STANDARDIZATION OF PROPAGATION AND AGRO-TECHNIQUES FOR CULTURE OF HOUSE PLANTS

A Thesis
submitted to the
Bidhan Chandra Krishi Viswavidyalaya
for the Award of the Degree of Doctor of Philosophy
in
HORTICULTURE

BY

Arun Kumar Pal

DEPARTMENT OF HORTICULTURE
FACULTY OF AGRICULTURE
BIDHAN CHANDRA KRISHI VISWAVIDYALAYA
MOHANPUR, NADIA, WEST BENGAL
1992

Dedicated to
the respectful memory of
my beloved father
late Jagadish Chandra Pal

Bidhan Chandra Krishi Viswavidyalaya

DEPARTMENT OF HORTICULTURE

Dr.B.K.Jana
Reader(Research) & Head.



P. O. KRISHI VISWAVIDYALAYA
MOHANPUR, Dist. NADIA.
WEST BENGAL.
PIN--741 252

Ref. No.....

Date..21.12.92

C E R T I F I C A T E

This is to certify that the work recorded in the thesis entitled "STANDARDIZATION OF PROPAGATION AND AGRO-TECHNIQUES FOR CULTURE OF HOUSE PLANTS" submitted by Shri Arun Kumar Pal for the award of the degree of Doctor of Philosophy in Horticulture of the Bidhan Chandra Krishi Viswavidyalaya, is a faithful and bonafide research work carried out under my personal supervision and guidance.

The results of the investigation reported in the thesis have not so far been submitted for any other Degree or Diploma. The assistance and help received during the course of investigation have been duly acknowledged.

21/12/92

(B. K. Jana)

ACKNOWLEDGEMENT

It is of immense pleasure to me to express my deep sense of gratitude to Dr.B.K.Jana, Reader (Research) of Horticulture & Head, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia (W.B.) for suggesting and initiating this problem, intensive encouragement, valuable guidance, keen and sustained interest throughout the course of this investigation as well as for his toiling over and correcting this manuscript.

I wish to express my sincere gratitude to Prof.T.K.Bose and Prof.S.Sen, Department of Horticulture for their valuable advice in carrying out the investigation.

I would like to acknowledge all the departmental helps received from the Head , Department of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, W.B.

I gratefully acknowledge my sincere gratitude to the Secretary, Agri Horticulture Society of India, Alipore, Calcutta for providing me laboratory and field facilities during the course of investigation.

The author is grateful to Indian Council of Agricultural Research, New Delhi for providing me the Junior Research Fellowship for conducting this study.

Sincere thanks are also extended to Dr.S.Bandyopadhyay, A.Mujib, I. Maity, C.Satpati, S.Khara and others for their help, assistance and encouragement during the course of my work.

I must not omit to thank Mr.J.C.Samanta for the arduous task of typing the manuscript.

I am very much indebted to my mother and other members of my family for their blessings, inspiration and assistance.

Arun Kumar Pal

Date: 21.12.92 (Arun Kumar Pal)

C O N T E N T S

	CHAPTER	PAGE NO.
1	I N T R O D U C T I O N ...	1
2	REVIEW OF LITERATURE ...	8
2.1	Growth factors	8
2.1.1	Light intensity	8
2.1.2	Temperature	11
2.1.3	Mineral nutrition	13
2.1.4	Growth retardant	19
2.1.5	Irrigation	23
2.1.6	Types of container	25
2.2	Propagation	26
3	MATERIALS AND METHODS	30
4	RESULTS AND DISCUSSION	45
4.1	Results	45
4.1.1	Standardization of agrotechniques for culture of house plants	45
4.1.1.1	Influence of light intensity on growth and development of house plants.	45
4.1.1.2	Studies on the effect of mineral nutrition on growth and development of house plants.	54
4.1.1.2.1	Effect of different levels of nitrogen and potassium on the growth and development of house plants.	54
4.1.1.2.2	Response of organic and inorganic fertilizers on growth and development of house plants.	76
4.1.1.3	Effect of growth retardants on growth and development of house plants.	89
4.1.1.4	Influence of irrigation frequency on growth and development of house plants.	103

	CHAPTER	PAGE NO.
4.1.1.5	Effect of different types of container on growth and development of house plants.	112
4.1.2	Standardization of propagation of house plants.	119
4.1.2.1	Effect of nodal position on the propagation of house plants	119
4.1.2.2	Regeneration of plantlets from cutting with varying number of nodes	126
4.1.2.3	Regeneration of plantlets from node with leaf, node without leaf and leaf cuttings.	138
4.1.2.4	Effect of rooting media on root regeneration and plant growth in cuttings of some house plants.	143
4.1.2.5	*In vitro* propagation of *Philodendron erubescens* 'Ceylon Gold'	149
4.2	Discussion	161
4.2.1	Standardization of agrotechniques for culture of house plants.	161
4.2.1.1	Influence of light intensity on growth and development of house plants.	161
4.2.1.2	Studies on the effect of mineral nutrition on growth and development of house plants.	164
4.2.1.3	Effect of growth retardants on growth and development of house plants.	168
4.2.1.4	Influence of irrigation frequency on growth and development of house plants.	174
4.2.1.5	Effect of different types of container on growth and development of house plants.	176
4.2.2	Standardization of propagation of house plants	177
4.2.2.1	Effect of nodal position on the propagation of house plants.	177
4.2.2.2	Regeneration of plantlets from cuttings with varing number of nodes.	179

CHAPTER		PAGE NO.
4.2.2.3	Regeneration of plantlets from node with leaf, node without leaf and leaf cuttings of Scindapsus aureus and Peperomia obtusifolia.	180
4.2.2.4	Effect of rooting media on root regeneration and plant growth in cuttings of some house plants.	181
4.2.2.5	In vitro propagation of Philodendron erubescens 'Ceylon Gold'.	182
5	SUMMARY AND CONCLUSION ...	185
6	FUTURE SCOPE OF RESEARCH ...	196
7	B I B L I O G R A P H Y ...	(i-xviii)

****

LIST OF TABLES

TABLE NO.	TITLE	PAGE NO.
1	Influence of light intensity on growth and development of *Calathea zebrina* and *Syngonium podophyllum* 'White Butterfly'.	50
2	Influence of light intensity on growth and development of *Dieffenbachia maculata*, *Monstera pertusa* and *Pleomele reflexa*.	51
3	Influence of light intensity on growth and development of *Aglaonema commutatum* 'Treubii' and *Calathea ornata*.	52
4	Influence of light intensity on growth and development of *Monstera deliciosa*, *Philodendron erubescens* 'Ceylon Gold' and *Scindapsus aureus* 'Marble Queen'.	53
5	Effect of N and K on growth and development of *Aglaonema commutatum* 'Treubii'.	67
6	Effect of N and K on growth and development of *Cordyline terminalis*.	69
7	Effect of N and K on growth and development of *Dieffenbachia maculata* 'Exotica'.	71
8	Effect of N and K on growth and development of *Scindapsus aureus* 'Marble Queen'.	73
9	Influence of fertilizer on elemental composition of four house plants.	75
10	Response of organic and inorganic fertilizers on growth and development of *Aglaonema commutatum* 'Silver Queen', *Cordyline terminalis* and *Dieffenbachia maculata*.	82
11	Response of organic and inorganic fertilizers on growth and development of *Dieffenbachia maculata* 'Exotica', *Monstera deliciosa* and *Philodendron erubescens*.	84
12	Response of organic and inorganic fertilizers on growth and development of *Pleomele reflexa* 'Song of India' and *Scindapsus aureus* 'Marble Queen'.	86
13	Response of organic and inorganic fertilizers on growth and development of *Calathea zebrina*, and *Chlorophytum comosum* 'Variegatum'.	87

TABLE NO.	TITLE	PAGE NO.
14	Response of organic and inorganic fertilizers on growth and development of *Peperomia obtusifolia* and *Syngonium podophyllum* 'White Butterfly'.	88
15	Effect of growth retardants on growth and development of *Aglaonema commutatum* 'Treubii' and *Calathea zebrina*.	96
16	Effect of growth retardants on growth and development of *Dieffenbachia maculata* and *Monstera obliqua*.	98
17	Effect of growth retardants on growth and development of *Pleomele reflexa*.	100
18	Effect of growth retardants on growth and development of *Peperomia obtusifolia* and *Syngonium podophyllum* 'White Butterfly'.	101
19	Influence of irrigation frequency on growth and development of *Aglaonema commutatum* 'Treubii', *A.commutatum* 'Silver Queen' and *Dieffenbachia maculata*.	108
20	Influence of irrigation frequency on growth and development of *Monstera deliciosa*, *M.pertusa* and *Pleomele reflexa* 'Song of India'.	109
21	Influence of irrigation frequency on growth and development of *Calathea zebrina*, *Chlorophytum comosum* 'Variegatum' and *Peperomia obtusifolia*.	110
22	Influence of irrigation frequency on growth and development of *Syngonium podophyllum* 'White Butterfly'.	111
23	Effect of different types of container on growth and development of *Aglaonema commutatum* 'Silver Queen', *Cordyline terminalis*, *Dieffenbachia maculata* and *Monstera deliciosa*.	116
24	Effect of different types of container on growth and development of *Monstera obliqua*, *Philodendron erubescens* 'Ceylon Gold', *Syngonium podophyllum* 'Variegatum' and *Scindapsus aureus* 'Marble Queen'.	117
25	Effect of different types of container on growth and development of *Calathea zebrina*, *C.ornata*, *Chlorophytum comosum* 'Variegatum' and *Peperomia obtusifolia*.	118

TABLE NO.	TITLE	PAGE NO.
26	Effect of nodal position on regeneration and growth of Aglaonema commutatum 'Treubii'.	127
27	Effect of nodal position on regeneration and growth of Dieffenbachia maculata.	128
28	Effect of nodal position on regeneration and growth of Monstera obliqua.	129
29	Effect of nodal position on regeneration and growth of Philodendron erubescens.	130
30	Effect of nodal position on regeneration and growth of Scindapsus aureus 'Marble Queen'	131
31	Effect of nodal position on regeneration and growth of Syngonium podophyllum 'Variegatum'.	132
32	Response of cutting with varying number of nodes on regeneration and growth of plantlets of Aglaonema commutatum 'Treubii' and Dieffenbachia maculata.	136
33	Response of cutting with varying number of nodes on regeneration and growth of plantlets of Monstera obliqua and Philodendron erubescens.	137
34	Effect of different types of cutting on regeneration and growth of plantlets from Scindapsus aureus 'Marble Queen'.	141
35	Effect of different types of cutting on regeneration and growth of plantlets from Peperomia obtusifolia.	142
36	Effect of rooting media on regeneration and growth of Aglaonema commutatum 'Treubii'cuttings.	150
37	Effect of rooting media on regeneration and growth of Philodendron erubescens.cuttings.	151
38	Effect of rooting media on regeneration and growth of Dieffenbachia maculata.cuttings.	152
39	Effect of rooting media on regeneration and growth of Monstera obliqua.cuttings.	153
40	Effect of rooting media on regeneration and growth of Syngonium podophyllum 'Variegatum'. cuttings.	154

TABLE NO.	TITLE	PAGE NO.
41	Effect of MS medium supplemented with growth regulators on Philodendron erubescens 'Ceylon Gold'.	159
42	Effect of MS medium supplemented with growth regulators on shoot bud formation of Philodendron erubescens 'Ceylon Gold'.	160
43	Effect of Knudson 'C' medium supplemented with growth regulators on stem node explant of Philodendron erubescens 'Ceylon Gold!	160

LIST OF FIGURES

FIGURE NO.		PAGE (in Between)
1	Effect of light intensity on plant height and leaf number of some house plants.	53-54
2	Influence of light intensity on leaf area of some house plants.	53-54
3	Effect of N and K on plant height and leaf area of four house plants.	75-76
4	Response of organic and inorganic fertilizations on plant height of some house plants.	88-89
5	Response of organic and inorganic fertilizations on leaf area of some house plants.	88-89
6	Effect of growth retardants on plant height of some house plants.	102-103
7	Effect of growth retardants on leaf area of some house plants.	102-103
8	Influence of irrigation frequency on plant height and leaf number of house plant.	111-112
9a	Effect of cutting position on days required for shoot emergence of house plants.	132-133
9b	Effect of cutting position on days required for root emergence of house plants.	132-133
10a	Effect of cutting position on % of rooting of house plants.	132-133
10b	Effect of cutting position on number of primary roots of house plants.	132-133
11	The effect of rooting media on percentage of rooting of node cuttings of five house plants.	154-155

****

LIST OF PLATES

PLATE NO.		PAGE (in between)
1	Influence of light intensity on growth and development of Dieffenbachia maculata, Pleomele reflexa, Syngonium podophyllum 'White Butterfly' and Calathea zebrina.	53-54
2	Influence of light intensity on growth and development of Aglaonema commutatum 'Treubii', Philodendron erubescens 'Ceylon Gold' and Scindapsus aureus 'Marble Queen'.	53-54
3	Effect of N, P and K on growth and development of Aglaonema commutatum 'Treubii', Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen'.	75-76
4	Response of bonemeal and bloodmeal on growth and development of Peperomia obtusifolia, Philodendron erubescens, Pleomele reflexa 'Song of India' and Syngonium podophyllum 'White Butterfly'.	88-89
5	Response of Sterameal, Charcoal dust and NPK on growth and development of Calathea zebrina, Monstera deliciosa and Pleomele reflexa 'Song of India'.	88-89
6	Influence of irrigation frequency on growth and development of Aglaonema commutatum 'Treubii', Dieffenbachia maculata and Monstera pertusa.	111-112
7	Influence of irrigation frequency on growth and development of Calathea zebrina, Chlorophytum comosum 'Variegatum', Pleomele reflexa 'Song of India' and Syngonium podophyllum 'White Butterfly'.	111-112
8	Effect of different types of container on growth and development of Cordyline terminalis, Dieffenbachia maculata and Scindapsus aureus 'Marble Queen'.	118-119
9	Effect of different types of container on growth and development of Calathea zebrina, Chlorophytum comosum 'Variegatum' and Monstera obliqua.	118-119

PLATE NO.		PAGE (in between)
10	Effect of different types of container on growth and development of Philodendron erubescens 'Ceylon Gold' and Monstera deliciosa.	118-119
11	Effect of nodal position on propagation of Aglaonema commutatum 'Treubii' and Dieffenbachia maculata.	132-133
12	Effect of nodal position on propagation of Monstera obliqua and Philodendron erubescens.	132-133
13	Response of number of nodes per cutting on regeneration and growth of Aglaonema commutatum 'Treubii', Dieffenbachia maculata and Philodendron erubescens.	137-138
14a	Effect of rooting media on regeneration and growth of Monstera obliqua.	154-155
14b	Effect of different types of cutting on regeneration and growth of Peperomia obtusifolia.	154-155
15a	Callus induced on MS medium + 2,4-D (0.25 mg/l) in Philodendron erubescens 'Ceylon Gold'.	160-161
15b	Shoot regeneration on MS supplemented with BAP (0.5 mg/l) in Philodendron erubescens 'Ceylon Gold'.	160-161

Chapter 1

INTRODUCTION

INTRODUCTION

People have been using ornamental plants in and around their homes for atleast 3,500 years. Many conservatories were constructed in the 17th century Europe. With the increasing population in cities and towns, lack of open space and development of multistoried housing system, house with garden space are becoming limited. To add beauty to a house and to get immense pleasure and fun, city people can grow a wide range of flowering and foliage plants in every corner of his house. In recent years, there is an increasing demand for house plants which can be very effectively used in interior decoration. A well chosen house plant with little care will continue to decorate a room for a period of time. House plants are not restricted to residential houses alone (i.e. in living room, bed room, kitchen, stair case, patios and others), there has been a tremendous scope in the use of these plant in beautifying offices, hotels, hospitals and almost all public buildings. Foliage plant production has gained much importance in the recent years. Several nurserymen have taken up large scale multiplication of the foliage plants to cater to the growing needs of indoor decoration at homes and offices.

Growth and quality of foliage plants depend on interactions between environmental parameters (light, temperature, humidity, carbondioxide concentration and wind velocity) and genetic constitution (gene pool) of a particular plants. Foliage plants are used extensively for interior decoration because of their excellent ability to adopt to low light conditions in home. Although these

plants can grow at low light intensities, the optimum photoperiod as well as light intensity are needed to produce top quality plants. Colour intensity of colourful plants such as Cordyline terminalis and Codiaeum variegatum are severely reduced as light intensity is decreased below 32 kilo lux (Conover and Poole, 1972 a). Epipremnum aureum has less yellow variegation when light levels are less than 43 kilo lux (Conover and Poole, 1972 a), while Dracaena sanderiana or D.deremensis 'Warneckii' produces white stripes at less than 22 kilo lux than at higher level. Size, shape and orientation of individual leaf are also influenced by light intensity. Light conditions in the production phase also influence the height of the plant, growth rate, area and number of leaves and size of carbohydrate pool in the plant (Collins and Blessington, 1981; Johnson et al.1979a, 1979b, 1982a and 1982b).

Most foliage plants of tropical and subtropical regions do not tolerate freezing temperatures. Temperature is another factor which demands adequate attention in foliage industry. Like other tropical plants, these plants have critical temperature requirement for their optimum growth. Relative humidity is an important factor of plant growth as it affects transpiration rates and water usages. Most foliage plants grow better at relative humidity of more than 50 per cent. However, when relative humidity in the green house is very high, particularly during winter months, condensation becomes a major problem.

Nutrients for foliage plants can be obtained from many sources. Nutrients and the amounts required should be understood

before selecting the source of fertilizer to be used as well as the method of applying the nutrients. Good quality foliage plants have been grown with fertilizer that is liquid or dry, readily available or slow release, in the organic or inorganic form. Proper nutrient supply can be influenced by several factors. Adjusting fertilizer levels to light intensities is one of the most important problems faced by foliage growers. Under low light intensities and high fertilization rates, plants are usually leggy with long weak stems and light green foliage. With a reduction in fertilizer and higher light levels, plants produce green leaves and attractively shaped plants.

The height and diameter of stem increased with increasing nitrogen (as NH_4NO_3) rate from 140 ppm to 420 ppm in Scindapsus aureus (Pimpini, 1971). Poole and Conover (1977) also reported that plant height and number of shoots per plant increased and leaf colour improved with increasing nitrogen levels from 80 mg to 320 mg in Aglaonema commutatum. Growth and grade of Dieffenbachia and Nephrolepis were not influenced by N-source whereas Aglaonema and Philodendron were improved by N sources containing 25 to 100% NH_4-N or 100% Urea-N (Conover and Poole, 1986a).

Slow release fertilizers are widely used in the foliage industry since they supply adequate amounts of nutrition for extended periods of time when supplied in proper amounts. Organic or natural fertilizers include bonemeal, castor bean, cotton seed, fishmeal, dried blood, sewage, sludge, garbage tankage and wood ash

which are slow releasing fertilizers. Poole and Chase (1987b) showed that plant height of Peperomia obtusifolia increased with the increase in osmocote (19 : 6 : 12) rate upto 2.5 g/pot and then decreased.

Growth retardants are now-a-days widely used in ornamental horticulture for controlling growth, shortening internodes causing darker green leaves, accelerated growth or delayed flowering, increased drought tolerance, increased resistance to air pollutants and disease and delayed senescence. Retardants have been defined as substances that slow cell division and elongation in the sub-apical meristem, but do not completely inhibit these process. SADH inhibited internode elongation of Philodendron scandens ssp.oxycardium, Epipremnum aureum and Syngonium podophyllum without phytotoxic effects (Poole, 1970).

Foliage plants require a constant supply of water for optimum growth, but utilize only a small amount. This forces the producer to decide when, how much and how to apply the water to the foliage plants. An abundance of good quality water is preferable for production of foliage plants, but not essential. Concise schedules cannot be given for irrigation of foliage plants. Water necessary for foliage plant growth is stored in the potting medium and each grower must use judgement in evaluating environmental conditions, appearance or feel of the soil medium, pot size and the particular kind and size of the plant when determining watering regimes. A porous medium should be used to allow

penetration of water, yet the medium should store sufficient water for plant use until the next irrigation. With each irrigation, sufficient water should be applied to thoroughly moisten the medium. Improper watering is one of the largest causes of reduced plant quality and yield in the industry. The frequency of irrigation varies with size of plants and containers, soil and air temperature, potting mixtures, solar radiation, humidity and air movement. Dieffenbachia maculata, Dracaena surculosa or Syngonium podophyllum require watering four times per week for obtaining good quality of plant (Poole and Conover, 1981 and 1987) whereas Chlorophytum comosum require 3 times/week irrigation (Hipp et al., 1979).

Growth of good quality house plant is also influenced by the type of container used for culture. Christensen (1971, 1974) found that plastic pots were best on drained benches for growing Hedera canariensis and Codiaeum variegatum.

Cuttings most frequently used to propagate foliage plants include tip, single or double eye, leaf and cane. Greater uniformity, inexpensive, rapid and simple process are the basic criteria for cuttings. Cutting from sub apical position produced lower rooting percentage and rooted more slowly than cuttings from more basal region (Hansen, 1986a). Cuttings of many species root easily in variety of rooting media but those more difficult-to-root may be greatly influenced by the kind of rooting medium used in not only in the percentage of cutting rooted, but in the quality

of root system formed (Long, 1932). The application of tissue culture techniques to the regeneration and commercial propagation of plants is a more recent development. It is the aseptic culture of plant tissue, such as protoplasts, cell, meristems, shoot tips embryos, ovules, roots, or stem and leaf sections in a vessel containing microbe- free nutrient medium under environmental conditions suitable for plant development. Shoot formation was best on modified MS medium supplemented with 10 mg/l BA + 0.5 mg IAA in Philodendron scandens (Gertsson and Andersson, 1985).

