
Plant height	165.89**	289.98**	121.95**	5.27
Number of leaves	2495.95**	648.83**	455.40**	38.50
Total leaf area	19185593.00**	8962563.00**	4107430.00**	316538.00
Number of side shoots	29.75**	24.01**	26.12**	0.03
Number of roots	143.64*	74.80*	100.71**	13.56
Dry weight of roots	249.40**	235.61**	67.21**	10.18
Dry weight of aerial part	776.69**	1232.32**	206.78**	31.13

* Significant at five per cent level
** Significant at one per cent level

APPENDIX-V

Analysis of variance for the growth parameters in *Philodendron* 'Wendlandii' as influenced by media, containers and fertilizers at 75 per cent shade

Characters	Media	Containers	Fertilizers	
	Treatment mean squares	Treatment mean squares	Treatment mean squares	Error mean squares
(degree of freedom)	1	1	4	19
3 months after planting				
Plant height	7.88**	24.57**	57.72**	0.49
Number of leaves	47.09**	33.31**	11.43**	0.61
Total leaf area	166.73	35667.40**	2723.70**	543.20
6 months after planting				
Plant height	0.74**	68.89**	66.95**	2.69
Number of leaves	373.08**	45.49**	105.41**	0.63
Total leaf area	98388.40**	141650.40**	187185.00**	1245.10
9 months after planting				
Plant height	17.96**	44.73**	94.81**	0.86
Number of leaves	1036.68**	116.11**	289.69**	0.80
Total leaf area	489742.70**	509139.50**	625571.10**	3627.20
12 months after planting				
Plant height	31.06**	66.95**	120.16**	1.98
Number of leaves	1866.78**	230.11**	500.33**	2.56
Total leaf area	1196022.09**	1258479.90**	1373452.10**	15734.50
Number of side shoots	14.16**	15.25**	62.38**	0.08
Number of roots	629.64**	187.06**	107.53**	4.48
Dry weight of roots	0.39	1.22	3.65	0.36
Dry weight of aerial part	30.71**	64.69**	50.59**	2.93

* Significant at five per cent level
** Significant at one per cent level

APPENDIX-VI

Analysis of variance for growth parameters in *Philodendron* 'Wendlandii' as influenced by combinations of media, containers and fertilizers at different shade levels

Characters	25% shade		50% shade		75% shade	
	Treatment mean squares	Error mean squares	Treatment mean squares	Error mean squares	Treatment mean squares	Error mean squares
(degrees of freedom)	4	19	4	19	4	19
3 months after planting						
Plant height	9.47	3.45	4.05	4.04	6.01**	0.49
Number of leaves	4.99**	0.10	10.75*	3.24	1.30	0.61
Total leaf area	2950.40**	49.36	7447.40	2835.80	1875.40	543.20
6 months after planting						
Plant height	8.31*	2.11	10.28*	2.29	5.40	2.59
Number of leaves	15.71**	0.76	48.50**	13.56	9.25**	0.63
Total leaf area	13889.10**	1079.90	119027.10*	23206.20	24678.80**	1245.10
9 months after planting						
Plant height	9.99**	0.52	33.95**	3.56	16.07**	0.86
Number of leaves	28.86**	2.67	107.73*	28.02	33.55**	0.80
Total leaf area	46611.90**	12178.90	824237.90**	122897.00	98257.40**	3627.20
12 months after planting						
Plant height	10.79**	0.38	73.29**	5.27	28.22**	1.98
Number of leaves	41.60**	2.62	138.92*	38.50	7.15**	0.86
Total leaf area	173057.10**	3572.20	1073751.00*	316538.00	224705.70**	15734.50
Number of side shoots	4.66**	0.05	21.75**	0.03	5.96**	0.05
Number of roots	22.16**	4.27	27.56	13.56	22.48*	4.48
Dry weight of roots	3.76	2.19	89.19**	10.18	0.53	0.36
Dry weight of aerial part	234.81**	26.93	83.81	31.13	8.02	2.93

* Significant at five per cent level
** Significant at one per cent level

ENVIRONMENTAL EFFECTS ON THE GROWTH OF *Philodendron* 'Wendlandii'

By

S. SWAPNA

ABSTRACT OF A THESIS

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Faculty of Agriculture
Kerala Agricultural University

Department of Pomology & Floriculture
COLLEGE OF HORTICULTURE
VELLANIKKARA, THRISSUR - 680 654
Kerala, India

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ABSTRACT

An experiment was carried out at the Department of Pomology and Floriculture, College of Horticulture, Vellanikkara, to evaluate the environmental influence on the growth of *Philodendron* 'Wendlandii'. The effects of media, containers and fertilizer forms and doses were assessed at three levels of shade, namely, 25, 50 and 75 per cent.

Results revealed that treatments could significantly influence all the vegetative parameters, viz., plant height, number of leaves, total leaf area and number of side shoots, at different stages of growth. The superiority of the combination of peat, mud pot and soluble fertilizer at its higher concentration was clearly evident with respect to plant height at 25 and 50 per cent shade levels. Controlled release fertilizer substituted in the above combination recorded plant height on par with this, at 25 and 50 per cent shade levels whereas the height was significantly superior at 75 per cent shade level.

Number of leaves was higher in the case of peat + mud pot + controlled release fertilizer under all the three shade levels. The above treatment combination produced more leaf area under 50 per cent shade. This was comparable with that of the leaf area produced when soluble fertilizer was used at 75 per cent shade. Number of side shoots was also higher in a combination of peat + mud pot + controlled release fertilizer.

Total biomass was a good indicator of the superiority of peat + mud pot + controlled release fertilizer at 25 and 50 per cent shade levels. The response in

uptake was more in the case of peat supplied with controlled release fertilizer. Better plant quality was observed when grown in peat and mud pot.

The shade level of 50 per cent was considerably better with respect to all the growth parameters, such as, height, number of leaves and total leaf area. Although chlorophyll content was maximum under 75 per cent shade, it was on par with that at 50 per cent shade. Overall plant quality too showed superiority of 50 per cent shade level.