Although house plants are important group of ornamental foliage plants, very little investigations have been carried out to standardize the cultural practices of these plants. With a view to standardize improved method of propagation and agro-technique in culture of house plants a series of investigation on Aglaonema commutatum 'Silver Queen', A.commutatum 'Treubii', Calathea ornata 'Roseo-lineata', C.zebrina, Chlorophytum comosum 'Variegatum', Cordyline terminalis 'Baby T_1', Dieffenbachia maculata, D.maculata 'Exotica', Monstera deliciosa, M.obliqua, M.pertusa, Peperomia obtusifolia, Philodendron erubescens, P.erubescens 'Ceylon Gold', Pleomele reflexa, P.reflexa 'Song of India', Scindapsus aureus 'Marble Queen', Syngonium podophyllum 'Variegatum' and S.podophyllum 'White Butterfly' were taken up as follows: to Study the

i) Influence of light intensity on growth and development of house plants.

ii) Studies on the effect of mineral nutrition on growth and development of house plants.

iii) Effect of growth retardants on growth and development of house plants.

iv) Influence of irrigation frequency on growth and development of house plants.

v) Effect of different types of container on growth and development of house plants.

vi) To improve the method of propagation of house plants.

Chapter 2

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Production or ornamental foliage plants for indoor decoration is affected by many factors. The pot grown house plants require special attention for their successful growth and development as the microclimate of room is quite different from that of outdoor condition. The important factors that affect foliage plant production like propagation, temperature, light intensity, relative humidity, types of container, potting mixture, mineral nutrition, growth regulators and irrigation have been reviewed and presented below.

2.1 Growth factors

2.1.1 Light intensity

Solar radiant energy is the dominant factor in the indoor plant environment. Growth of foliage plants under specific light intensities is an important aspect of production. Since many plant genera included in the foliage plant group evolved under divergent environmental conditions of light intensity, temperature, humidity and soil type, yield, foliage colour, foliage size and shape, density of foliage, amount of stored carbohydrates, and susceptibility to disease or insects influence determinations of proper light intensities.

According to Conover and Poole (1973) forcing of Caladium bicolor at 90°F rather than at 70 or 80°F enhanced growth and quality of foliage, but root growth was adversely

affected, shade levels of 40 and 60% were most satisfactory.

The lower limit of light intensity required by green plants (Aechmea, Dieffenbachia, Vriesea and other species) is 800-1000 lux (Zimmer, 1977). Larsen (1979) recorded that Aglaonema sp., Chamaedorea elegans and Phoenix canariensis had the highest tolerance to low light intensities and it may be recommended for use in light intensities down to 200 lux.

Conover and Poole (1980a) found that the highest quality of Dracaena angustifolia 'Honoriae' was produced under 26 klx light intensity under different levels of fertilizers. Preissel et al., (1980) observed that the colour intensity and contrast were best at 17°C, short day and 3000 lux, and good at 22°C, long day and 3000 lux in Codiaeum variegatum and at 27°C and 8000 lux a check in the growth of young leaves occurred and yellow colour was masked by red. In an other experiment, Conover and Poole (1980b) obtained greatest yield of cut foliage when plants like Pittosporum tobira and P.tobira cv.Variegata were grown under 47% shade.

Conover and Poole (1981) also reported that growth and plant quality of Schefflera actinophylla and Dieffenbachia maculata cv.Perfection were increased with the level of light at 2 klux. Rioux and Dansereau (1981) pointed out that day length extension from 12 to 20 h at 2700 lux light intensity led to stronger stems, shorter internodes, enhanced leaf colour and the growth of secondary stems in Dieffenbachia amoena, Ficus benjamina

and Codiaeum variegatum. Increase in the amount of shade generally increased plant quality of Schefflera actinophylla (Conover and Poole, 1981b).

Conover et al. (1982) reported that overall growth of Schefflera actinophylla, Dracaena marginata, Ficus benjamina, Chamaedorea elegans and Dieffenbachia maculata cv. Exotica were best with 26 $\mu Em^{-2}s^{-1}$ light for 12 and 18 h/day and poor with 26 $\mu Em^{-2}s^{-1}$ light for 24 h/day.

Horn and Huber (1983)stated that the fresh weight of Ficus and Schefflera increased by 20-30% in response to increase in light intensity from 300 to 3000 lux but in Cissus growth was maximum at 2000 lux. Aglaonema ,however, proved insensitive to differences in light intensities. Sandved (1983) observed that at optimum temperature ($21^{o}C$) the growth of Aglaonema was increased with increased light intensity from 150 to 1250 lux. In Peperomia obtusifolia cvs.Albomarginata and Variegata, Shen and Seely (1983) found that reduction in the light intensity increased the relative amount of non green area/leaf and decreased plant fresh and dry weight but did not affect the leaf nutrient contents.

Kristensen (1984) showed that Peperomia obtusifolia cv. USA needed at least 60% light to keep it in good condition.

Donselman and Broschat (1985) observed that the number of basal branches was increased to 4.2 in Dracaena marginata held for 9 months in full sun followed by 3 months in 50% shade

and additional exposure to sun did not significantly increase branching.

Chase and Poole (1987b) showed that Syngonium podophyllum cv.White Butterfly grown with 200 $\mu mol.s^{-1}m^{-2}$ (80% shade) had taller plant heights with fewer but whiter leaves which were larger in size. The plants had lower quality grades, lower fresh weight of shoots, higher percentage of plants with healthy appearing roots than those grown with 700 $\mu mol.s^{-1}m^{-1}$ light (47% shade).

Peperomia obtusifolia grew better at light intensities below 1000 lux and Begonia semperflorens responded better than other plants to light levels of 5,000 to 1,00,000 lux producing dark coloured flowers and large number of leaves (Son and Yeam, 1987).

Hendriks and Ludolph (1988) found that Dieffenbachia maculata was responsive to light intensity 40 - 60 Klux h/day with an increase in plant size, branching and leaf number while Ficus benjamina was benefitted from 60 - 80 Klux h/day.

2.1.2 Temperature

Temperature affects the growth of house plants by influencing the rate of photosynthesis and respiration. Sandved (1975) studied various growing temperature regimes in the range of 12 to 24°C during November-February in case of Dieffenbachia, Ficus elastica 'Rubra', Monstera deliciosa and Philodendron scandens. He found that low temperature was more harmful than high temperature in Dieffenbachia and the plant quality was best

at 21°C or 24°C. The growth of Ficus was increased with raising temperature but the growth of Monstera did not respond to temperature above 21°C in poor light conditions. The plant quality of Philodendron was good at various temperatures. In Maranta leuconeura, Sandved (1983) suggested that a constant environment i.e. 24°C and slight shading gave the best growth in summer but in winter the growth was slow.

Poole and Conover (1985) noticed that Aglaonema cv.Silver Queen and Ficus benjamina grew equally well at 90 to 110°F but Spathiphyllum cv.Mauna Loa and Dracaena marginata grew best at 90°F. In another experiment, Poole and Conover (1986a) found that Dieffenbachia maculata cv.Camille grew best at constant 65°F minimum night temperature (MNT) where as Epipremnum aureum grew equally well at constant 60°F MNT or 1 night/week at 45°F + 6 night at 60 or 65°F, or 3 night/week at 45°F MNT were detrimental. In case of Syngonium cv.White Butterfly the growth of plant was best at constant 70°F MNT, and one cold (45, 50 or 55°F) night/week had no significant effect on plant quality. Optimum shoot growth was obtained for Syngonium podophyllum cv. White Butterfly with a maximum air temperature between 32°C and 41°C during the summer and a minimum air temperature between 18.5°C and 21°C during the winter (Chase and Poole, 1987b). Conover and Poole (1987) produced better plants of Dieffenbachia maculata cv.Perfection at air temperature 18.5°C than at 13°C when soil temperature was low. Poole and Conover (1987) also observed

that the optimum temperature for best growth of Aeschynanthus pulcher and Epipremnum aureum was 90°F, and Calathea cv.Argentea, Codiaeum variegatum cv.Petra,Maranta leuconeura, Peperomia obtusifolia and Philodendron scandens ssp.Oxycardium grew better at 95°F.

Mortensen (1988) opined that the growth rates of Ficus benjamina, F.elastica, Syngonium podophyllum and Radermachera sp. increased steadily upto 27°C and the optimum temperature for growth of Nephrolepis exaltata and Dieffenbachia sp. was found at 24°C.

According to Mortensen and Larsen (1989) the optimum temperature for dry weight production of Hedera helix was $\leq$ 21°C day or night and they also noted that Dieffenbachia maculata, Epipremnum aureum and Nephrolepis exaltata responded well upto a temperature of 24-27°C day or night.

Serra and Carrai (1989) reported that dry weight of root, stem and new leaf of Dieffenbachia amoena cv.Tropic White were maximum with the extended day temperature at 24°C than with the normal day treatment. Increase in the rate of stem dry weight was maximum at 16°C night temperature and an extended day, but the increase in leaf dry weight was maximum at the highest night temperature (22°C).

2.1.3 Mineral nutrition

Nutrients influence the growth of foliage plants and

nutrients can be obtained from many sources. Required quantity of nutrients should be understood before selecting the source of fertilizer as well as the method of application. Good quality foliage plants can be grown with fertilizer that is liquid or dry, readily available or slow releasing , in the organic or inorganic form.

Pimpini (1971) found that N at 420 ppm in spite of 140 and 280 ppm as NH_4NO_3 per week in soil was effective in increasing height and diameter of stem of Scindapsus aureus and leaf size increased with foliar applied N. Fertilizer level of N at 1650 kg/ha/yr was recommended by Poole and Conover (1974). Poole and Conover (1977) reported that the plant height and number of shoots/plant increased and leaf colour improved in both cvs. 'Fransher' and 'Pseudobracteatum' of Aglaonema commutatum when N application was increased from 80 mg to 240 or 320 mg/15 cm pot. Rodriguez and Rivera-Lopez (1977a) noticed that number of cuttings, total weight, root weight and top growth of Dracaena sanderiana were maximum with application of nitrogen between 1300-1600 kg/ha/year. The number of leaves, length and weight of plants were significantly affected by N levels (Rodriguez and Cibes, 1977). In nutritional studies on pot plants of Calathea ornata, Beel and Schelstraete (1980a)found that the best N treatment was 50 mg/litre substrate as a basal dressing + 25 mg N as a top dressing, or 100 mg N/litre substrate as a single basal dressing. Poole and Conover (1982) recommended fertilizer rates of 1200 kg

N $ha^{-1}y^{-1}$ and 1800 kg N $ha^{-1}y^{-1}$ for Dieffenbachia maculata and Schefflera actinophylla respectively and these fertilizers increased top growth but reduced root growth. Thomas and Teoh (1983) noticed that increasing level of N improved plant height, stem thickness, leaf area, foliar dry weight of Ficus macrophylla. Conover and Poole (1986a) observed that the growth and grade of Dieffenbachia maculata cv.Camille and Nephrolepis exaltata cv. Florida Rubble were not influenced by nitrogen source, whereas Aglaonema 'Silver Queen' and Philodendron scandens ssp.oxycardium were improved by N-source containing 25 to 100% NH_4- nitrogen or 100% urea-nitrogen; Aphelandra squarrosa cv.Dania, Chamaedorea elegans and Peperomia obtusifolia responded to N-source, but the differences were not of commercial significance. Conover and Poole (1987) also stated that Dieffenbachia maculata cv.Camille grown with NH_4 -N were taller than with urea-N, but plant quality and root development were not affected by N-source. Khattab et al. (1987) obtained maximum leaves of Monstera deliciosa with N application at 2g/pot.

Poole and Conover (1977) found that increasing levels of K from 80 mg to 240 or 320 mg/15 cm pot increased the number of shoots/plant but had no effect on plant height and colour of leaves of Aglaonema commutatum. Beel and Schelstraete (1979) recorded that the optimum amount of K for best growth of Dieffenbachia picta and D.exotica cv.Perfecta was 150-180 mg K_2O/litre of substrate. The best K treatment was 150 mg K_2O/litre

substrate as a basal dressing + 75 mg K_2O as a top dressing in Calathea ornata (Beel and Schelstraete, 1980 a). Khattab et al. (1987) showed that plant height of Monstera deliciosa was best with K at 1 g/pot.

Beel and Schelstraete (1979) showed that the optimum N/K ratio for best growth of Dieffenbachia picta and D.exotica cv. Perfecta was about 1 : 4. Khattab et al.(1987) found that K and P together at high rates reduced stem and leaf fresh weight of Monstera deliciosa.

Rodriguez and Rivera-Lopez (1979) obtained maximum yield of cuttings of Dracaena sanderiana with a combination of N : P_2O_5 : K_2O at the rate of 648 : 465 : 583 lb/acre/year. Poole and Henley (1981) stated that the NPK levels of 500 : 200 : 400 or 750 : 330 : 600 mg/litre reduced the growth of Brassaia actinophylla, Chamaedorea elegans and Peperomia obtusifolia cv.Variegata grown in 15 cm tube compared to NPK levels of 250 : 110 : 200 mg/litre but had no effect on Philodendron scandens ssp.oxycardium or Maranta leuconeura erythroneura, and application of NPK at 800 : 360 : 680 mg/litre reduced fresh weight of Peperomia and Brassaia. Thomas and Teoh (1983) noted that the response of nitrogen was enhanced at high P and K levels. Conover and Poole (1985) obtained best colour of foliage of Schefflera actinophylla and Ficus benjamina with the liquid fertilizer 19-6-10 (NH_4NO_3 : P_2O_5 : KNO_3). In an experiment, Badawy et al.(1987) reported that the lowest level fertilizer of

2.5 g/pot (NPK in the ratio of 28 : 9 : 19) resulted best growth of Chamaedorea elegans and C.constricta. Poole and Chase (1987c) obtained best result in Peperomia obtusifolia at the lowest NPK (20N- 9P-17K) rates (3.5 g/9 litres). Maximum number of stolons and optimum plant growth of Chlorophytum comosum cv.Variegatum were obtained with solution containing 2 g/litre NPK mixed (20 N-8.3 P-14.9 K) fertilizer applied twice weekly (Hipp et al., 1979).

Conover and Poole (1975) showed that osmocote (14-14-14) at 12 or 16 g per container at 3 months interval was effective in securing good growth of Dracaena marginata. In an experiment, Beel and Schelstraete (1980b)reported that plant height was best with osmocote (18-11-11) at 400-1200 mg/litre substrate but leaf number was greatest with osmocote (18-11-10) at the same rate. Conover and Poole (1985) noted that Schefflera actinophylla grew best with either osmocote (18-6-12) or surrabian (19-6-10). In Begonia, Chase and Poole (1987a) found that the best plant quality and height were obtained with 0.5 - 3.5 g osmocote (19 N-2.6 P-10 K) per pot. Poole and Chase (1987b) reported that plant height increased with an increase in osmocote (19-6-12) rate upto 2.5 g/pot and recommended 2 g osmocote (19 N-6 P-12 K) per pot in Peperomia obtusifolia. Chase (1989) suggested that the lowest rate of osmocote (19 N-6 P-12 K) at 2 g/pot was useful for production of good quality Calathea at minimum cost. Poole and Conover (1987) found that the best quality plants of Cissus rhombifolia were produced with 2.8 to 4.8 g osmocote (19 N-6 P-12 K) per pot and

with 4 times irrigation per week.

According to Wang and Boogher (1989), the admixture of a polyacrylamide hydrogel (Agrosoka) with potting medium at 1.5 or 2.25 kg/m^3 resulted in increased number and dry weight of shoot and roots of Chlorophytum comosum cv.Vittatum but had no effect on shoot fresh weight. Wang and Boogher (1989) also found that slow releasing fertilizer (nutricole, 16 N-4.3 P-8.3 K) at 6.0 kg/m^3 resulted in maximum shoot growth of Chlorophytum comosum cv. Vittatum. In hydroculture experiment, Leinfeder and Rober (1986) used Flory 9 containing 15 N : 7 P_2O_5: 22 K_2O : 6 Mgo at the rate of 1.5 g/litre for best growth of Aglaonema commutatum. In Monstera deliciosa, Moschini et al. (1985) found that the growth was poorest on 40 g resin (Lewatit HDS from Bayer) containing NPK at 18-7-15 plus Fe, Mn, Cu, Mo, Zn and B but satisfactory with other treatments i.e. in a nutrient solution (containing some nutrients) at 2 or 3 g/litre.

In Ficus benjamina,Wiedenfeld (1985) pointed out that increasing levels of nitrogen increased plant nitrogen content but decreased plant dry weight. The chemical composition of six tropical foliage plant species viz.Dieffenbachia exotica, Monstera deliciosa, Philodendron oxycardium, Sansevieria zaylanica, Scindapsus aureus and Syngonium podophyllum were analysed for N, P, K, Ca, Mg, Cu, Fe, Mn and Zn and suggested levels of these elements needed for good growth were tabulated by Joiner and Waters (1970). Poole et al.(1976) also analysed and tabulated

tissue composition (N, P, K, Ca and Mg) of 26 good quality foliage plants.

2.1.4 Growth retardant

Growth retardants are now widely used in the ornamental horticulture since treated plants usually do not show growth malformations or reduced vigour and plants respond over a wide range of concentration. The most commonly used growth retardants and inhibitors are ancymidol (A-Rest), Chlormequat (Cycocel), Phosphon, Maleic hydrazide and SADH (Alar, B-9).

Poole (1970) reported that B-nine reduced growth approximately by 50% with no distortion or discolouration of Philodendron oxycardium, Scindapsus aureus and Syngonium podophyllum cv.Emerald Gem. Will (1977) found that B-9 was superior for reduction in height of Elatior Begonia. Broschat et al. (1987) showed that the best height control in Raderonachera sinica was obtained with daminozide, as B-Nine, at 2500-7500 ppm. In Philodendron scandens, B-Nine (daminozide) increased leaf width and reduced vine length, internode length and number of nodes per vine (Mansour and Poole, 1987b).

Foliar sprays of ancymidol at 1.25 mg/ft^2 or above reduced growth, improved foliage colour and increased axillary vegetative shoot of 11 tropical foliage plant species including Gynura, Strobilanthes, Syngonium and Philodendron (Frank and Donnan, 1975). Joiner et al. (1978) found that ancymidol at 0.66 mg/29 cm pot

proved the best for reduction in growth of Dieffenbachia maculata cv.'Bara quiniara'. Blessington and Link (1980) noted that ancymidol at different concentrations i.e. 0.25, 0.50 or 1 mg/pot decreased internodal vine length, more compact growth and more intense colour for Tradescantia, Philodendron and Fatshedera. Ancymidol as a soil drench at 0.25 - 0.75 mg/15 cm pot reduced internode and stem length in Epipremnum aureum by 22-33% and 20-30% respectively (Blessington et al.,1980). Collins and Blessington (1981) stated that Peperomia was taller with increasing light and decreasing in growth with increasing ancymidol concentration (0 - 1.0 mg/15 cm pot). Mansour and Poole (1987a) reported that A-Rest (Ancymidol) at 0.25 - 1.0 mg ai/6 inch pot reduced the height of Peperomia obtusifolia, Dieffenbachia maculata cv. Camille and Epipremnum aureum. Mansour and Poole (1987b) also reported that ancymidol retarded the height of Peperomia obtusifolia and reduced height and leaf area of Dieffenbachia maculata cv.Camille. Wang (1987b)recommended that ancymidol at 0.25 - 1.0 mg/pot reduced plant height of Syngonium podophyllum cv.White Butterfly by 40-60% and total length of the top three internodes by 25-50% and ancymidol also increased leaf length and width of the uppermost fully expanded leaf of the said plant.

Cycocel had little effect on growth of Philodendron oxycardium, Scindapsus aureus and Syngonium podophyllum (Poole, 1970). Will (1977) opined that spraying with Cycocel 0.05 - 0.2% or watering with 0.5% reduced the height of Elatior Begonia by

15-20% without affecting the diameter of the plants. Schenk and Brundert (1981) recorded that the triple spray with 0.3% CCC (Chlormequat) every 3 weeks considerably inhibited plant growth by reducing length of internodes without affecting the number of leaves and improved leaf colour in Philodendron erubescens cv. Red Emerald, Pseuderanthemum atropurpureum, Schefflera arboricola and Syngonium podophyllum. Cycocel did not affect the plant size of Scindapsus aureus when applied at 2000 ppm on pot grown plants (Pimpini and Arcella, 1987).

Regulation of vine length or plant height of Scindapsus aureus could be achieved by Henley and Poole (1974), and McConnell and Poole (1972) with ancymidol, chlormequat and Alar.

Cathey and Stuart (1961) reported that Phosphon retarded the growth of Schefflera actinophylla. Poole (1970), on the other hand, noted that Phosphon had little effect on growth of Philodendron oxycardium, Scindapsus aureus and Syngonium podophyllum. Moderate growth retardation was reported on Pilea cadierei, P.depressa and Sedum arglicum (Vienrevee and Rogers, 1974).

Maleic hydrazide almost completely stopped growth and killed some tips of Philodendron and Scindapsus (Poole, 1970).

Rodriguez et al.(1972) found that ethrel at 4000 and 8000 ppm caused a marked reduction in height of Cordyline terminalis cv.Baby Doll, at the higher rate growth was almost suppressed and the leaf form was modified. A combination of 1.0 mg ancymidol and

500 mg ethephon/pot caused intermediate growth of Ficus benjamina compared with ethephon or ancymidol treatment alone (Johnson and Joiner, 1978).

Bazzocchi and Gambini (1985) proved the lowest rate of paclobutrazol at 25 ppm gave a greater reduction in canopy development, shorter stems and smaller leaf surface of potted plants than ancymidol at 10 ppm applied in the substrate on Philodendron and excessive reduction on growth was obtained with 50 and 75 ppm. LeCain et al. (1986) found that Ficus benjamina treated with soil drench of paclobutrazol at rates from 0.125 to 8.0 mg/10 cm pot exhibited retardation in height, leaf production, internode length and leaf size. Bazzocchi et al.(1987) suggested that a single spray of 25 ppm paclobutrazol was sufficient to ensure more compact and leafier plants of Syngonium podophyllum. In an experiment, Mansour and Poole (1987a and 1987b) reported that significant height reduction was obtained by using Bonzi (Paclobutrazol) as soil drench at 0.062 - 0.25 mg ai/6 -inch pot in case of Peperomia obtusifolia, Dieffenbachia maculata cv.Camille and Epipremnum aureum. Pimpini and Arcella (1987) stated that soil application of paclobutrazol at 50 ml of 2000 ppm solution/600 ml pot gave a greater reduction in stem and weakened apical dominance of Scindapsus aureus. Soil drenches of paclobutrazol (0.6 - 2.0 mg/pot) or Uniconazole (0.1 - 1.0 mg/2 litre pot) were equally effective in reducing stem growth of Syngonium podophyllum cv. White Butterfly and increasing leaf width, but had no effect on the rate of leaf production or length of blade (Wang and Blessington, 1990).

In case of Philodendron scandens spp.oxycardium, Mensour and Poole (1987b) observed that XE-1019 (Sumagic) caused only a temporary reduction in leaf size.

2.1.5 Irrigation

House plants require a constant supply of water for optimum growth, but utilize only a small amount. This forces the producers to decide when, how much and how to apply the water to the foliage house plants. An abundance of good quality water is preferable for production of foliage plants.

Conover and Poole (1977b) reported that the best growth of Aphilandra squarrosa and Nephrolepis exaltata cv.Bostoniensis was with capillary watering, but Dieffenbachia maculata and Philodendron scandens ssp.oxycardium were generally better when watered by hand. Spooner et al. (1978) found that daily watering gave increased growth of Crassula argentea compared with weekly watering if NPK fertilizer was applied.

Hipp et al. (1979) pointed out that higher fertility levels were required for maximum plantlet production in Chlorophytum comosum cv.Variegatum, especially with frequent watering i.e. 3 times/week rather than once/week.

Fitzpatrick (1980) evaluated the actual water consumption for 15 spp.of container grown ornamental plants and was measured by subtracting volume leached/pot from volume applied/pot. McConnell

and Host (1980) found that stem elongation and number of new leaves of Pereskia aculeata cv.Godseffiana were reduced with decreased watering frequency and also observed that plant watered once every 3 weeks had dull green leaves compared to plants watered twice weekly. Johnson et al., (1981) noted that an increased soil moisture stress reduced growth and transpiration rate of potted Ficus benjamina. Good quality of Nephrolepis exaltata cv.Bostoniensis and Dieffenbachia maculata cv.Perfection were obtained when irrigated 4 times/week compared to 2 or 3 times/week (Poole and Conover, 1981). Use of tensiometer was found beneficial for better growth of Nephrolepis exaltata cv.Rooseveltii fern when kept at 0.05 to 0.10 bar moisture tension by applying water (Morgan et al., 1981).

Fitzpatrick (1983) stated that the relative water demand was low in the slow growing species and the highest relative water demand occurred in the moderate and first growing species of container grown ornamental plants. Tesi (1983) suggested that Rieger Begonia and Dracaena deremensis required constant supply of moisture and responded to capillary watering.

In an experiment, Djurhuus and Gislerod (1985) found that Aphelandra and Begonia X hiemalis tolerated a wide range of moisture conditions, and plants watered once a day grew as well as those watered several times.

Poole and Chase (1987a) found that for Schefflera actino-

phylla one irrigation/2 weeks was insufficient. Epipremnum aureum showed the best growth response to frequent irrigation especially during warm season, Peperomia obtusifolia required one irrigation/two weeks during cool season but 3-4 irrigations during warm season and Philodendron scandens was best responsive to irrigation frequency during both the seasons. Poole and Conover (1986c) produced best growth and quality of Cissus rhombifolia and Syngonium podophyllum cv.White Butterfly with irrigation frequency at 4 times/week and Dracaena surculosa cv.Florida Beauty did not respond to irrigation frequency.

2.1.6 Types of container

Different types of plant growing container plays an important role on proper growth of indoor plants. Variation of moisture and temperature of potting compost reflect the growth of house plants.

Christensen (1971) reported that Hedera canariensis grew best in plastic pot in summer on drained benches whereas plants on undrained benches grew better in clay pots and in winter, plastic pots were preferable for both bench types. Christensen (1974) also found that plastic pots were best on drained benches compared to clay pot for Codiaeum variegatum.

Tesi (1983) showed that plastic pots retained moisture better than clay pots in summer and favoured species with high water requirements. He also found that clay pots were cooler than plastic pots in summer but warmer in winter.

2.2 Propagation

Propagation of plants that have specific value to foliage producers is an important aspect of plant multiplication. Foliage plants may be propagated by seed, cuttings, air layers, division and spores but propagation by cutting is most common.

Marlatt (1969) found that single node cuttings from uppermost part of the stem of Dieffenbachia produced larger plants than cuttings from basal nodes. Hansen (1986a) reported that the axillary bud break and shoot growth were improved considerably in Schefflera arboricola cuttings from subapical to basal positions. He also found that cutting from subapical position rooted more slowly, produced fewer roots and had a lower rooting percentage than cuttings from more basal region. Wang and Boogher (1988) observed that days to first leaf unfolding, axillary shoot growth, leaf area and shoot fresh weight were increased when cuttings were taken more basipetally from second apical node to 14th node in Epipremnum aureum.

Rodriguez and Rivera-Lopez (1977b) obtained highest profit from 13.5 inch long cuttings of Dracaena sanderiana planted at 6 x 6 inches spacing under 47% shade. The rooting success, number of roots, percentage of bud break and shoot length were increased with the increase in the length of single node cuttings from 0.5 to 3.0 cm of the stem length of Schefflera arboricola (Hansen and Andersen, 1987).

Hansen (1986b) found that cutting with 2 or 3 fully

developed leaves rooted much better, giving more stronger and longer roots than smaller cuttings with one leaf with subsequent vigorous growth in case of Schefflera arboricola. Wang (1987a) reported that leaf bud cuttings of golden pothos needed 10 more days to unfold the first leaf compared with stem cuttings without parent leaves and shoots developed from leaf bud cuttings had longer stem, more leaves, total leaf area and heavier dry matter than shoots from stem cuttings.

The response of potting medium on rooting of cutting was studied by Marlatt (1969) and it was observed that sphagnum moss was better potting medium for rooting of cuttings than sand peat mixtures in Dieffenbachia. Rodriguez et al. (1973) noted that top cuttings of Dracaena sanderiana under mist were rooted well in muck soil, spent coffee and tobacco industry residues whereas tobacco residues caused a basal end rot but the cutting eventually produced root. Propagation of Aglaonema and Dieffenbachia was better in peat/perlite mixture than in fired monmorillonite clay, solite and Gro-sorb while Maranta produced better root in Gro-sorb and propagating media had no effect on rooting of Epipremnum and Syngonium (Joiner and Nell, 1980). Higaki (1981) noted that one node cuttings of Dracaena goldieana rooted equally well in peat moss, perlite, black cinder or vermiculite under intermittent mist, with or without heating.

In vitro propagation of Cordyline terminalis, Kunisaki (1975) found that rapid propagation was achieved through the

induction and proliferation of shoots of stem explants using a modified Murashige and Skoog medium supplemented with 0.5 ppm of 6-benzylaminopurine (BAP). No growth regulator was required for rapid rooting of shoots and could be successfully transplanted in vermiculite under light mist and reduced light intensity. Evaldasson and Welander (1985) obtained largest number of shoots per explant of C.terminalis cv. Atoom by using 2 mg/l BAP and the most effective auxin was NAA (0.1 mg/l). Voyatzi and Voyatzis (1989) suggested that the presence of 2ip or Kinetin in the medium was a pre-requisite for in vitro shoot formation in Dieffenbachia exotica cv.Marianna and 2ip at 16 mg/l proved more effective than Kinetin at 2 mg/l.

The best callus formation was obtained in explants of Dracaena deremensis cv.Warnecki with a dormant eye when cultured on a modified Murashige and Skoog's medium with addition of different auxins and cytokinins and the addition of IBA at 2 mg/l gave the most satisfactory result (Debergh, 1975). Chua et al. (1981) observed that plantlets were produced in vitro from stem callus of D.marginata cv.Tricolor on Murashige and Skoog medium supplemented with coconut water with 2,4-D and sub-cultured on medium supplemented with kinetin. Roots were obtained by sub-culture on medium supplemented with NAA at 1 mg/l.

According to Fonnesbech and Fonnesbech (1980), shoot tips and lateral buds of Monstera deliciosa were developed best on MS medium supplemented with 10 mg/l PBA + 2 mg/l IAA and rooting was

best on MS basal medium with 2 mg/l IAA and plants were easily established in soil.

Henny (1978) noted that shoots were readily produced from leaf disc of Peperomia 'Red Ripple' on Schenk and Hildebrandt medium with 2.5 to 10 mg Kinetin and 0.05 mg NAA/l, and the shoots could be induced to root by 0.01 mg Kinetin and 0.05 mg NAA/l.

Gertsson and Andersson (1985) observed that the shoot formation was best with axillary buds of Philodendron scandens cultured on MS medium supplemented with 10 mg/l BA + 0.5 mg/l IAA and the percentage of plantlet survival after transfer to soil was high.

Chapter 3

MATERIALS AND METHODS

MATERIALS AND METHODS

A detailed account of the materials utilised and the various methods adopted in this study is given in the following paragraphs.

Experimental site:

The investigation was carried out at the garden of the Agri-Horticultural Society of India, Calcutta and Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia during 1988-91. The experimental site is situated at 22.32° North latitude and 88.20° East longitude with an average altitude of 9.66 metre above the mean sea level. The soil of the experiment was Gangetic alluvial (Entisol) and was sandy loam in texture and its pH ranges from 7.2 to 7.8 (mild alkaline). The soil contains sand 52.4, silt 35.2, clay 12.4, total nitrogen 0.044 and organic carbon 0.030 per cent, available P_2O_5 42.6 and K_2O 139.1 kg/ha. The greenhouse temperatures were maintained at 18° ± 3°C minimum and 32° ± 5°C maximum. The mean relative humidity was maintained at 60 ± 15%.

3.1 Standardization of agrotechniques for culture of house plant:

3.1.1 Influence of light intensity on growth and development of house plants.

In this experiment, ten house plants namely Aglaonema commutatum 'Treubii', Calathea ornata, Calathea zebrina, Dieffenbachia maculata, Monstera deliciosa, Monstera pertusa,

Pleomele reflexa, Philodendron erubescens 'Ceylon Gold', Scindapsus aureus 'Marble Queen', Syngonium podophyllum 'White Butterfly' were selected.

Well rooted plants of uniform growth of Calathea zebrina having 15 cm height and Dieffenbachia maculata, Monstera pertusa both having 25 cm height and Pleomele reflexa, Syngonium podophyllum 'White Butterfly' both having 10 cm height were selected for this experiment. Calathea zebrina and Syngonium podophyllum 'White Butterfly' contained 2-3 leaves and rest of three plants contained 4-5 leaves. Plants were grown in earthen pots containing one part each of loam, screened leafmould and well rotted cowdung manure. The potted plants were kept in green house for 30 days for their establishment and placed in cloth covered growing chambers. Four cloth chambers were constructed having single, double, triple and quadriple cover. Ten plants were placed under each treatment during April'89 to August '89.

Well rooted cuttings of five commonly grown house plants like Aglaonema commutatum 'Treubii', Calathea ornata, Monstera deliciosa, Philodendron erubescens 'Ceylon Gold' and Scindapsus aureus 'Marble Queen' with plant height ranging between 14-15, 19-21, 30-32, 26-28 and 8-9 cm respectively, were selected and potted in 12.5 cm earthen pots. All the plants have 4-5 leaves except Philodendron which had 11-13 leaves. The experiment started in December 1990 and ended in June 1991, thus lasting for six months.

Light intensity was measured by luxmeter thrice in a day. Minimum-Maximum thermometer, and wet and dry bulb hygrometer were placed in cloth chamber to record the data regularly at 8 A.M., 12 A.M. and 4 P.M.

Two sets of experiments both in summer and winter months of the year were repeated during 1989-90 and 1990-91.

3.1.2 Studies on the effect of mineral nutrition on growth and development of house plants

3.1.2.1 Effect of different levels of nitrogen and potassium on growth and development of house plants in sand culture

Uniform well rooted cuttings of Aglaonema commutatum 'Treubii' and Scindapsus aureus 'Marble Queen' each having 9-11 cm plant height and 3-4 leaves, Cordyline terminalis and Dieffenbachia maculata 'Exotica' each having 14-16 cm plant height with 6-7 and 2-3 leaves respectively were potted in 12.5 cm pot filled with coarse sand. The sand was treated overnight with 3 per cent hydrochloric acid and thoroughly washed in water before potting. The treatment consisted of 3 x 3 factorial combinations in randomised block design with N at 200, 400, 600 mg/l and K at 200, 400, 600 mg/l were applied at every alternate day with 50 ml of solution in each pot. A constant dose of 400 mg/l of P was applied. The treatments were replicated 5 times with one plant in each pot as an experimental unit.

The experiment was initiated during the month of August and continued for 75 days.

3.1.2.2 Response of organic and inorganic fertilizers on growth and development of house plants

During the studies on mineral nutrition of some house plants, the following plants like Aglaonema commutatum 'Silver Queen', Calathea zebrina, Chlorophytum comosum 'Variegatum', Cordyline terminalis, Dieffenbachia maculata, D.maculata 'Exotica', Monstera deliciosa, Peperomia obtusifolia, Pleomele reflexa 'Song of India', Philodendron erubescens, Scindapsus aureus 'Marble Queen', Syngonium podophyllum 'White Butterfly' were used.

Well rooted cuttings of Aglaonema commutatum 'Silver Queen', Dieffenbachia maculata, Peperomia obtusifolia, Pleomele reflexa having plant height between 11-13 cm , Calathea zebrina, Cordyline terminalis, Philodendron erubescens having plant height between 16-18 cm and Monstera deliciosa and Syngonium podophyllum 'White Butterfly' having plant height between 25-27 cm and 8-9 cm respectively were grown in earthen pot, each of 12.5 cm size with compost containing a mixture of loam and leafmould (1 : 1). In addition to basic compost, bonemeal, bloodmeal, sterameal, charcoal dust, at 50 g per pot and NPK mixture (1 : 1 : 1) at the rate of 2.5 g per pot were used. The experiment consisted of six treatments having 5 replications with 5 plants in each replication. The experiment was set up in the month of October 1988 and continued upto April 1989.

During the month of April 1989 another set of experiment comprising of Dieffenbachia maculata 'Exotica' with plant height

ranging between 8-9 cm, Chlorophytum comosum 'Variegatum' and Scindapsus aureus 'Marble Queen' with plant height between 15-16 cm and 12-13 cm respectively was started with similar basic compost and nutrient combination. Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen' had 2-4 leaves and Chlorophytum comosum 'Variegatum' had 9-10 leaves.

3.1.3 Effect of growth retardants on growth and development of house plants

The foliage plant species used in this study were Aglaonema commutatum 'Treubii', Calathea zebrina, Dieffenbachia maculata, Monstera obliqua, Peperomia obtusifolia, Pleomele reflexa and Syngonium podophyllum 'White Butterfly'. Well rooted cutting of the above plants were potted in 12.5 cm pots one month before treatment. The potting compost was composed of one part each of loam, screened leafmould and well rotted cowdung manure. Shoot length at the time of treatment were 18-20 cm for Calathea zebrina, Dieffenbachia maculata, Pleomele reflexa and Syngonium podophyllum 'White Butterfly' ; 15-17 cm for Aglaonema commutatum 'Treubii' and Monstera obliqua, and 10-11 cm for Peperomia obtusifolia. The number of leaves of the above mentioned plant were 3-5 except Pleomele reflexa which had 11-12 leaves.

Spraying of B-Nine (N-dimethylamine succinamic acid), CCC (2-chloroethyl trimethyl ammonium chloride) and MH (Maleic hydrazide) were done at the concentration of 1000, 2000 and 4000 ppm.

Second spraying was done one month after first spray. In this experiment, each treatment with five plants was replicated five times in a randomized block design.

3.1.4 Influence of irrigation frequency on growth and development of house plants

Frequency of irrigation was studied in Aglaonema commutatum 'Treubii', Aglaonema commutatum 'Silver Queen', Calathea zebrina, Chlorophytum comosum 'Variegatum', Dieffenbachia maculata, Monstera deliciosa, M.pertusa, Peperomia obtusifolia, Pleomele reflexa 'Song of India' and Syngonium podophyllum 'White Butterfly'. Rooted cuttings of the above mentioned house plants were planted during April, 1989 under the following stage of growth.

Plant species	Height of plant(cm)	Number of leaves
Aglaonema commutatum 'Silver Queen'	23-24	8-9
A.commutatum 'Treubii'	13-14	4-5
Calathea zebrina	15-16	4-5
Chlorophytum comosum	18-19	13-14
Dieffenbachia maculata	16-17	4-5
Monstera deliciosa	40-42	6-7
M.pertusa	16-17	4-5
Peperomia obtusifolia	9-10	5-6
Pleomele reflexa	17-18	11-12
Syngonium podophyllum	13-14	5-6

Selected plants were potted in 12.5 cm size pots containing a pot mixture of loam : screened leafmould : well rotted cowdung manure (1 : 1 : 1). Treatments were started four weeks after potting and included irrigation water of 50 ml per pot daily and at intervals of 1, 2, 3, 4 days and continued for six months. The experiment was conducted in randomised complete block design with 5 replications and five plants in each replication.

3.1.5 Effect of different types of container on growth and development of house plants

In this experiment Aglaonema commutatum 'Silver Queen', Calathea ornata, C.zebrina, Chlorophytum comosum 'Variegatum', Cordyline terminalis, Dieffenbachia maculata, Monstera deliciosa, M.obliqua, Peperomia obtusifolia, Philodendron erubescens 'Ceylon Gold', Scindapsus aureus 'Marble Queen' and Syngonium podophyllum 'Variegatum' were selected. Three types of containers such as earthen pots,wax coated earthen pots and plastic pots were used.

Established plants of uniform size in case of Aglaonema commutatum 'Silver Queen', Peperomia obtusifolia and Scindapsus aureus 'Marble Queen' with 10-12 cm plant height and Calathea zebrina, Monstera deliciosa and Philodendron 'Ceylon Gold' with 20-22 cm plant height were potted in 15 cm earthen, plastic and wax coated earthen pots. Aglaonema commutatum 'Silver Queen', Calathea zebrina and Scindapsus aureus 'Marble Queen' had 3-4 leaves. The pots were filled with compost containing each of loam and well rotted cowdung manure with 50 g bonemeal per pot.

Comparable and well established plants of Cordyline terminalis and Calathea ornata with plant height between 18-20 cm, Chlorophytum comosum 'Variegatum', Dieffenbachia maculata, Monstera obliqua and Syngonium podophyllum 'Variegatum' with plant heights varying between 14-15 cm were grown in 15 cm pots in similar potting compost as stated before. Cordyline terminalis and Chlorophytum comosum had 6-7 and 10-11 leaves respectively and rest of the plants were selected at 3-4 leaves stage. This set of experiment was started in June and completed in December, 1990.

Collection of data:

During the course of investigation on the different ornamental foliage plants, data were collected on the following parameters.

a) Plant height(cm); The height of the plant was measured from soil surface to the leaf tip of last fully opened leaf (i.e. highest point of the plant) at monthly interval.

b) Number of leaves: The total number of mature leaves per plant in each treatment were recorded.

c) Number of branches or plantlets: The main or primary branches or plantlets from the main stem were recorded at the termination of the experiment.

d) Leaf length and width: Two mature leaves from top of the plant (second, third or fourth leaf) were measured length and breadthwise.

e) Leaf area: The area of leaf blade (second, third or fourth mature leaf from top) were measured with the help of planimeter.

f) Internodal length and nodal diameter: The internodal lengths and nodal diameters were measured with the help of metre scale and slide-callipers respectively.

g) Fresh and dry weight of plant top and root: Top portion of plants and underground roots were washed thoroughly in tap water and weighed with the help of electrical balance. The plant parts were dried in a drier at 41°C.

h) Plant grade: Plant quality was determined visually on the following scale: 1 = dead; 2 = poor, unsalable; 3 = moderate, salable; 4 = good, salable and 5 = excellent, salable for all plant species used in the experiment.

i) Colour grade: Leaf colour also rated visually on the scale 1, 3 and 5.

Plant species	Rating scale		
	1	3	5
a) Aglaonema commutatum 'Silver Queen'	Light green	Medium green	Dark green
b) A.commutatum'Treubii'			
c) Calathea ornata			
d) C.zebrina			
e) Monstera deliciosa			
f) M.obliqua			
g) M.pertusa			
h) Peperomia obtusifolia			
i) Philodendron erubescens			
j) Pleomele reflexa			

Plant species	Rating scale		
	1	3	5
k) Chlorophytum comosum 'Variegatum'	Light green with white margin	Medium green with white margin	Dark green with white margin
l) Cordyline terminalis	Light red	Medium red	Dark red
m) Dieffenbachia maculata			
n) D.maculata 'Exotica'	Light green with white variegation	Medium green with creamy white variegation	Dark green with creamy white variegation
o) Scindapsus aureus 'Marble Queen'			
p) Philodendron erubescens 'Ceylon Gold'	Greenish yellow	Light yellow	Yellow
q) Pleomele reflexa 'Song of India'	Light green with yellow margin	Medium green with golden yellow margin	Dark green with golden yellow margin
r) Syngonium podophyllum 'Variegatum'	Light green variegated with white	Medium green variegated with white	Dark green variegated with milky white

In case of Syngonium podophyllum 'White Butterfly' leaf colour was rated in the following scale 1 = solid pale greenish white of all leaves, 2 = light green on 50% of all leaves, 3 = medium green on 50% of all leaves, 4 = medium green of all leaves and 5 = solid dark green on all leaves.

j) Analysis of leaf sample for estimation of NPK : Leaf sample was dried for each treatment seperately and total nitrogen, phosphorus and potassium contents were estimated from the dry

plant materials.

i) Total nitrogen: Total nitrogen content was estimated by modified micro Kjeldahl method of Humphries (1956).

ii) Phosphorus: Phosphorus was estimated by Vanadomolybdo phosphoric yellow colour following the procedure of Kitson and Millon (1944).

iii) Potassium: Potassium was estimated by flame emission technique with the help of a flame photometer (Piper, 1944).

k) Tensiometer reading: Tensiometer reading (kg/cm^2) was recorded in ten potted plants and presented below:

Plant species	Treatments(Interval of watering)				
	4 days	3 days	2 days	1 day	Daily
a) Aglaonema commutatum 'Silver Queen'	0.81	0.70	0.66	0.65	0.42
b) A.commutatum 'Treubii'	0.78	0.65	0.62	0.50	0.05
c) Calathea zebrina	0.72	0.71	0.69	0.45	0.21
d) Chlorophytum comosum	0.83	0.80	0.76	0.58	0.02
e) Dieffenbachia maculata	0.82	0.75	0.72	0.62	0.29
f) Monstera deliciosa	0.82	0.81	0.75	0.51	0.31
g) M.pertusa	0.85	0.81	0.70	0.42	0.12
h) Peperomia obtusifolia	0.85	0.75	0.70	0.20	0.02
i) Pleomele reflexa 'Song of India'	0.68	0.65	0.47	0.10	0.05
j) Syngonium podophyllum 'White Butterfly'	0.80	0.70	0.65	0.62	0.28

3.2 Standardization of propagation of house plants

All the experiments on the propagation of house plants were conducted in the month of June-July during 1988 to 1991.

3.2.1 Effects of nodal position on the propagation of house plants

Aglaonema commutatum 'Treubii', Dieffenbachia maculata, Monstera obliqua, Philodendron erubescens, Scindapsus aureus 'Marble Queen' and Syngonium podophyllum 'Variegatum' were selected in this experiment. The plants having at least 15 nodes were selected except Aglaonema commutatum 'Treubii' which had 20 nodes. The stem of the above six plants were cut transversely and grouped according to their position on the plants from apical 2nd node to the basal upto 11th node leaving top with apical node. The length of nodal cuttings of Aglaonema commutatum 'Treubii' and Dieffenbachia maculata were 1 cm and 2 cm per cutting respectively and for Monstera deliciosa, Philodendron erubescens, Scindapsus aureus 'Marble Queen' and Syngonium podophyllum 'Variegatum' 4 cm each per cutting. The node diameters of cuttings varied between 0.85 to 1.05, 1.60 to 2.15, 0.95 to 1.45, 1.05 to 1.15, 0.60 to 0.70 and 0.60 to 0.70 cm respectively.

In this study twenty cuttings were taken for each treatment replicated three times in a randomised block design.

Cuttings were placed in flat pots filled with sand for rooting and placed in a mist propagation chamber.

3.2.2 Regeneration of plantlets from cuttings with varying number of nodes

In this study, the following four house plants i.e. Aglaonema commutatum 'Treubii', Dieffenbachia maculata, Monstera obliqua and Philodendron erubescens were selected. Plants with uniform growth were selected and were transversely cut into one node, two nodes and three nodes pieces. The length of cuttings of Aglaonema commutatum 'Treubii', Dieffenbachia maculata, Monstera obliqua and Philodendron erubescens were 1, 1.5, 5 and 3.5 cm respectively for one node cutting and 2.2, 3.5, 12.0 and 7.5 cm for two node cuttings and 3.2, 5.2, 17.0 and 10.5 cm for three node cuttings. The diameter of three types of node cuttings of the four house plants were 1.20, 1.75, 1.10 and 0.95 cm respectively.

In this experiment ten cuttings per treatment were planted and replicated seven times in a randomised block design.

Individual cutting of all treatments were placed in a flat pot filled with sterilized sand with facing eye upwards above the media and pots were kept in a mist propagating chamber.

3.2.3 Regeneration of plantlets from node with leaf and node without leaf and leaf cuttings

Peperomia obtusifolia and Scindapsus aureus 'Marble Queen' were used in this experiment. The length and diameter of node were 2.75 and 0.70 cm in Peperomia obtusifolia, and 4.0 and

0.70 cm in Scindapsus aureus 'Marble Queen' respectively. The node cuttings with and without leaf of the above plants were made and planted in vermiculite medium under mist chamber. Leaf cuttings of above mentioned two plants were also planted in vermiculite.

3.2.4 Effect of rooting media on root regeneration and plant growth in cuttings of some house plants

Five house plants namely Aglaonema commutatum'Treubii', Dieffenbachia maculata, Monstera obliqua, Peperomia obtusifolia and Philodendron erubescens were selected for this experiment. In Peperomia obtusifolia only leaf cutting and in the rest of the four plants single node cutting were used. The above cuttings were planted in different media seperately or their combinations. These media were loam, leafmould, sand, vermiculite, soilrite, leafmould + sand (1 : 1), loam + sand (1 : 1) and loam + leafmould (1 : 1).

In this experiment, ten cuttings were taken for each treatment and replicated three times in a randomised block design.

Collection of data:

Observations were recorded on number of days required for root and shoot emergence. Plants were lifted 80 days after planting. In case of Peperomia obtusifolia leaf cutting final observation was noted 150 days after planting. Data including number of leaves, stem length, number of rooted cutting, root length, number

of root and shoot, fresh and dry weight of shoot and root were recorded.

3.2.5 *In vitro* propagation of *Philodendron erubescens* 'Ceylon Gold'

Primary explants were obtained from vigorously growing *Philodendron erubescens* 'Ceylon Gold'plants. The leaves were removed from the main stem and stem pieces with dormant buds were taken for explants. To remove contamination the stem pieces were transferred to labklin solution (a detergent) for 15 minutes and washed with running tap water. After a brief rinse for 45 seconds in 70% alcohol, the buds were surface sterilized by 0.1% $HgCl_2$ for 4-5 minutes and were subsequently rinsed in three changes of sterile distilled water. After sterilization, the dormant buds were further dissected into explants (0.8 - 1.0 cm in size) and were placed in a culture tube containing sterilized media. Culture media (Murashige and Skoog, Knudson 'C') supplemented with various growth regulators (2,4-dichloro-phenoxy acetic acid,, Napthalene acetic acid and 6-benzylaminopurine) were prepared. The media were solidified with 8 g/l Difco Bacto agar and pH was adjusted to 5.7 before sterilization. The culture tubes were kept in a growth chamber at a temperature of 25 $\pm$ 2°C under light intensity of 2,200 lux for 12 hours.

Chapter 4

RESULTS AND DISCUSSION

R E S U L T S

Experiment 4.1.1 Standardization of agrotechniques for culture of house plants.

Experiment 4.1.1.1 Influence of light intensity on growth and development of house plants

Height of the plant : It is evident from Table -1 to 4 that plant height was significantly influenced by various light intensities. Generally plant height increased with the increase in light intensity (Fig.1). Plant grown under the highest light intensity (8,000 - 22,000 lux) caused the maximum height of Dieffenbachia maculata, Calathea zebrina, Monstera pertusa, Pleomele reflexa and Syngonium podophyllum 'White Butterfly'. However, plant growth was suppressed under the lowest light intensity between 450 - 1,000 lux in all the above species of plants. The light intensity between 3,500 - 9,000 lux, on the other hand, produced the maximum plant height in case of Philodendron erubescens 'Ceylon Gold' and Calathea ornata whereas the growth of Aglaonema commutatum 'Treubii' and Scindapsus aureus 'Marble Queen' were maximum between 10,000 - 23,000 lux. In case of Calathea ornata and Philodendron erubescens 'Ceylon Gold' the highest light intensity between 10,000 - 23,000 lux slightly reduced the growth of plant compared to low light intensity between 3,500 - 9,000 lux. It is interesting to note that the growth of Monstera deliciosa was reduced under the highest light intensity. But the tallest plants were obtained under light intensity between 1,600 -3,000 lux. The plants were lanky in growth(Plate 1 and 2).

Number of leaves: It is revealed from the data presented in Table

1 to 4 that the number of leaves increased with the increase in the level of light intensity which responded well in same pattern as in plant height to light intensity. The number of leaves of Calathea zebrina, Dieffenbachia maculata, Monstera pertusa, Pleomele reflexa and Syngonium podophyllum 'White Butterfly' were maximum when plants were grown between 8,000 - 22,000 lux. Low light intensity (450 - 1,000 lux) suppressed the number of leaves in all treated plants. Maximum number of leaves occurred when the plants of Aglaonema commutatum 'Treubii' and Scindapsus aureus 'Marble Queen' were grown under light intensities of 10,000 -23,000 lux. Light intensity between 3,500 - 9,000 lux increased the number of leaves of Philodendron erubescens 'Ceylon Gold' (23), Monstera deliciosa (8) and Calathea ornata (17.8) compared to the light intensity between 10,000 - 23,000 lux. Low light intensity, on the other hand, suppressed the production of leaves of house plants used in the experiment (Fig.1).

Length of leaves: Intensity of light influenced the growth of leaves. The similar trend of leaf growth was followed as in case of plant height. Significant increase in leaf length was recorded with the increase in light intensity. The length of leaf was maximum when Calathea zebrina, Syngonium podophyllum 'White Butterfly', Dieffenbachia maculata and Monstera pertusa were grown under the highest light intensity (8,000 - 22,000 lux) and in case of Aglaonema commutatum 'Treubii' under the 10,000 - 23,000 lux light intensity. Pleomele reflexa while grown under

3,000 - 7,000 lux light intensity produced the longest leaf. Maximum leaf length was recorded in Scindapsus aureus 'Marble Queen' and Monstera deliciosa when grown under 1,600 - 3,000 lux light intensity. Light intensity between 3,500 - 9,000 lux caused maximum leaf length of Philodendron erubescens 'Ceylon Gold' and Calathea ornata. Low light intensity, however, caused marked reduction in leaf growth of all house plants used in this experiment.

Width of leaves: The data presented in the Table 1 to 4 reveal that increased light intensity also influenced the width of leaves of house plants. Wider leaves of Calathea zebrina, Syngonium podophyllum 'White Butterfly', Monstera pertusa and Pleomele reflexa were observed under 8,000 - 22,000 lux light intensity whereas Dieffenbachia maculata produced wider leaf under 3,000 - 7,000 lux light intensity. Light intensity between 3,500 - 9,000 lux caused maximum width of leaves in Scindapsus aureus 'Marble Queen', Philodendron erubescens 'Ceylon Gold', Monstera deliciosa and Calathea ornata compared to the highest light intensity while in Aglaonema commutatum 'Treubii' the highest light intensity produced wider leaf. The width of leaf was markedly reduced under the lowest light intensity in all plants used in this experiment.

Area of leaves: Increased level of light intensity caused the largest area of leaves in Calathea zebrina, Syngonium podophyllum 'White Butterfly', Monstera pertusa and Aglaonema commutatum 'Treubii' (Fig.2). The light intensity between 3,000 - 7,000 lux influenced the production of maximum leaf area in Dieffenbachia

maculata and Pleomele reflexa which recorded 226.84 cm^2 and 23.97 cm^2 leaf area respectively (Table-2). Light intensity between 3,500 - 9,000 lux showed the largest area of leaf in Scindapsus aureus 'Marble Queen', Philodendron erubescens 'Ceylon Gold', Monstera deliciosa and Calathea ornata (Table-3 and 4). Maximum reduction in leaf area was observed under the lowest light intensity in all the plants under study.

Number of plantlets or branches: The production of branches or plantlets tended to decline with decreasing level of light intensity. Light intensity below 3,000 lux did not produce any plantlet of Calathea zebrina whereas Calathea ornata and Syngonium podophyllum 'White Butterfly' were not able to produce good number of plantlets and branches respectively. Highest light intensity (8,000 - 23,000 lux) developed 2-4 branches/plantlets of above mentioned plants but the number of plantlets/branches were quite less at lowest light intensity (450 - 1,500 lux).

Length of internode: The longest internodal lengths were obtained when Scindapsus aureus 'Marble Queen' and Philodendron erubescens 'Ceylon Gold' received 3,500 - 9,000 lux light intensity during the growing period while the longest internode in Monstera deliciosa was obtained under the light intensity of 1,600 - 3,000 lux. Shorter internodal lengths in Philodendron erubescens (2.88 cm) and Monstera deliciosa (4.20 cm) were recorded under the highest light intensity.

Diameter of vine: It is evident from Table-4 that diameter of

vine of house plants were increased with increasing levels of light intensity. Plants of Scindapsus aureus 'Marble Queen', Philodendron erubescens 'Ceylon Gold' and Monstera deliciosa produced more diameter of vine under 10,000 - 23,000 lux light intensity.

Colour grade: Colour grades of house plant were significantly affected by different light intensities. Under light intensity between 8,000 to 23,000 lux, colour grade of Aglaonema commutatum 'Treubii', Monstera deliciosa, M.pertusa, Pleomele reflexa and Syngonium podophyllum 'White Butterfly' were maximum while Dieffenbachia maculata, Calathea ornata, C.zebrina, Philodendron erubescens 'Ceylon Gold' and Scindapsus aureus 'Marble Queen' were obtained highest colour grade under light intensity between 3,000 - 7,000 lux and 3,500 - 9,000 lux. Low light intensity showed poor colour grade in all house plants used in this investigation.

Plant grade: Plant grades of house plants in the experiment were similarly affected as in case of colour grades. Light intensity of 8,000 - 23,000 lux and 3,000 - 9,000 lux produced best quality of plant. Low light intensity caused poor quality of all plants used in the experiment.

Table-1 Influence of light intensity on growth and development of Calathea zebrina and Syngonium podophyllum 'White Butterfly'.

Light intensity (lux)	Plant height (cm)	No.of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	No.of plantlets or branches/plant	Colour grade	Plant grade
				Calathea zebrina				
8,000-22,000	34.48	14.60	31.70	7.06	89.32	2.0 (1.58)	3.80	4.40
3,000-7,000	33.88	10.40	27.56	6.34	70.87	1.0 (1.29)	4.60	4.80
1,500-2,500	24.74	6.40	18.74	4.90	34.42	0 (0.71)	3.00	3.40
450-1,000	12.54	3.00	10.68	3.30	23.98	0 (0.71)	1.80	1.40
S.Em.±	2.52	1.88	1.76	0.40	7.98	0.03	0.57	0.25
C.D.at 0.05 P	7.76	5.80	5.42	1.25	24.58	0.10	1.76	0.78
				Syngonium podophyllum 'White Butterfly'				
8,000-22,000	26.10	40.40	22.58	6.86	54.67	4.40 (2.21)	3.60	4.60
3,000-7,000	19.86	23.80	17.22	6.08	34.64	2.40 (1.69)	3.00	4.20
1,500-2,500	19.08	13.60	16.62	5.72	25.25	0.60 (0.98)	2.20	3.40
450-1,000	14.28	5.40	12.50	4.14	18.16	0.20 (0.81)	1.20	1.40
S.Em.±	1.44	1.99	1.77	0.50	5.92	0.11	0.28	0.26
C.D.at 0.05 P	4.44	6.14	5.45	1.54	18.24	0.33	0.87	0.80

*Figures in parentheses indicate the square root transformed values.

Table-2 Influence of light intensity on growth and development of *Dieffenbachia maculata*, *Monstera pertusa* and *Pleomele reflexa*.

Light intensity (Lux)	Plant height(cm)	No.of leaves/ plant	Leaf length(cm)	Leaf width(cm)	Leaf area (cm^2)	Colour grade	Plant grade
			Dieffenbachia maculata				
8,000-22,000	54.78	11.00	39.00	11.56	218.29	3.80	4.60
3,000-7,000	52.52	8.60	38.92	12.24	226.84	4.20	4.60
1,500-2500	49.00	7.80	37.24	9.90	133.76	2.20	3.40
450-1,000	33.54	6.00	28.22	6.76	75.30	1.40	2.00
S.Em.±	3.51	0.83	2.54	0.45	10.69	0.49	0.28
C.D.at 0.05P	10.82	2.56	7.84	1.39	32.96	1.53	0.87
			Monstera pertusa				
8,000-22,000	65.10	13.80	32.30	12.20	169.57	4.20	4.60
3,000-7,000	62.80	12.80	30.62	11.44	165.79	3.80	4.20
1,500-2,500	40.04	8.80	26.20	7.96	93.00	2.20	3.20
450-1,000	26.86	5.00	23.66	6.98	50.53	1.40	1.80
S.Em.±	1.64	1.12	0.91	0.26	10.80	0.49	0.20
C.D.at 0.05 P	5.06	3.47	2.82	0.81	33.30	1.53	0.62
			Pleomele reflexa				
8,000-22,000	33.44	31.80	14.80	2.08	23.28	4.60	4.80
3,000-7,000	27.54	22.40	16.20	2.08	23.97	3.80	4.20
1,500-2,500	20.78	14.20	13.40	1.84	13.13	2.20	2.20
450-1,000	15.08	8.80	10.72	1.70	10.64	1.00	1.20
S.Em.±	0.68	0.99	0.40	0.08	1.15	0.45	0.22
C.D.at 0.05 P	2.09	3.04	1.24	0.24	3.54	1.38	0.67

Table-3 Influence of light intensity on growth and development of Aglaonema commutatum 'Treubii' and Calathea ornata

Light intensity (Lux)	Plant height(cm)	No.of leaves/ plant	Leaf length(cm)	Leaf width(cm)	Leaf area (cm^2)	No.of plant-lets /plant	Colour grade	Plant grade
			Aglaonema commutatum 'Treubii'					
10,000-23,000	37.00	12.40	24.96	3.22	76.85		4.60	4.60
3,500-9,000	36.72	12.20	22.86	2.58	66.04		4.20	4.20
1,600-3,000	35.28	11.60	23.56	2.72	66.53		2.20	3.20
900-1,500	29.72	10.60	19.34	2.48	39.67		1.40	1.40
S.Em.±	1.34	0.57	0.94	0.13	5.65		0.50	0.28
C.D.at 0.05 P	4.15	N.S.	2.88	0.41	17.41		1.55	0.86
			Calathea ornata					
10,000-23,000	23.10	13.40	15.48	4.34	75.49	3.40 (1.92)	3.40	4.00
3,500-9,000	26.20	17.80	20.40	4.60	80.14	4.80 (2.25)	3.80	4.40
1,600-3,000	24.06	12.00	18.82	4.60	61.89	2.80 (1.75)	1.80	2.80
900-1,500	19.10	4.40	15.76	3.90	24.00	0.80 (1.09)	1.00	1.40
S.Em.±	1.35	2.49	1.20	0.16	11.29	0.23	0.42	0.27
C.D.at 0.05 P	4.17	7.68	3.69	0.50	34.79	0.70	1.30	0.83

N.S. = Not significant

*Figures in parentheses indicate the square root transformed values.

Table-4 Influence of light intensity on growth and development of *Monstera deliciosa*, *Philodendron erubescens* 'Ceylon Gold' and *Scindapsus aureus* 'Marble Queen'.

Light intensity (Lux)	Plant height (cm)	No.of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Internode length (cm)	Diameter of vine (cm)	Colour grade	Plant grade
				Monstera deliciosa					
10,000-23,000	47.48	7.20	35.00	13.44	224.92	4.20	1.26	4.60	4.80
3,500-9,000	58.20	8.00	35.82	13.50	226.19	5.74	1.14	4.20	5.00
1,600-3,000	65.00	7.60	38.16	12.58	192.16	7.08	1.05	2.60	2.40
900-1,500	59.78	5.80	34.66	12.00	167.01	6.36	0.93	1.00	1.60
S.Em.±	2.37	0.51	0.75	0.37	12.87	0.58	0.06	0.37	0.20
C.D.at 0.05 P	7.30	1.56	2.33	1.15	39.68	1.80	0.19	1.15	0.61
				Philodendron erubescens 'Ceylon Gold'					
10,000-23,000	57.38	22.60	31.98	7.80	116.91	2.88	1.13	3.80	4.60
3,500-9,000	61.94	23.00	32.28	7.96	128.26	3.92	0.97	4.20	4.80
1,600-3,000	59.72	21.80	26.00	6.60	99.05	3.84	0.74	2.20	3.20
900-1,500	47.70	19.00	26.90	6.74	70.95	3.08	0.66	1.00	2.20
S.Em.±	2.11	0.80	1.14	0.30	6.59	0.24	0.04	0.47	0.23
C.D.at 0.05 P	6.51	2.47	3.52	0.92	20.30	0.74	0.13	1.44	0.73
				Scindapsus aureus 'Marble Queen'					
10,000-23,000	30.28	26.20	12.82	4.64	32.33	2.47	0.43	4.20	4.60
3,500-9,000	30.02	16.80	13.02	4.68	37.97	2.64	0.41	4.60	4.40
1,600-3,000	20.16	12.20	13.98	4.28	30.52	1.02	0.38	2.60	3.40
900-1,500	12.76	6.00	10.18	3.00	18.21	0.75	0.36	1.00	1.20
S.Em.±	0.88	0.67	0.74	0.21	3.87	0.16	0.01	0.37	0.26
C.D.at 0.05 P	2.72	2.09	2.28	0.67	11.93	0.50	0.04	1.15	0.80

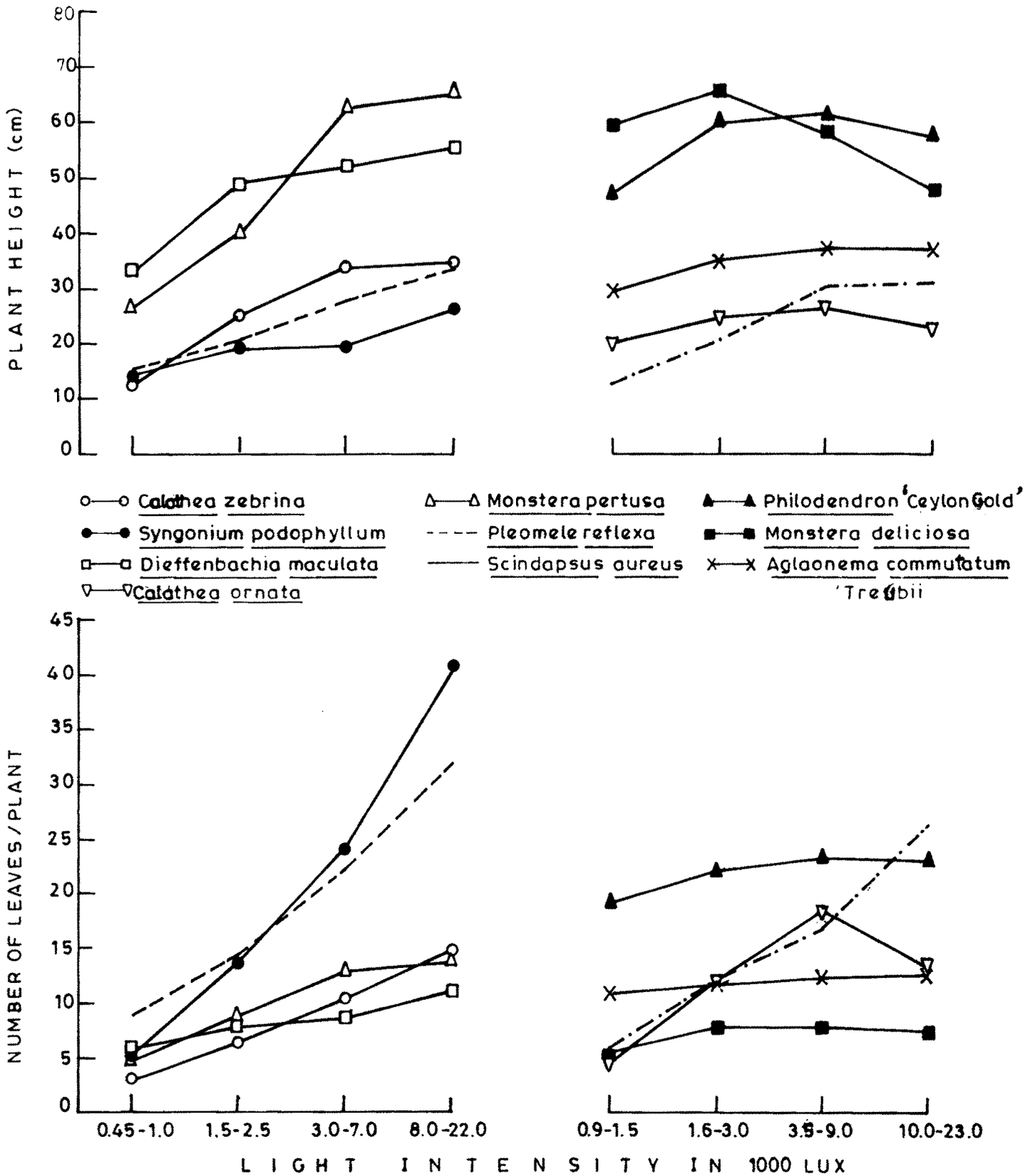


FIG. 1: EFFECT OF LIGHT INTENSITY ON PLANT HEIGHT AND LEAF NUMBER OF SOME HOUSE PLANTS

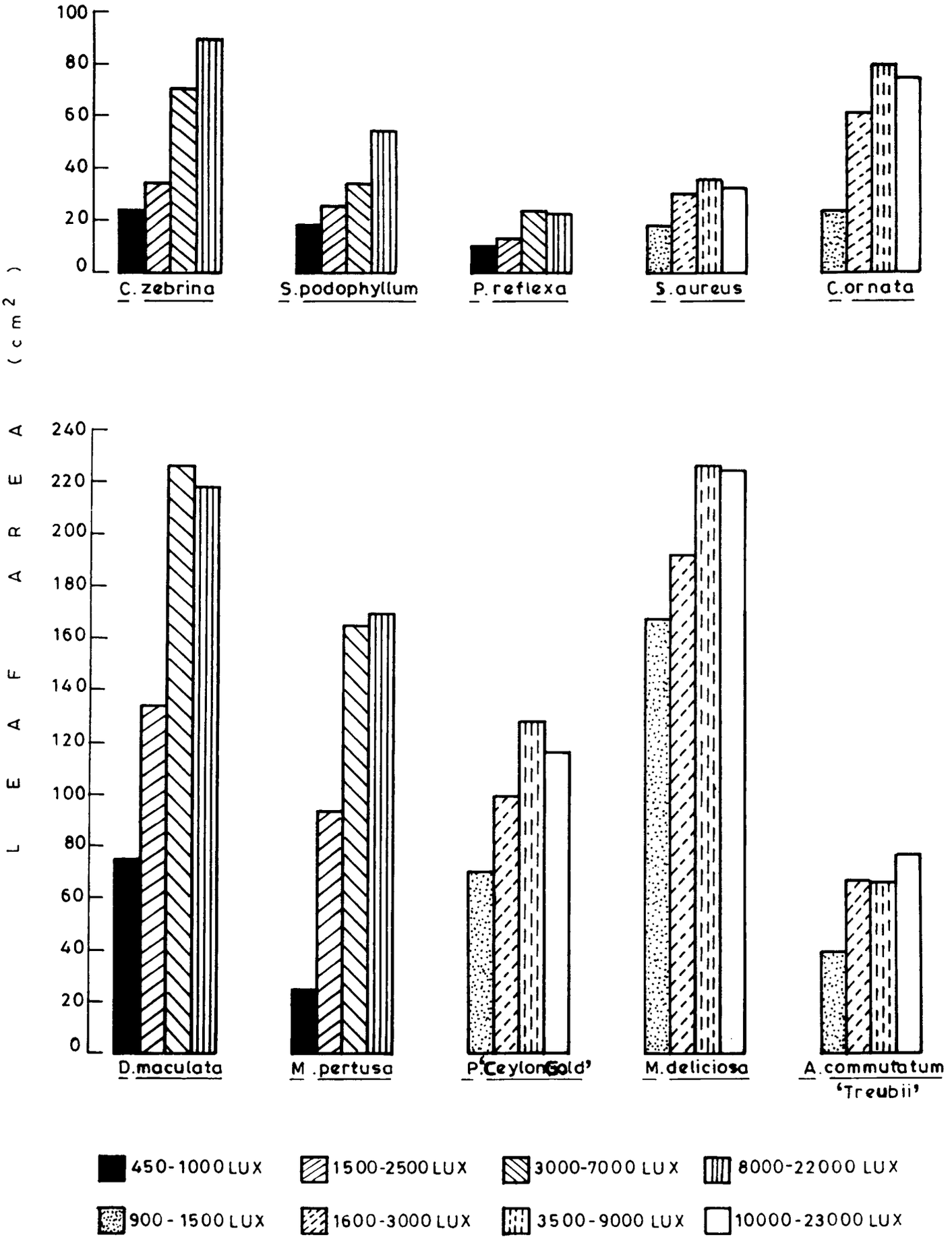


FIG.2: INFLUENCE OF LIGHT INTENSITY ON LEAF AREA OF SOME HOUSE PLANTS



Dieffenbachia maculata



Pleomele reflexa



Syngonium podophyllum 'White Butterfly'



Calathea zebrina

Plate No.1 Influence of light intensity on growth and development of Dieffenbachia maculata, Pleomele reflexa, Syngonium podophyllum 'White Butterfly' and Calathea zebrina.



Aglaonema commutatum 'Treubii



Philodendron erubescens 'Ceylon Gold'



Scindapsus aureus 'Marble Queen'

Plate No.2 Influence of light intensity on growth and development of Aglaonema commutatum 'Treubii', Philodendron erubescens 'Ceylon Gold' and Scindapsus aureus 'Marble Queen'.

Experiment 4.1.1.2 Studies on theeffectof mineral nutrition on growth and development of some house plants.

In order to study the effect of different levels of nitrogen, phosphorus and potassium on the growth of house plants and also to study the effect of various sources of organic and inorganic nutrients on the growth of house plants, the following experiments were carried out.

Experiment 4.1.1.2.1 Effect of different levels of nitrogen and potassium on the growth and development of some house plants in sand culture.

Experiment 4.1.1.2.2 Response of organic and inorganic fertilizers on growth and development of house plants.

Experiment 4.1.1.2.1 Effect of different levels of nitrogen and potassium on the growth and development of some house plants in sand culture.

The plants showed differences in growth about 30 days after the treatment. Symptoms of deficiency on foliage first appeared in nitrogen and potassium deficient plants.

Nitrogen deficiency symptoms

i) Height of the plant was reduced.

ii) Leaves were yellowish green in colour, yellowing increased with the advancement of plant growth.

iii) Number and size of the leaves were reduced.

iv) Plantlet formation was suppressed.

Potassium deficiency symptoms

i) Plants were stunted in growth.

ii) Leaves were lighter green in colour.

iii) Number and size of leaves were reduced.

Effect of nitrogen

Height of the plant: It is evident from the data in Table-5 that the plant height of Cordyline terminalis was significantly influenced by the application of fertilizers. Low level of nitrogen greatly increased the height of plants compared to higher levels of nitrogen used in this experiment. Maximum plant height (25.10 cm) was recorded with 200 mg/l of nitrogen. The height of the plant was suppressed under high level of nitrogen. The similar trends in plant growth was also observed in Aglaonema commutatum 'Treubii', Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen'(Table-6 to 8).

Number of leaves: Leaf production of Cordyline terminalis was significantly affected by the different levels of nitrogen. The lowest level of nitrogen produced more number of leaves as compared to highest level of nitrogen and maximum number of leaves occurred when each plant received 200 mg/l nitrogen. The highest level of nitrogen caused reduction in leaf number compared to rest of treatments. Similar response of nitrogen in production of leaves was also recorded in Aglaonema commutatum 'Treubii', Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen'.

Length of leaves: The length of leaves tended to increase with lower levels of nitrogen. Higher level of nitrogen reduced the leaf lengths of all house plants used in this experiment. Significant variations in leaf length were observed under various nitrogen levels.

Width of leaves: It is revealed from the data presented in the Table –5 to 8 that highest level of nitrogen caused detrimental effect as regard to width of leaves in case of Aglaonema commutatum 'Treubii',Cordyline terminalis, Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen'. Lower dose of nitrogen significantly increased the width of leaves. Maximum width of leaves (1.96 cm) was recorded in Cordyline terminalis when plant received nitrogen 200 mg/l of water.

Area of leaves: Plants receiving low dose of nitrogen exhibited marked improvement in leaf area. The highest dose of nitrogen (600 mg/l) did not improve the leaf area in Aglaonema commutatum 'Treubii' Cordyline terminalis, Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen'.

Fresh weight of shoot: The fresh weight of shoot in Aglaonema commutatum 'Treubii', Cordyline terminalis, Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen'differed under various levels of nitrogen application. Lower level of nitrogen increased fresh weight of shoot whereas the highest level tended to decrease the fresh weight.

Dry weight of shoot: Dry weight of shoot in Cordyline terminalis

increased with lower level of nitrogen. Maximum dry weight of shoot was obtained when plants received 200 mg/l nitrogen. Similar trend in dry weight of shoot was also noticed in Aglaonema commutatum 'Treubii', Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen' (Table –6 to 8).

Fresh weight of root: Application of nitrogen markedly influenced the growth of root. Lower dose of nitrogen improved the fresh weight of root compared to the highest dose of nitrogen. The highest dose of nitrogen (600 mg/l) reduced the root growth in all the plants.

Dry weight of root: Low rate of nitrogen fertilization improved dry weight of roots in case of Cordyline terminalis. Similar response was also recorded in other plants used in this experiment.

Colour grade: Aglaonema commutatum 'Treubii', Cordyline terminalis, Dieffenbachia maculata, 'Exotica' and Scindapsus aureus 'Marble Queen' under different doses of nitrogen fertilizer did not show significant variation in colour grade. However, low level of nitrogen improved colour of leaves of all the plants used in this experiment.

Plant grade: It is evident from Table –5 to 8 that plant grade expressed quality of plant was significantly improved by different levels of nitrogen application. The best plant grade was obtained when plant received 200 mg nitrogen per litre of water; the plant grade gradually decreased with the increasing level of nitrogen.

Effect of potassium:

Height of the plant: Plant height of Cordyline terminalis improved with application of potassium fertilizer. The tallest plants were obtained with 200 mg/l potassium. The maximum plant heights in Aglaonema commutatum 'Treubii', Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen' were also obtained with 200 mg/l potassium.

Number of leaves: The number of leaves per plant was increased by low level of potassium. The maximum number of leaves were obtained when Aglaonema commutatum 'Treubii', Cordyline terminalis, Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen' received 200 mg potassium per litre of water.

Length of leaves: Leaf lengths of different plant species were influenced by the different levels of potassium fertilizer. Higher level of potassium significantly reduced the leaf length and maximum leaf length was obtained at the lowest level of potassium (200 mg/l) (Table-5 to 8).

Width of leaves: Aglaonema commutatum 'Treubii', Cordyline terminalis, Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen' had wider leaves when these plants received the lowest dose of potassium i.e. 200 mg/l. The highest dose of potassium (600 mg/l) reduced width of leaves of the plants.

Area of leaves: A significant variation in the leaf area of Aglaonema commutatum 'Treubii', Cordyline terminalis,

Dieffenbachia maculata 'Exotica'and Scindapsus aureus 'Marble Queen' was obtained among different levels of potassium. Maximum leaf area was recorded with the lowest dose of potassium.

Fresh weight of shoot: Application of low doses of potassium improved the fresh weight of shoot in Aglaonema commutatum 'Treubii',Cordyline terminalis, Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen'. Highest dose of potassium reduced the fresh weight of shoot of the house plants.

Dry weight of shoot: It is evident from Table –5 to 8 that dry weight of shoot increased with low level of potassium and the maximum dry weight was obtained when the plant received 200 mg/l of potassium.

Fresh weight of root: Fresh weight of root also followed similar trend in growth as observed in case of fresh weight of shoot.

Dry weight of root: Dry weight of root of the treated plants showed similar response as in case of dry weight of shoot. The lowest level of potassium increased dry weight of root. As the dose of potassium increased the dry weight of root gradually decreased. Root damage was also observed when the plant received higher doses of potassium fertilization.

Colour grade: Foliage colour (indicated as Colour grade) was better when Aglaonema commutatum 'Treubii',Cordyline terminalis and Dieffenbachia maculata 'Exotica' were treated with potassium at 200 mg/l. However, in Scindapsus aureus 'Marble Queen'colour

grade was not influenced when plant received various levels of potassium.

Plant grade: Quality of plant improved with the low dose of potassium application. Plant grades of Cordyline terminalis, Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen'were improved significantly when plants received low dose of potassium fertilizer. In case of Aglaonema commutatum 'Treubii' application of potassium fertilizer had no effect on plant grade.

Effect of interaction:

While studying the interaction effect of nitrogen and potassium, marked responses on growth and development of Aglaonema commutatum 'Treubii', Cordyline terminalis, Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen' were noted and presented in Table-5 to 8.

Height of the plant: Maximum height of Cordyline terminalis was obtained when plants were fertilized with nitrogen and potassium both at the rate of 200 mg/l as well as nitrogen and potassium at the rate of 400 mg/l and 200 mg/l respectively. The highest dose of nitrogen and potassium (both at 600 mg/l) reduced the plant height (Table-5 and Fig.3). Fertilizer application showed beneficial effect on height of Dieffenbachia maculata 'Exotica'; the maximum plant height being recorded (20.50 cm) under the lowest doses of nitrogen and potassium (both at 200 mg/l). In case of Aglaonema commutatum 'Treubii' the lowest dose each of

nitrogen and potassium produced maximum height of plant (17.70 cm) compared to control (11.60 cm)(Table-6). Similarly, in case of Scindapsus aureus 'Marble Queen' maximum height was obtained when plants received nitrogen and potassium both at 200 mg/l(Table-8, Fig.3 and Plate-3).

Number of leaves: Application of nitrogen and potassium had pronounced effect on the production of leaves per plant. When the rate of nutrient application increased, the production of leaves gradually decreased in case of Aglaonema commutatum 'Treubii', Cordyline terminalis, Dieffenbachia maculata 'Exotica'and Scindapsus aureus 'Marble Queen'. Maximum production of leaves was obtained in Cordyline terminalis and Scindapsus aureus 'Marble Queen' when plants received nitrogen at 400 mg/l andpotassium at 200 mg/l. Dieffenbachia maculata 'Exotica' and Aglaonema commutatum 'Treubii', on the other hand, developed maximum number of leaves when plant received 200 mg/l each of nitrogen and potassium.

Length of leaves: The data presented in the Table-6 to 8 clearly indicate that the lowest doses of nitrogen and potassium (200 mg/l) produced maximum length of leaves in Aglaonema commutatum 'Treubii', Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen'. Higher doses reduced the length of leaves in all plants used in this experiment. However, in case of Cordyline terminalis, nitrogen at 400 mg/l and potassium at 200 mg/l produced larger leaves followed by nitrogen and potassium both at 200 mg/l.

Width of leaves: The width of leaves of Cordyline terminalis was significantly influenced by the different doses of nutrients and more width of leaves was noticed when nitrogen at 400 mg/l and potassium at 200 mg/l were applied to each plant. Low dose (200 mg/l) each of nitrogen and potassium produced the widest leaves of Aglaonema commutatum 'Treubii', Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen'. Nitrogen and potassium both in high doses and in deficient condition reduced width of leaves of all the four plant species mentioned above. Plants which received higher doses of nitrogen and potassium and plants without any nutrients showed reduction in width of leaves in all house plants used in this experiment.

Area of leaves: As regards to area of leaves, significant variations were recorded with the different doses of fertilizers. The lowest dose of nitrogen and potassium (200 mg/l) increased the area of leaves in Dieffenbachia maculata 'Exotica', whereas higher doses reduced the area of leaves. In Cordyline terminalis, application of nitrogen at 400 mg/l and potassium at 200 mg/l produced maximum area of leaves and significant differences existed among the treatments. Application of nitrogen and potassium at the lowest dose (each 200 mg/l) also increased the area of leaves of Aglaonema commutatum 'Treubii' and Scindapsus aureus 'Marble Queen'(Table-6 and 8, Fig.3). Similarly, higher doses reduced the area of leaves of the above plants.

Fresh weight of shoot: Shoot growth of all house plants used in

this experiment was influenced by the application of low doses of nutrients. Plants treated with higher doses of nutrients or without nutrients produced shoots of low fresh weight. Low rate of fertilization increased the fresh weight of shoot in Aglaonema commutatum 'Treubii',Cordyline terminalis, Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen'. Addition of low doses of nitrogen and potassium (both at 200 mg/l) produced maximum fresh weight of shoot in Aglaonema commutatum 'Treubii',Cordyline terminalis, Dieffenbachia maculata 'Exotica'and Scindapsus aureus 'Marble Queen' (Table.—5 to 8).

Dry weight of shoot: A significant variation in the dry weight of shoot of Cordyline terminalis was noted and maximum dry weight of shoot was obtained when plant received nitrogen and potassium at the rate of 400 mg/l and 200 mg/l respectively. Maximum dry weight of shoot in Aglaonema commutatum 'Treubii',Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen' was observed when plant received lowest dose of nitrogen and potassium. Highest dose of nitrogen and potassium reduced dry weight of shoot in all the plants used in this experiment.

Fresh weight of root: Root growth was also influenced by the application of nutrients. Maximum root fresh weights in Aglaonema commutatum 'Treubii' and Dieffenbachia maculata 'Exotica' were obtained when plants received the lowest amount of nitrogen and potassium. Reduction in fresh weight of root was noted when plants received high doses of nitrogen and potassium or in absence of additional nutrients. In Cordyline terminalis and Scindapsus

aureus 'Marble Queen', application of nitrogen and potassium at 400 mg/l and 200 mg/l respectively influenced by increasing the fresh weight of root.

Dry weight of root: The dry weight of root of Aglaonema commutatum 'Treubii', Cordyline terminalis, Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen' increased with low level of fertilization. The maximum root dry weight was recorded when plants were treated with nitrogen and potassium both at 200 mg/l. Higher doses of nitrogen and potassium both at 600 mg/l reduced the dry weight of root in plants.

Colour grade: Regarding the colour grade of the plants used in the investigation, marked influence was noted in Aglaonema commutatum 'Treubii', Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen'. Plants receiving the lowest level of nitrogen and potassium showed improvement in the colour of leaves in Aglaonema commutatum 'Treubii' and Scindapsus aureus 'Marble Queen'. In Cordyline terminalis and Dieffenbachia maculata 'Exotica' application of nitrogen at 400 mg/l and potassium at 200 mg/l improved colour of leaves. Pale colour of leaves was noticed when plants did not receive any fertilizer.

Plant grade: Plant quality in all house plants used in this investigation was influenced by the application of nutrients. In Cordyline terminalis,better quality of plants were obtained when plants received nitrogen at 400 mg/l and potassium at 200 mg/l. The lowest dose of nitrogen and potassium (both at 200 mg/l)

produced the best quality of plants in Aglaonema commutatum 'Treubii', Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen'. The untreated plants produced poor quality of plants used in this experiment.

Influence of fertilizers on elemental composition of four house plants (per cent dry weight)

Data presented in Table-9 are not intended to establish critical nutrient levels of the various elements for plants used in this experiment but to indicate levels that appear adequate for growth of good quality plants.

N-Composition:

Levels of nitrogen in leaf composition of Cordyline terminalis was maximum when plants received maximum potassium with moderate quantity of nitrogen and phosphorus ($N_{400}P_{400}K_{600}$). Plant showed poor quantity of nitrogen in leaf tissue when plants were treated with highest dose of nitrogen and potassium, and moderate quantity of phosphorus ($N_{600}P_{400}K_{600}$). In this experiment plants treated with maximum quantity of fertilizer showed poor uptake of nutrient compared to rest of the treatments. Plants grown under optimum level of fertilizers produced better quality of plants.

In case of Dieffenbachia maculata 'Exotica', similar response was recorded when plant treated with higher doses of nitrogen and potassium. Better quality of plants showed 3.06 per

cent nitrogen in leaf tissues over rest of the treatments. Both Aglaonema commutatum 'Treubii' and Scindapsus aureus 'Marble Queen' showed better response in growth when plants were treated with moderate quantity of nitrogen and phosphorus, and highest dose of potassium ($N_{400}P_{400}K_{600}$). Good quality of plants treated with lower doses of nutrients showed lower percentage of nitrogen in plant tissue composition.

P-composition:

As regards to phosphorus availability in leaf tissue composition, response of all nutrients used in this experiment did not show marked influence of phosphorus level in leaf composition of Aglaonema commutatum 'Treubii', Cordyline terminalis, Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen'.

K-composition:

Potassium fertilization of plants responded differently in leaf tissue composition of different plant species used in this experiment. Both low level of nitrogen and potassium fertilization alongwith moderate quantity of phosphorus ($N_{200}P_{400}K_{200}$) influenced good quality of foliage plants and tissue composition of leaf. Higher doses of potassium and nitrogen application showed toxic effect to the plants and showed poor response to leaf tissue composition in all plants used in this experiment. Dieffenbachia maculata 'Exotica' was most responsive to tissue composition of potassium compared to Aglaonema commutatum 'Treubii', Cordyline terminalis and Scindapsus aureus 'Marble Queen'.

Table-5 Effect of N and K on growth and development of Cordyline terminalis

Treatments (mg/l)	Plant height (cm)	No.of leaves/ plant	Leaf length (cm)	Leaf width (cm)	leaf area (cm^2)	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root (g)	Colour grade	Plant grade
1	2	3	4	5	6	7	8	9	10	11	12
Effect of nitrogen											
N_{200}	25.10	11.66	13.68	1.96	23.77	10.58	1.76	3.39	0.35	4.33	4.13
N_{400}	20.23	9.93	12.13	1.75	17.87	10.33	1.68	2.33	0.23	4.30	3.87
N_{600}	17.04	6.86	9.62	1.59	11.09	4.78	0.69	1.35	0.13	3.93	2.47
S.Em(±)	0.85	0.56	0.32	0.05	0.80	0.41	0.09	0.14	0.02	0.25	0.18
C.D.at 0.05P	2.45	1.62	0.90	0.16	2.30	1.17	0.27	0.40	0.05	N.S.	0.51
Effect of potassium											
K_{200}	24.93	11.93	13.50	2.08	23.38	10.34	1.78	2.97	0.33	4.60	4.06
K_{400}	20.16	8.80	11.43	1.71	16.39	7.87	1.35	2.33	0.23	3.93	3.40
K_{600}	17.27	7.73	10.49	1.51	12.95	7.48	1.02	1.76	0.16	3.93	3.00
S.Em.(±)	0.85	0.56	0.32	0.05	0.80	0.41	0.09	0.14	0.02	0.25	0.18
C.D.at 0.05P	2.45	1.62	0.90	0.16	2.30	1.17	0.27	0.40	0.05	N.S.	0.51

Contd.....

Table-5 Contd....

Treatments (mg/l)	Plant height (cm)	No.of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area(cm^2)	Fresh weight of shoot(g)	Dry weight of shoot(g)	Fresh weight of root (g)	Dry weight of root(g)	Colour grade	Plant grade
1	2	3	4	5	6	7	8	9	10	11	12
Effect of interaction											
$N_{200}K_{200}$	27.50	14.20	14.52	2.20	26.67	13.10	2.04	3.62	0.42	4.60	4.60
$N_{200}K_{400}$	24.60	11.20	14.34	2.01	25.04	9.59	1.74	3.50	0.34	4.20	4.00
$N_{200}K_{600}$	23.20	9.60	12.18	1.67	19.60	9.06	1.28	3.06	0.27	4.20	3.80
$N_{400}K_{200}$	27.50	14.40	15.06	2.26	30.28	13.00	2.54	3.84	0.39	5.00	4.80
$N_{400}K_{400}$	18.50	8.20	10.76	1.59	12.17	9.32	1.54	2.10	0.20	3.80	3.80
$N_{400}K_{600}$	14.70	7.20	10.56	1.41	11.12	8.68	1.22	1.06	0.10	3.80	3.00
$N_{600}K_{200}$	19.80	7.20	10.94	1.78	13.18	4.92	0.77	1.47	0.16	4.20	2.80
$N_{600}K_{400}$	17.40	7.00	9.18	1.54	11.97	4.71	0.76	1.40	0.13	3.80	2.40
$N_{600}K_{600}$	13.92	6.40	8.74	1.45	8.12	4.72	0.56	1.18	0.10	3.80	2.20
Control	18.70	7.40	11.14	1.53	13.95	5.22	0.90	2.96	0.32	1.00	1.40
S.Em.±	1.47	0.97	0.54	0.09	1.39	0.70	0.16	0.24	0.03	0.43	0.31
C.D.at 0.05P	4.24	2.79	1.56	0.27	3.99	2.03	0.47	0.70	0.09	N.S.	N.S.
Control Vs.Rest											
S.Em.±	1.47	0.97	0.54	0.09	1.39	0.70	0.16	0.24	0.03	0.43	0.31
C.D.at 0.05P	N.S.	2.79	N.S.	0.27	3.99	2.03	0.47	0.70	0.09	N.S.	0.89

N.S. = Not significant

Table-6 Effect of N and K on growth and development of Aglaonema commutatum 'Treubii'.

Treatments (mg/l)	Plant height (cm)	No.of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root (g)	Colour grade	Plant grade
1	2	3	4	5	6	7	8	9	10	11	12
Effect of nitrogen											
N_{200}	16.90	7.06	11.51	2.05	18.18	6.60	0.76	2.68	0.18	3.80	4.33
N_{400}	14.60	5.80	11.12	1.73	11.37	3.37	0.40	0.97	0.06	3.67	3.40
N_{600}	12.33	5.00	10.04	1.65	10.27	2.76	0.32	0.59	0.04	3.53	2.80
S.Em.(±)	0.44	0.27	0.26	0.06	0.50	0.25	0.04	0.13	0.02	0.25	0.14
C.D.at 0.05P	1.26	0.79	0.75	0.17	1.44	0.72	0.12	0.38	0.05	N.S.	0.39
Effect of Potassium											
K_{200}	15.40	6.40	11.38	1.87	14.56	4.80	0.59	1.96	0.14	3.93	3.73
K_{400}	14.76	5.80	10.81	1.83	13.49	4.28	0.48	1.37	0.09	3.67	3.53
K_{600}	13.66	5.66	10.48	1.74	11.77	3.65	0.41	0.91	0.06	3.40	3.27
S.Em(±)	0.44	0.27	0.26	0.06	0.50	0.25	0.04	0.13	0.02	0.25	0.14
C.D.at 0.05P	1.26	N.S.	N.S.	N.S.	1.44	0.72	0.12	0.38	0.05	N.S.	N.S.

Contd.....

Table-6 Contd...

Treatments (mg/l)	Plant height (cm)	No.of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area (Cm^2)	Fresh weight of shoot(g)	Dry weight of shoot(g)	Fresh weight of root (g)	Dry weight of root(g)	Colour grade	Plant grade
1	2	3	4	5	6	7	8	9	10	11	12
Effect of interaction											
$N_{200}K_{200}$	17.70	7.40	12.20	2.13	20.47	7.21	0.93	3.75	0.280	4.20	4.60
$N_{200}K_{400}$	16.90	7.00	11.14	2.10	17.81	6.21	0.67	2.44	0.168	3.80	4.40
$N_{200}K_{600}$	16.10	6.80	11.20	1.94	16.27	6.40	0.66	1.87	0.108	3.40	4.00
$N_{400}K_{200}$	15.90	6.40	11.56	1.78	12.35	3.93	0.44	1.46	0.092	3.80	3.60
$N_{400}K_{400}$	14.90	5.60	11.16	1.73	12.00	3.82	0.43	1.08	0.062	3.80	3.40
$N_{400}K_{600}$	13.00	5.40	10.64	1.69	9.76	2.37	0.33	0.39	0.030	3.40	3.20
$N_{600}K_{200}$	12.60	5.40	10.38	1.72	10.88	2.37	0.40	0.67	0.054	3.80	3.00
$N_{600}K_{400}$	12.50	4.80	10.14	1.65	10.67	2.64	0.33	0.61	0.044	3.40	2.80
$N_{600}K_{600}$	11.90	4.80	9.62	1.59	9.27	2.37	0.23	0.49	0.036	3.40	2.60
Control	11.60	4.80	10.02	1.72	9.58	3.06	0.34	2.29	0.182	1.00	1.20
S.Em.±	0.76	0.47	0.45	0.10	0.87	0.43	0.07	0.23	0.030	0.43	0.23
C.D.at 0.05P	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	0.66	N.S.	N.S.	N.S.
Control Vs.Rest											
S.Em.±	0.76	0.47	0.45	0.10	0.87	0.43	0.07	0.23	0.030	0.43	0.23
C.D.at 0.05P	2.18	1.37	N.S.	N.S.	2.49	1.24	N.S.	0.66	0.090	1.23	0.68

N.S. = Not significant

Table-7 Effect of N and K on growth and development of Dieffenbachia maculata 'Exotica'

Treatments (mg/l)	Plant height (cm)	No.of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root (g)	Colour grade	Plant grade
1	2	3	4	5	6	7	8	9	10	11	12
Effect of nitrogen											
N_{200}	19.78	6.33	14.43	4.62	50.12	17.79	2.06	3.71	0.38	4.20	4.40
N_{400}	16.14	5.13	12.03	3.87	32.09	13.15	1.34	2.05	0.23	4.07	3.60
N_{600}	14.76	3.46	11.33	3.57	23.17	4.50	0.41	0.63	0.06	3.80	2.80
S.Em.(±)	0.54	0.31	0.43	0.12	1.27	0.66	0.09	0.15	0.02	0.27	0.11
C.D.at 0.05P	1.55	0.90	1.22	0.33	3.65	1.89	0.27	0.43	0.07	N.S.	0.31
Effect of Potassium											
K_{200}	18.60	5.60	13.57	4.48	41.01	15.12	0.85	2.78	0.29	4.47	4.33
K_{400}	16.63	4.73	12.68	3.92	33.97	11.68	1.23	2.10	0.22	3.93	3.40
K_{600}	15.54	4.60	11.54	3.68	30.38	8.64	1.73	1.51	0.17	3.67	3.07
S.Em.(±)	0.54	0.31	0.43	0.12	1.27	0.66	0.09	0.15	0.02	0.27	0.11
C.D.at 0.05P	1.55	0.90	1.22	0.33	3.65	1.89	0.27	0.43	0.07	N.S.	0.31

Contd.....

Table-7 Contd....

Treatments (mg/l)	Plant height (cm)	No.of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root(g)	Colour grade	Plant grade
1	2	3	4	5	6	7	8	9	10	11	12
Effect of interaction											
$N_{200}K_{200}$	20.50	7.00	15.02	4.81	52.84	20.86	2.42	4.24	0.390	4.60	5.00
$N_{200}K_{400}$	19.70	6.20	14.22	4.75	49.77	17.48	2.08	3.58	0.380	4.20	4.20
$N_{200}K_{600}$	19.14	5.80	14.04	4.31	47.74	17.30	1.90	3.32	0.350	3.80	4.00
$N_{400}K_{200}$	20.32	6.20	14.34	4.70	46.63	18.60	2.22	3.38	0.380	4.60	4.60
$N_{400}K_{400}$	15.00	4.60	12.50	3.58	29.17	13.37	1.27	2.10	0.220	3.80	3.40
$N_{400}K_{600}$	13.10	4.60	9.24	3.35	20.45	5.22	0.33	0.66	0.096	3.80	2.80
$N_{600}K_{200}$	15.00	3.60	11.36	3.93	23.56	5.90	0.55	0.71	0.070	4.20	3.40
$N_{600}K_{400}$	14.90	3.40	11.32	3.42	22.98	4.20	0.36	0.63	0.060	3.80	2.60
$N_{600}K_{600}$	14.40	3.40	11.32	3.38	22.96	3.40	0.31	0.56	0.058	3.40	2.40
Control	12.70	4.40	11.64	3.47	17.51	4.60	0.45	2.34	0.270	1.00	1.40
S.Em.±	0.93	0.54	0.73	0.20	2.20	1.14	0.16	0.26	0.040	0.46	0.18
C.D.at 0.05P	2.68	N.S.	2.12	N.S.	6.32	3.27	0.48	0.74	0.12	N.S.	N.S.
Control Vs.Rest											
S.Em.±	0.93	0.54	0.73	0.20	2.20	1.14	0.16	0.26	0.04	0.46	0.18
C.D.at 0.05P	2.68	N.S.	N.S.	0.57	6.32	3.27	0.48	N.S.	N.S.	1.33	0.53

N.S. = Not significant

Table-8 Effect of N and K on growth and development of Scindapsus aureus 'Marble Queen'

Treatments (mg/l)	Plant height (cm)	No.of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root (g)	Colour grade	Plant grade
1	2	3	4	5	6	7	8	9	10	11	12
Effect of nitrogen											
N_{200}	17.20	10.20	9.53	3.77	23.46	11.99	1.24	5.86	0.52	3.80	3.93
N_{400}	15.30	10.13	9.04	3.25	17.99	8.77	0.89	4.81	0.41	3.53	3.53
N_{600}	11.50	8.60	7.84	3.23	13.45	5.70	0.54	2.48	0.25	3.53	2.87
S.Em.(±)	0.55	0.41	0.28	0.11	0.80	0.56	0.06	0.26	0.03	0.25	0.15
C.D.at 0.05P	1.59	1.18	0.80	0.33	2.31	1.62	0.19	0.75	0.09	N.S.	0.42
Effect of potassium											
K_{200}	15.90	10.53	9.15	3.58	19.85	10.39	1.05	5.27	0.48	3.67	3.80
K_{400}	14.56	9.60	8.80	3.45	18.71	9.17	0.93	4.58	0.39	3.53	3.33
K_{600}	13.53	8.80	8.47	3.22	16.35	6.90	0.69	3.31	0.30	3.67	3.20
S.Em.(±)	0.55	0.41	0.28	0.11	0.80	0.56	0.06	0.26	0.03	0.25	0.15
C.D.at 0.05P	1.59	1.18	N.S.	N.S.	2.31	1.62	0.19	0.75	0.09	N.S.	0.42

Contd.....

Table-8 Contd....

Treatments (mg/l)	Plant height (cm)	No.of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area(cm^2)	Fresh weight of shoot(g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root (g)	Colour grade	Plant grade
1	2	3	4	5	6	7	8	9	10	11	12
Effect of interaction											
$N_{200}K_{200}$	19.20	11.20	9.76	4.00	24.63	14.31	1.42	6.34	0.60	4.20	4.40
$N_{200}K_{400}$	16.70	9.80	9.56	3.78	23.93	11.30	1.17	6.29	0.52	3.80	3.80
$N_{200}K_{600}$	15.70	9.60	9.28	3.55	21.81	10.36	1.14	4.95	0.44	3.40	3.60
$N_{400}K_{200}$	16.60	11.20	9.52	3.35	20.24	10.83	1.15	6.58	0.54	3.40	3.80
$N_{400}K_{400}$	15.60	10.20	8.94	3.23	18.32	10.45	1.05	4.98	0.42	3.40	3.40
$N_{400}K_{600}$	13.70	9.00	8.68	3.18	15.43	5.05	0.48	2.89	0.26	3.80	3.40
$N_{600}K_{200}$	11.90	9.20	8.16	3.40	14.67	6.05	0.59	2.89	0.29	3.40	3.20
$N_{600}K_{400}$	11.40	8.80	7.92	3.36	13.80	5.78	0.56	2.49	0.24	3.40	2.80
$N_{600}K_{600}$	11.20	7.80	7.46	2.94	11.80	5.29	0.47	2.08	0.19	3.80	2.60
Control	12.60	8.80	8.20	2.80	12.68	6.53	0.64	3.83	0.40	1.00	1.20
S.Em.±	0.96	0.71	0.48	0.20	1.39	0.98	0.11	0.45	0.05	0.43	0.25
C.D.at 0.05P	N.S.	N.S.	N.S.	N.S.	N.S.	2.81	N.S.	1.29	N.S.	N.S.	N.S.
Control Vs.Rest											
S.Em.±	0.96	0.71	0.48	0.20	1.39	0.98	0.11	0.45	0.05	0.43	0.25
C.D.at 0.05P	2.75	N.S.	N.S.	0.57	3.99	2.81	0.33	N.S.	N.S.	1.24	0.72

N.S. = Not significant

Table-9 Influence of fertilizerson elemental composition of four house plants, per cent dry weight.

Treatments	N	P	K	N	P	K
	Cordyline terminalis			Dieffenbachia maculata 'Exotica'		
$N_{200}P_{400}K_{200}$	2.21	0.19	1.80	3.06	0.20	3.38
$N_{200}P_{400}K_{400}$	2.36	0.20	1.80	3.17	0.24	3.50
$N_{200}P_{400}K_{600}$	2.43	0.21	2.05	3.32	0.22	4.10
$N_{400}P_{400}K_{200}$	2.08	0.24	1.60	3.03	0.24	3.80
$N_{400}P_{400}K_{400}$	2.13	0.22	1.85	3.18	0.26	4.00
$N_{400}P_{400}K_{600}$	2.62	0.20	1.90	3.92	0.26	4.50
$N_{600}P_{400}K_{200}$	2.40	0.23	1.81	3.80	0.25	4.50
$N_{600}P_{400}K_{400}$	2.18	0.20	1.60	3.52	0.27	3.37
$N_{600}P_{400}K_{600}$	1.96	0.22	1.55	2.03	0.30	2.50
	Aglaonema commutatum 'Treubii'			Scindapsus aureus 'Marble Queen'		
$N_{200}P_{400}K_{200}$	2.50	0.19	2.50	2.45	0.17	3.00
$N_{200}P_{400}K_{400}$	2.80	0.20	2.75	2.50	0.20	3.10
$N_{200}P_{400}K_{600}$	2.85	0.22	2.82	2.96	0.22	3.61
$N_{400}P_{400}K_{200}$	2.59	0.18	2.58	2.54	0.20	3.13
$N_{400}P_{400}K_{400}$	2.82	0.21	2.85	2.85	0.18	3.60
$N_{400}P_{400}K_{600}$	3.33	0.21	3.10	3.20	0.16	3.75
$N_{600}P_{400}K_{200}$	2.70	0.20	2.56	2.80	0.21	3.40
$N_{600}P_{400}K_{400}$	2.35	0.18	2.50	2.59	0.20	3.23
$N_{600}P_{400}K_{600}$	2.14	0.21	2.38	2.60	0.20	2.87

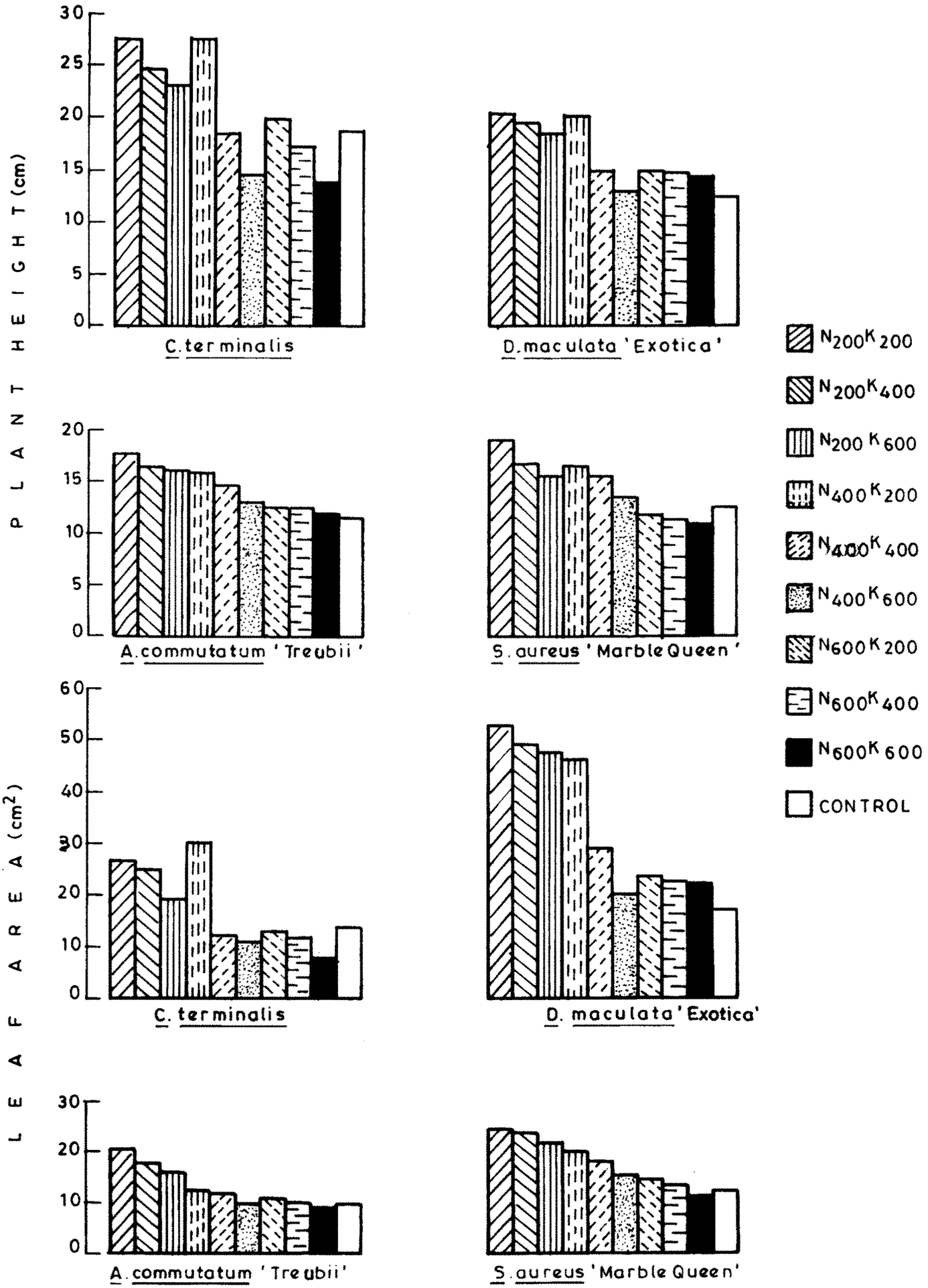
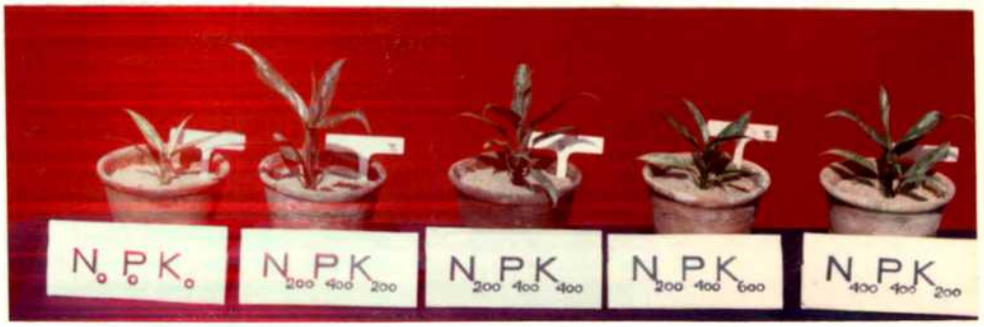


FIG. 3: EFFECT OF N AND K ON PLANT HEIGHT AND LEAF AREA OF FOUR HOUSE PLANTS



Aglaonema commutatum 'Treubii'



Dieffenbachia maculata 'Exotica'



Scindapsus aureus 'Marble Queen'

Plate No.3 Effect of N, P and K on growth and development of Aglaonema commutatum 'Treubii', Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen!

Experiment 4.1.1.2.2 Response of organic and inorganic fertilizers on growth and development of house plants.

Height of the plant: Height of foliage plants responded well to the application of organic and inorganic fertilizers. Maximum increases in plant height of Philodendron erubescens, Monstera deliciosa and Dieffenbachia maculata 'Exotica' were noted when the plants were grown in media containing sterameal. Bonemeal on the other hand, did not much affect the growth of Monstera deliciosa (Table-11, Fig.4 and Plate-4). Plant heights of Calathea zebrina and Syngonium podophyllum 'White Butterfly' were significantly increased with different inorganic and organic fertilizers and the maximum height of the plants were obtained with basal media containing 50 gm bonemeal per pot (Table 13 and 14; Plate 4 and 5). Aglaonema commutatum 'Silver Queen', Dieffenbachia maculata, Peperomia obtusifolia and Scindapsus aureus 'Marble Queen' showed maximum height with basal media containing 50 gm bloodmeal per pot followed by the plants grown in media enriched with bonemeal (Table 10,12 and 14; Fig.4). In case of Pleomele reflexa 'Song of India' maximum plant height was noted when plants were grown in media containing charcoal dust (Plate-5). Application of NPK (1 : 1 : 1) also improved the plant height of Chlorophytum comosum 'Variegatum' and Cordyline terminalis.

Number of leaves: It is revealed from Table-11 that maximum number of leaves of Monstera deliciosa, Philodendron erubescens

and Dieffenbachia maculata 'Exotica' were obtained in media containing sterameal and the significant difference was recorded among the treatments. Calathea zebrina, Pleomele reflexa 'Song of India' and Syngonium podophyllum 'White Butterfly' produced more number of leaves when plants were grown in media enriched with bonemeal compared to rest of the treated and control plants. Bloodmeal also had a significant effect on leaf production of foliage plant and caused maximum number of leaves of Aglaonema commutatum 'Silver Queen', Dieffenbachia maculata, Peperomia obtusifolia and Scindapsus aureus 'Marble Queen' compared to untreated plants. It is interesting to note that leaf production of Chlorophytum comosum 'Variegatum' and Cordyline terminalis were markedly influenced when media were enriched with 2.5 gm of NPK (1 : 1 : 1) per pot. All the treated plants in this experiment produced more number of leaves compared to untreated plants.

Length of leaves: Leaf lengths of Aglaonema commutatum 'Silver Queen', Monstera deliciosa and Syngonium podophyllum 'White Butterfly' were not markedly influenced by the application of organic and inorganic fertilizers. The application of sterameal markedly influenced the leaf length of Philodendron erubescens and Dieffenbachia maculata 'Exotica'. The longest leaf of Calathea zebrina and Peperomia obtusifolia were obtained when plants were grown in basal media enriched with bonemeal. In case of Dieffenbachia maculata , plant produced longer leaf when grown in bloodmeal enriched media and other media also

influenced the length of leaves. It is interesting to note that maximum length of leaves were obtained in Pleomele reflexa 'Song of India' when plants were grown in media with charcoal dust while Scindapsus aureus 'Marble Queen', Chlorophytum comosum 'Variegatum' and Cordyline terminalis produced maximum length of leaves when plants were grown in media enriched with 2.5 gm NPK (1 : 1 : 1) per pot.

Width of leaves: It is revealed from the data presented in Table-11 that application of sterameal influenced the production of wider leaves in Monstera deliciosa, Philodendron erubescens and Dieffenbachia maculata 'Exotica'. There was no significant difference in width of leaves among the different treatments in case of Aglaonema commutatum 'Silver Queen', Chlorophytum comosum 'Variegatum' and Peperomia obtusifolia. Wider leaves were obtained in Calathea zebrina and Syngonium podophyllum 'White Butterfly' when plants were grown on basal media containing 50 gm bonemeal per pot. It was observed that the application of charcoal dust caused formation of wider leaf in Pleomele reflexa 'Song of India' whereas Cordyline terminalis and Scindapsus aureus 'Marble Queen' produced wider leaves in medium containing 2.5 gm NPK (1 : 1 : 1) per pot. In case of Dieffenbachia maculata, use of bloodmeal had beneficial effect on production of wider leaves and best quality plants.

Area of leaves: Application of organic and inorganic fertilizers had beneficial effect on the area of leaves per plant. Monstera

deliciosa, Philodendron erubescens and Dieffenbachia maculata 'Exotica' significantly improved leaf area when plants were grown in media with sterameal (Table-11 and Fig.5). The area of leaves in Calathea zebrina and Syngonium podophyllum 'White Butterfly' were markedly increased when grown in media enriched with bonemeal compared to control(Table - 13 and 14). Application of bonemeal also improved the leaf area of Peperomia obtusifolia. Application of bloodmeal in basal media significantly increased the leaf area of Aglaonema commutatum 'Silver Queen' and Dieffenbachia maculata whereas in Cordyline terminalis, Chlorophytum comosum 'Variegatum' and Scindapsus aureus 'Marble Queen', use of inorganic fertilizer (NPK) caused maximum leaf area compared to control (Table –10, 12 and 13; Fig.5). Addition of charcoal dust in media improved the leaf area of Pleomele reflexa 'Song of India'.

Number of plantlets or branches: As regards to number of plantlets or branches, no marked variation was recorded among the treatments in Chlorophytum comosum 'Variegatum' and Peperomia obtusifolia. But increased number of plantlets or branches per plant were recorded when plants received additional nutrients in media compared to control plants. In Syngonium podophyllum 'White Butterfly' , maximum branches were obtained when grown in media enriched with bonemeal. Calathea zebrina,on the other hand, produced maximum plantlets when plants were grown in media containing bloodmeal. Application of 50 gm bonemeal per plant produced more number of plantlets or branches in Chlorophytum

comosum 'Variegatum' and Peperomia obtusifolia.

Colour grade: Foliage colour was better when Dieffenbachia maculata 'Exotica', Monstera deliciosa and Philodendron erubescens were treated with sterameal compared to control. Bonemeal improved the foliage colour of Calathea zebrina, Syngonium podophyllum 'White Butterfly', Chlorophytum comosum 'Variegatum' and Cordyline terminalis. In case of Pleomele reflexa 'Song of India', charcoal dust produced better colour of leaves compared to control. Peperomia obtusifolia, Calathea zebrina, Dieffenbachia maculata, D.maculata 'Exotica' and Aglaonema commutatum 'Silver Queen' produced better leaf colour when media were enriched with bloodmeal. In Scindapsus aureus 'Marble Queen', application of inorganic fertilizer NPK (1 : 1 : 1) produced better colour of leaves. The poor colour grades occurred when the plants were grown without addition of manures and fertilizers.

Plant grade: Plant grade was greatly affected by the application of different doses of manures and fertilizers. The best plant grades of Monstera deliciosa, Philodendron erubescens, Calathea zebrina and Dieffenbachia maculata 'Exotica' were observed when plants were grown in media enriched with sterameal. Pleomele reflexa 'Song of India'grown in media containing charcoal dust had the highest plant grade (Table-12) compared to other treatments. In case of Syngonium podophyllum 'White Butterfly',

Peperomia obtusifolia, Chlorophytum comosum 'Variegatum' and Cordyline terminalis, plants grown in media enriched with bonemeal showed improved plant grades (Table - 10, 13 and 14). Scindapsus aureus 'Marble Queen' grown in NPK (1 : 1 : 1) enriched media had the best plant grade (Table-12). Plant grade of Dieffenbachia maculata and Aglaonema commutatum 'Silver Queen' were best when plants were grown in media enriched with bloodmeal. All plants grown without addition of manures and fertilizers showed poor quality in all respects of growth.

Table-10 Response of organic and inorganic fertilizers on growth and development of *Aglaonema commutatum* 'Silver Queen', *Cordyline terminalis* and *Dieffenbachia maculata*.

Treatments	Plant height(cm)	No.of leaves/plant	Leaf length(cm)	Leaf width(cm)	Leaf area (cm^2)	Colour grade	Plant grade
1	2	3	4	5	6	7	8
			Aglaonema commutatum 'Silver Queen'				
Bonemeal	16.82	7.00	13.64	3.11	22.90	3.80	3.80
Bloodmeal	18.14	7.20	14.98	2.63	23.66	4.20	4.40
Sterameal	15.80	6.20	12.97	2.67	20.71	3.40	3.60
Charcoal dust	15.10	6.00	13.40	2.73	21.22	2.60	3.40
NPK (1:1:1)	16.24	6.40	14.04	2.93	22.12	3.40	3.80
Control	15.00	4.80	13.72	2.72	20.32	1.80	1.80
S.Em.±	0.49	0.47	0.93	0.15	0.75	0.41	0.26
C.D.at 0.05P	1.44	1.40	N.S.	N.S.	2.23	1.20	0.77
			Cordyline terminalis				
Bonemeal	26.04	35.00	11.91	3.20	20.89	4.20	4.60
Bloodmeal	22.80	30.40	10.81	2.90	19.57	3.80	4.00
Sterameal	21.40	30.20	10.57	2.83	19.13	2.60	3.40
Charcoal dust	24.18	33.80	11.46	3.16	20.59	2.20	2.00
NPK (1:1:1)	28.12	38.80	12.13	3.40	20.96	3.80	4.00
Control	21.04	29.00	10.23	2.70	18.57	1.80	2.20
S.Em.±	1.09	1.49	0.32	0.11	0.93	0.46	0.32
C.D.at 0.05P	3.21	4.39	0.96	0.31	N.S.	1.36	0.93

Contd.....

Table-10 Contd....

Treatments	Plant height(cm)	No.of leaves/plant	Leaf length(cm)	Leaf width(cm)	Leaf area(cm^2)	Colour grade	Plant grade
1	2	3	4	5	6	7	8
			Dieffenbachia maculata				
Bonemeal	25.08	6.60	21.62	6.11	82.20	4.20	4.00
Bloodmeal	29.56	7.40	21.79	6.67	89.95	4.60	4.20
Sterameal	25.04	6.20	19.73	5.97	74.47	3.80	3.80
Charcoal dust	20.82	6.40	14.15	4.35	45.57	3.40	3.40
NPK (1:1:1)	22.14	6.40	17.06	5.02	53.06	3.80	4.00
Control	19.84	5.60	15.91	3.72	46.81	2.20	2.20
S.Em.±	1.28	0.26	1.23	0.28	3.34	0.53	0.32
C.D.at 0.05 P	3.77	0.76	3.63	0.84	9.86	N.S.	0.96

N.S. = Not significant

Table-11 Response of organic and inorganic fertilizers on growth and development of *Dieffenbachia maculata* 'Exotica', *Monstera deliciosa* and *Philodendron erubescens*.

Treatments	Plant height(cm)	No.of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area(cm^2)	Colour grade	Plant grade
1	2	3	4	5	6	7	8
			Dieffenbachia maculata 'Exotica'				
Bonemeal	29.22	9.20	24.72	7.88	78.23	4.20	4.20
Bloodmeal	27.20	9.20	20.87	7.64	74.59	4.60	4.60
Sterameal	31.88	10.40	25.70	8.04	90.88	4.60	4.80
Charcoal dust	23.36	7.40	18.07	6.17	58.44	1.80	3.00
NPK(1:1:1)	25.40	7.60	20.08	6.78	66.75	3.00	3.80
Control	22.70	8.20	20.01	5.81	55.53	1.40	2.00
S.Em.±	1.31	0.64	1.28	0.30	3.09	0.50	0.29
C.D.at 0.05 P	3.87	1.87	3.79	0.88	9.12	1.48	0.87
			Monstera deliciosa				
Bonemeal	40.00	5.40	30.21	10.70	142.55	3.40	3.60
Bloodmeal	45.90	5.80	30.44	12.43	170.55	3.80	4.40
Sterameal	48.84	8.00	31.11	12.66	178.71	4.20	4.60
Charcoal dust	42.20	5.60	31.05	10.64	165.56	2.60	3.60
NPK (1:1:1)	41.84	5.40	31.11	11.09	135.54	3.40	3.40
Control	36.62	3.80	29.84	9.64	116.00	1.40	2.60
S.Em.±	1.96	0.55	0.86	0.44	10.33	0.45	0.26
C.D.at 0.05 P	5.80	1.62	N.S.	1.30	30.49	1.32	0.76

Contd.....

Table-11 Contd....

Treatments	Plant height(cm)	No.of leaves/plant	Leaf length(cm)	Leaf width(cm)	Leaf area(cm^2)	Colour grade	Plant grade
1	2	3	4	5	6	7	8
			Philodendron erubescens				
Bonemeal	43.36	9.80	28.05	6.61	102.63	3.80	4.20
Bloodmeal	40.68	8.20	25.35	6.38	100.92	3.40	3.40
Sterameal	44.72	10.00	28.36	7.01	104.34	3.80	4.40
Charcoal dust	40.14	7.20	28.29	5.47	82.89	3.00	3.40
NPK (1:1:1)	37.32	6.40	27.66	6.19	84.52	3.40	3.20
Control	37.28	4.60	24.45	5.94	87.02	1.80	2.20
S.Em.±	1.82	0.63	0.93	0.30	3.94	0.44	0.22
C.D.at 0.05 P	5.36	4.17	2.73	0.89	11.63	1.29	0.65

N.S. = Not significant

Table-12 Response of organic and inorganic fertilizers on growth and development of *Pleomele reflexa* 'Song of India' and *Scindapsus aureus* 'Marble Queen'.

Treatments	Plant height (cm)	No.of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Colour grade	Plant grade
			Pleomele reflexa 'Song of India'				
Bonemeal	25.12	30.60	12.56	1.84	22.30	3.40	4.40
Bloodmeal	24.04	28.20	10.55	1.71	15.92	3.80	4.00
Sterameal	24.36	29.40	12.38	1.74	20.78	3.40	4.00
Charcoal dust	27.20	30.40	12.66	1.96	24.11	4.20	4.60
NPK (1 :1:1)	22.66	25.40	11.35	1.68	17.16	3.40	3.60
Control	19.92	17.20	9.99	1.63	13.76	1.80	2.20
S.Em.±	0.81	1.79	0.27	0.05	0.86	0.44	0.27
C.D.at 0.05 P	2.39	5.28	0.79	0.16	2.55	1.32	0.79
			Scindapsus aureus 'Marble Queen'				
Bonemeal	82.00	27.00	14.45	6.12	43.52	3.80	4.20
Bloodmeal	82.80	27.40	13.47	6.05	40.00	3.40	4.00
Sterameal	79.00	26.00	13.92	5.75	39.59	3.80	4.00
Charcoal dust	64.30	22.20	13.21	5.07	35.73	3.00	2.80
NPK (1:1:1)	77.70	23.80	15.73	6.15	46.00	4.20	4.40
Control	73.50	24.80	12.35	4.91	35.25	1.80	1.60
S.Em.±	3.38	0.96	0.49	0.21	2.23	0.51	0.29
C.D.at 0.05 P	9.97	2.83	1.46	0.61	6.57	1.51	0.85

Table-13 Response of organic and inorganic fertilizers on growth and development of *Calathea zebrina* and *Chlorophytum comosum* 'Variegatum'.

Treatments	Plant height (cm)	No.of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	No.of plant-lets or branches/plant	Colour grade	Plant grade
				Calathea zebrina				
Bonemeal	29.98	26.00	22.64	7.25	75.78	3.80	3.80	3.60
Bloodmeal	26.68	24.40	19.18	6.36	65.45	5.20	3.80	4.20
Sterameal	28.42	25.40	21.70	6.81	69.30	4.80	3.40	4.20
Charcoal dust	27.70	15.80	21.44	6.93	58.71	2.80	2.60	3.40
NPK (1:1:1)	25.24	17.00	17.88	5.92	59.26	3.00	3.00	2.60
Control	22.68	19.50	18.69	6.17	56.41	3.40	2.20	2.40
S.Em.±	0.95	1.41	0.91	0.21	3.26	0.55	0.50	0.32
C.D.at 0.05 P	2.81	4.17	2.69	0.62	9.63	1.63	1.48	0.95
				Chlorophytum comosum 'Variegatum'				
Bonemeal	20.20	31.20	15.35	1.24	16.42	2.80	4.60	4.20
Bloodmeal	21.50	23.80	15.51	1.25	17.58	2.60	3.40	3.60
Sterameal	23.44	33.80	16.12	1.26	18.53	1.80	3.80	3.60
Charcoal dust	24.50	36.40	17.35	1.27	19.12	2.60	2.20	3.00
NPK (1:1:1)	27.00	38.20	19.25	1.30	21.90	1.80	3.80	4.00
Control	20.80	25.20	13.01	1.21	13.64	1.60	1.80	1.80
S.Em.±	1.41	1.70	0.91	0.07	1.13	0.39	0.46	0.38
C.D.at 0.05 P	4.17	5.01	2.69	N.S.	3.35	N.S.	1.35	1.12

N.S. = Not significant

Table-14 Response of organic and inorganic fertilizers on growth and development of *Peperomia obtusifolia* and *Syngonium podophyllum* 'White Butterfly'.

Treatments	Plant height (cm)	No.of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	No.of plant-lets or branches/plant	Colour grade	Plant grade
				Peperomia obtusifolia				
Bonemeal	36.60	48.20	10.07	5.60	29.89	5.60	4.20	4.60
Bloodmeal	37.68	50.80	9.54	5.45	29.05	5.40	4.60	4.60
Sterameal	32.48	38.00	9.04	5.25	28.72	5.40	4.20	4.40
Charcoal dust	34.76	37.00	8.88	5.58	26.60	4.60	3.40	3.80
NPK (1:1:1)	31.84	39.40	9.06	5.41	27.63	5.00	3.40	4.20
Control	25.22	23.20	8.76	5.11	23.43	3.40	1.40	2.40
S.Em.±	1.57	2.17	0.20	0.16	1.24	0.52	0.46	0.24
C.D.at 0.05 P	4.63	6.42	0.60	N.S.	3.65	N.S.	1.37	0.72
				Syngonium podophyllum 'White Butterfly'				
Bonemeal	33.22	44.20	20.54	7.43	71.66	5.60	4.00	4.60
Bloodmeal	31.08	25.82	19.68	6.76	68.96	4.80	3.40	4.00
Sterameal	33.14	29.00	19.89	7.26	71.36	3.40	3.40	3.80
Charcoal dust	29.30	25.20	19.15	6.26	57.19	3.40	2.40	3.40
NPK (1:1:1)	26.30	31.00	19.50	6.33	50.73	3.60	2.80	3.20
Control	25.62	23.60	17.80	6.56	45.42	3.60	1.40	2.00
S.Em.±	1.45	1.91	1.07	0.25	3.46	0.48	0.29	0.30
C.D.at 0.05 P	4.28	5.63	N.S.	0.74	10.21	1.43	0.87	0.88

N.S. = Not significant

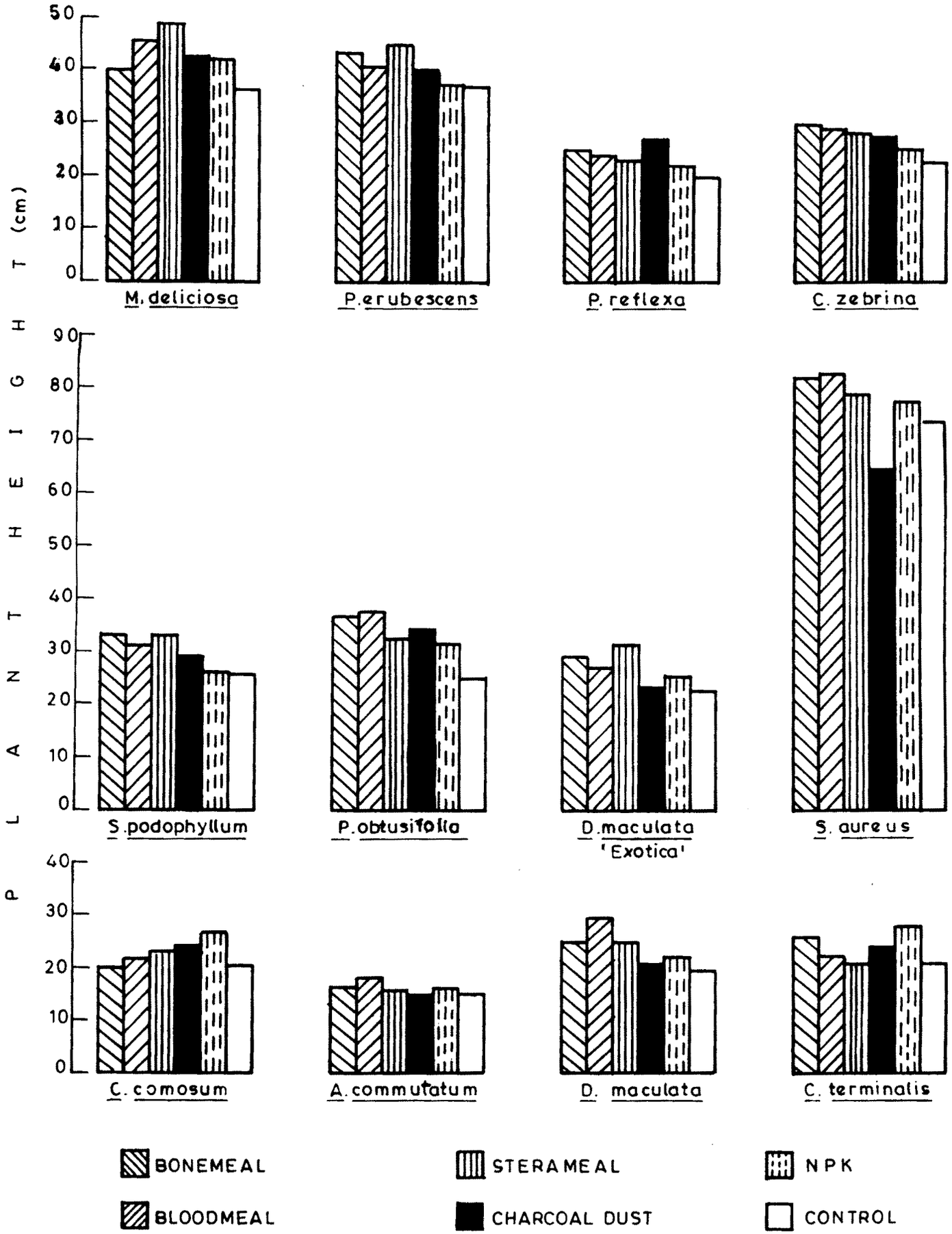


FIG. 4: RESPONSE OF ORGANIC AND INORGANIC FERTILIZATION ON PLANT HEIGHT OF SOME HOUSE PLANTS

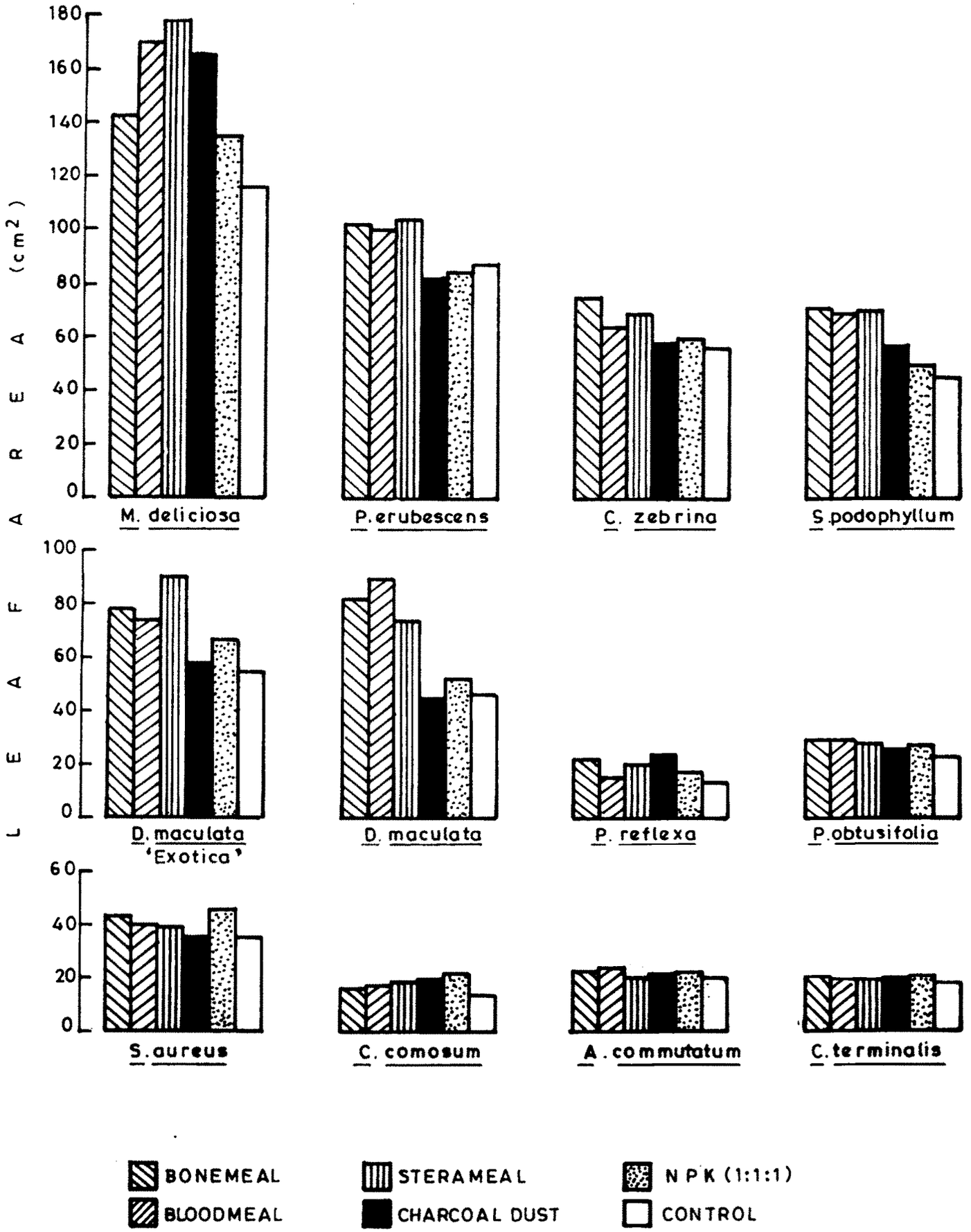


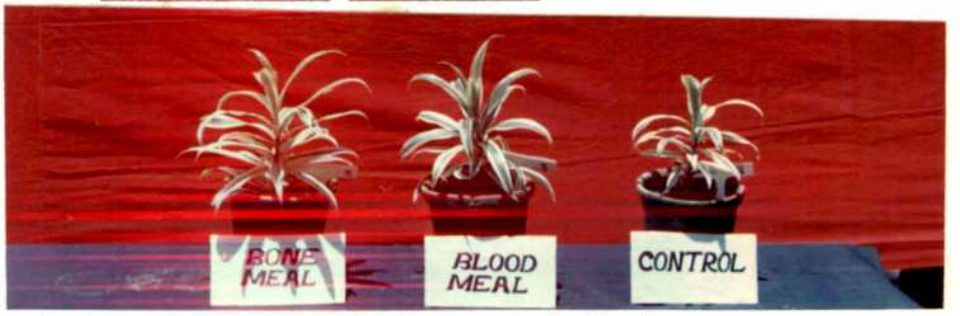
FIG.5: RESPONSE OF ORGANIC AND INORGANIC FERTILIZATION ON LEAF AREA OF SOME HOUSE PLANTS



Peperomia obtusifolia



Philodendron erubescens



Pleomele reflexa 'Song of India'



Syngonium podophyllum 'White Butterfly'

Plate No.4 Response of bonemeal and bloodmeal on growth and development of Peperomia obtusifolia, Philodendron erubescens, Pleomele reflexa 'Song of India' and Syngonium podophyllum 'White Butterfly'.



Calathea zebrina



Monstera deliciosa



Pleomele reflexa 'Song of India'

Plate No.5 Response of sterameal, charcoal dust and NPK on growth and development of Calathea zebrina, Monstera deliciosa and Pleomele reflexa 'Song of India.

Experiment 4.1.1.3 Effect of growth retardants on growth and development of house plants.

Application of growth retardants markedly affected plant growth in some house plants.

Height of the plant: Application of higher concentration each of Cycocel, B-9 and Maleic hydrazide caused significant reduction in plant height of Aglaonema commutatum 'Treubii' and Pleomele reflexa. Cycocel, B-9 and Maleic hydrazide at 1000 ppm enhanced plant height over control (Table -15 and 17; Fig.6). Plant height on the other hand, was reduced considerably by the use of higher concentrations of growth retardants. In case of Aglaonema commutatum 'Treubii', Maleic hydrazide at 4000 ppm was more effective in the reduction of plant height than rest of the treatments and it caused about 20 per cent reduction as compared to control. Pleomele reflexa , however, showed maximum reduction in plant height when treated with Cycocel at 4000 ppm(Table-17 and Fig.6). In case of Dieffenbachia maculata and Monstera obliqua all the growth retardants suppressed the plant height. It is found in Table-16 that the higher concentrations of Cycocel, B-9 and Maleic hydrazide markedly reduced the plant height compared to lower concentrations (1000 ppm). Maximum reduction in plant height was noted with Maleic hydrazide at 4000 ppm and it caused about 33 per cent reduction in Dieffenbachia maculata and 36 per cent reduction in Monstera obliqua. In case of Calathea zebrina, Peperomia obtusifolia and Syngonium podophyllum 'White Butterfly' application of Cycocel, B-9 and Maleic hydrazide at 2000 ppm and

4000 ppm markedly suppressed plant height. It is found in the Table 15 and 18 that the application of Cycocel, B-9 and Maleic hydrazide at 1000 ppm did not suppress the plant height. Plants treated with Maleic hydrazide at 4000 ppm markedly suppressed plant height followed by Maleic hydrazide at 2000 ppm.

Number of leaves: It is revealed from the data in Table -15 to 18 that the number of leaves per plant were significantly affected by the application of different concentrations of growth retardants. In Aglaonema commutatum 'Treubii' spraying of Cycocel, B-9 and Maleic hydrazide at higher concentrations caused slight reduction in number of leaves. Lower concentrations of all growth retardants did not suppress the number of leaves. In Calathea zebrina, application of Maleic hydrazide at 2000 ppm, 4000 ppm, and B-9 at 4000 ppm increased the leaf number whereas the number of leaves were reduced considerably in the rest of the treatments used in this experiment. Application of Maleic hydrazide at 4000 ppm markedly reduced the number of leaves in Dieffenbachia maculata. It is interesting to note that the number of leaves, however, increased with increasing concentrations of B-9 and maximum number of leaves occurred with 4000 ppm (Table-16). In case of Monstera obliqua application of Cycocel, B-9 and Maleic hydrazide at 2000 ppm and 4000 ppm reduced the number of leaves. Maximum reduction in leaf number was recorded with Maleic hydrazide at 4000 ppm. In case of Pleomele reflexa, the number of leaves increased considerably with low concentrations of all the growth retardants used in this experiment (Table-17).

In Peperomia obtusifolia Maleic hydrazide at all concentrations markedly improved the number of leaves and the maximum leaf number was recorded when plants were treated with Maleic hydrazide at 4000 ppm. Less number of leaves per plant were obtained when plants were treated with B-9 at 1000 ppm and 2000 ppm. Cycocel in all concentrations and B-9 at 4000 ppm improved the number of leaves over control. The number of leaves increased significantly in treated plants of Syngonium podophyllum 'White Butterfly'. Treatment with Cycocel and B-9 enhanced the number of leaves with the increase in concentration and maximum leaf number was obtained when plants were treated with B-9 at 4000 ppm. Maleic hydrazide at low concentration (1000 ppm) positively influenced the leaf number of Syngonium podophyllum 'White Butterfly' but leaf number was suppressed by higher concentration of the same chemical (Table-18).

Length of leaves: Length of leaves of house plants responded differently under different treatments. In Aglaonema commutatum 'Treubii', leaf length was influenced significantly in treated plants. Maximum reduction in leaf length was noted with Maleic hydrazide at 4000 ppm. Growth retarding chemicals had significantly affected the leaf length of Calathea zebrina and the maximum reduction was noted when the plants were treated with Maleic hydrazide at 4000 ppm. Application of Cycocel, B-9 and Maleic hydrazide caused significant differences in leaf lengths of Dieffenbachia maculata. Maximum reduction in leaf

length was recorded with Maleic hydrazide at 4000 ppm. In Monstera obliqua, spraying of low concentrations of B-9 and Maleic hydrazide slightly improved the length of leaves. Plants treated with Cycocel at the highest concentration, on the other hand, showed increase in the length of leaves compared to lower concentration. The length of leaves of Pleomele reflexa did not show any good response to the application of growth retarding chemicals. Application of B-9 at 1000 ppm improved the length of leaves compared to rest of the treatments. Peperomia obtusifolia did not show any marked response to the application of growth retarding chemicals used in this experiment. However, marked reduction in leaf length was obtained with Cycocel at 4000 ppm. Plants of Syngonium podophyllum 'White Butterfly' treated with Maleic hydrazide and Cycocel at all concentrations had reduced leaf lengths compared to rest of the treatments and maximum reduction was obtained when plants were sprayed with Maleic hydrazide at 4000 ppm. Slight improvement in leaf length was recorded when plants were treated with B-9 at 4000 ppm.

Width of leaves: It is evident from the data in Table 15 and 16 that growth retardants caused significant reduction in the width of leaves of Aglaonema commutatum 'Treubii' and Dieffenbachia maculata. Spraying with B-9 and Maleic hydrazide both at 4000 ppm caused less width of leaves in Aglaonema commutatum 'Treubii' and Dieffenbachia maculata respectively. Application of B-9 and Maleic hydrazide at high concentrations showed more response regarding reduction of width of leaves in Calathea zebrina. Maximum reduction in width of leaves was noted

when plants were sprayed with Maleic hydrazide at 2000 ppm followed by Maleic hydrazide at 4000 ppm. In Pleomele reflexa leaf width was reduced considerably in all the treated plants except CCC at 1000 ppm. The marked reduction in leaf width was noted both with Cycocel and Maleic hydrazide at 4000 ppm in Pleomele reflexa and Monstera obliqua respectively. Cycocel, B-9 and Maleic hydrazide had little effect on width of leaves in Peperomia obtusifolia. However, all these chemicals reduced leaf width at higher concentration. At low concentration of all chemicals, on the other hand, slightly increased the width of leaves compared to control. It is interesting to note that application of Maleic hydrazide at 4000 ppm reduced the width of leaves considerably in case of Syngonium podophyllum 'White Butterfly'.

Area of leaves: Cycocel, B-9 and Maleic hydrazide at different concentrations affected differentially the production of leaf area in Aglaonema commutatum 'Treubii', Calathea zebrina, Dieffenbachia maculata, Monstera obliqua, Peperomia obtusifolia, Pleomele reflexa and Syngonium podophyllum 'White Butterfly' (Table-15 to 18). Treatments with Cycocel and B-9 both at 2000 and 4000 ppm, and Maleic hydrazide at 1000, 2000 and 4000 ppm reduced leaf area considerably in Aglaonema commutatum 'Treubii' and Dieffenbachia maculata (Table-15 and 16; Fig.7). It is interesting to note that treatment with Cycocel and B-9 at 1000 ppm increased the leaf area of Aglaonema commutatum 'Treubii'and Dieffenbachia maculata compared to untreated plants. Maximum

reduction in leaf area was noted when the plants of Aglaonema commutatum 'Treubii' and Dieffenbachia maculata were treated with B-9 at 4000 ppm and Maleic hydrazide at 4000 ppm respectively. Application of Cycocel and Maleic hydrazide both at 1000 ppm and B-9 at 4000 ppm produced maximum area of leaves in Calathea zebrina over untreated plants and maximum reduction of leaf area was noted when the plants were sprayed with Maleic hydrazide at 4000 ppm.

Maleic hydrazide at 4000 ppm markedly reduced leaf area of Monstera obliqua. Low concentrations of both Cycocel and Maleic hydrazide also reduced leaf area compared to untreated plants. Application of B-9 at 1000 ppm enhanced leaf area of Monstera obliqua.

Treatment with Maleic hydrazide significantly reduced the area of leaves of Syngonium podophyllum 'White Butterfly' and Peperomia obtusifolia, and maximum reduction of leaf area was obtained with the highest concentration of Maleic hydrazide both in Syngonium podophyllum 'White Butterfly' and Peperomia obtusifolia.

Leaf area in case of Pleomele reflexa was significantly reduced by the application of Cycocel at 4000 ppm compared to rest of the treatment used in this experiment. The area of leaves slightly increased when plants were treated with Cycocel and B-9 both at 1000 and 2000 ppm.

Number of branches or plantlets: It is evident from the Table-18 that the number of branches or plantlets increased significantly with the increasing concentration of growth retarding chemicals. Branches of Peperomia obtusifolia was markedly influenced by the application of Maleic hydrazide and the maximum number of branches were obtained when plants were treated with the highest concentration of Maleic hydrazide (4000 ppm). Application of B-9 at 4000 ppm produced maximum number of branches in case of Syngonium podophyllum 'White Butterfly'.

Colour grade: Foliage colour grade of seven plant species was influenced under different treatments used in this experiment. Application of Cycocel, B-9 and Maleic hydrazide caused intensification of foliage colour in all plant species and are presented in Table 15 to 18. It was observed that treated plants produced darker green foliage as compared to untreated plants. Colour grades of leaves of most of the plant species were better with the increasing concentrations of growth retarding chemicals.

Plant grade: Plants treated with Cycocel, B-9 and Maleic hydrazide had improved quality of plants. Better quality of plants were obtained when plants were treated with highest concentration (4000 ppm) of all growth retarding chemicals used in this experiment. Untreated plants were of poor quality of plants in most of the plant species compared to treated plants.

Table-15 Effect of growth retardants on growth and development of *Aglaonema commutatum* 'Treubii' and *Calathea zebrina*.

Treatments (ppm)	Plant height (cm)	No.of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Colour grade	Plant grade
1	2	3	4	5	6	7	8
			Aglaonema commutatum 'Treubii'				
CCC 1000	44.20	14.80	29.05	3.70	90.81	3.40	3.00
CCC 2000	38.74	12.80	26.17	3.41	57.49	3.80	3.20
CCC 4000	37.80	12.20	24.77	3.52	46.98	3.80	4.00
B_9 1000	45.10	14.80	28.19	3.54	90.64	3.00	3.40
B_9 2000	34.80	13.80	23.13	3.03	66.71	3.40	3.80
B_9 4000	34.62	13.60	22.23	3.01	45.44	4.20	4.40
MH 1000	42.38	15.40	27.69	3.52	59.18	3.40	3.20
MH 2000	35.40	14.20	24.27	3.28	48.79	3.40	3.20
MH 4000	32.86	13.40	20.50	3.03	46.04	4.20	4.40
Control	40.70	15.20	28.58	3.71	60.13	2.20	2.20
S.Em.±	1.86	0.59	1.38	0.15	2.96	0.43	0.37
C.D.at 0.05 P	5.35	1.69	3.96	0.42	8.49	N.S.	1.05

Contd.....

Table-15 Contd....

Treatments (ppm)	Plant height (cm)	No.of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Colour grade	Plant grade
1	2	3	4	5	6	7	8
			Calathea zebrina				
CCC 1000	31.54	9.00	25.00	6.14	67.20	2.60	3.00
CCC 2000	29.12	9.60	22.85	5.57	54.96	3.00	3.40
CCC 4000	26.58	10.20	22.16	5.61	56.60	3.40	3.60
B_9 1000	28.02	10.00	24.50	5.81	57.73	3.00	3.00
B_9 2000	26.92	10.80	24.75	5.33	58.96	3.40	3.20
B_9 4000	26.84	12.80	26.41	5.31	61.29	3.80	3.40
MH 1000	30.78	10.00	25.60	5.99	71.65	3.00	3.40
MH 2000	25.20	12.60	17.80	4.09	53.03	3.80	3.80
MH 4000	19.64	13.20	14.80	4.26	34.98	4.20	4.60
Control	29.26	10.00	25.00	5.47	54.82	2.20	2.60
S.Em.±	1.90	0.97	1.77	0.38	3.09	0.44	0.25
C.D.at 0.05 P	5.49	2.79	5.09	1.10	8.86	N.S.	0.72

N.S. = Not significant

Table-16 Effect of growth retardants on growth and development of *Dieffenbachia maculata* and *Monstera obliqua*

Treatments (ppm)	Plant height(cm)	No.of leaves/plant	Leaf length (cm)	Leaf width (cm)	Leaf area(cm^2)	Colour grade	Plant grade
1	2	3	4	5	6	7	8
			Dieffenbachia maculata				
CCC 1000	53.96	10.00	36.14	10.82	215.44	3.00	3.20
CCC 2000	49.42	9.60	32.90	9.52	194.90	3.80	3.60
CCC 4000	49.24	9.40	32.66	9.39	193.36	4.20	4.00
B_9 1000	53.28	9.80	38.01	11.63	218.84	3.40	3.60
B_9 2000	53.04	10.80	37.06	11.59	209.31	3.80	3.80
B_9 4000	43.32	11.00	30.86	9.54	176.76	4.20	3.80
MH 1000	39.02	8.20	29.49	9.55	135.97	3.40	3.60
MH 2000	37.20	7.40	27.60	9.02	123.68	4.20	3.80
MH 4000	34.60	6.80	26.84	8.92	116.70	4.20	4.40
Control	54.12	10.20	38.10	11.75	209.39	2.20	2.80
S.Em.±	1.96	0.77	1.65	0.56	10.62	0.46	0.28
C.D.at 0.05 P	5.64	2.20	4.75	1.62	30.48	N.S.	0.81

Contd.....

Table-16 Contd....

Treatments (ppm)	Plant height(cm)	No.of leaves/plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Colour grade	Plant grade
1	2	3	4	5	6	7	8
			Monstera obliqua				
CCC 1000	37.08	8.40	31.55	9.48	158.08	2.20	3.20
CCC 2000	36.90	8.00	31.28	9.57	160.18	3.00	3.20
CCC 4000	36.20	7.00	32.06	9.88	167.87	3.40	3.80
B_9 1000	42.96	7.80	31.64	10.81	214.56	3.40	3.20
B_9 2000	38.94	7.40	28.11	8.32	137.14	3.40	4.00
B_9 4000	37.00	7.00	28.00	8.29	132.65	3.80	4.40
MH 1000	37.80	8.60	30.15	9.44	152.78	3.40	3.80
MH 2000	35.82	7.40	26.48	7.67	140.49	3.40	4.00
MH 4000	25.72	5.40	22.18	6.44	81.55	4.20	4.40
Control	40.08	8.20	27.63	8.45	166.13	1.80	2.60
S.Em.±	1.63	0.69	1.26	0.59	10.37	0.43	0.29
C.D.at 0.05 P	4.68	2.00	3.63	1.71	29.77	1.24	0.85

Table-17 Effect of growth retardants on growth and development of Pleomele reflexa

Treatments (ppm)	Plant height(cm)	No.of leaves/plant	Leaf length (cm)	Leaf width (cm)	Leaf area(cm^2)	Colour grade	Plant grade
			Pleomele reflexa				
CCC 1000	40.16	36.60	15.68	2.54	30.85	3.00	3.20
CCC 2000	38.18	32.40	15.51	2.36	30.77	3.40	3.40
CCC 4000	33.36	31.20	15.16	1.85	26.27	3.40	3.40
B_9 1000	39.76	34.60	16.27	2.43	31.52	3.00	2.80
B_9 2000	35.56	33.80	15.83	2.38	30.37	3.40	3.60
B_9 4000	34.72	32.80	15.39	2.33	28.09	3.80	4.20
MH 1000	39.76	37.40	15.79	2.40	30.60	3.00	3.20
MH 2000	34.56	36.60	15.70	2.34	28.22	3.80	4.00
MH 4000	35.02	35.80	15.16	2.11	27.65	3.80	4.40
Control	36.04	31.20	15.77	2.43	29.95	2.20	2.60
S.Em.±	1.37	1.32	0.36	0.13	0.91	0.37	0.35
C.D.at 0.05 P	3.95	3.79	N.S.	0.37	2.61	N.S.	0.99

N.S. = Not significant

Table-18 Effect of growth retardants on growth and development of *Peperomia obtusifolia* and *Syngonium podophyllum* 'White Butterfly'.

Treatments (ppm)	Plant height(cm)	No.of leaves/plant	Leaf length (cm)	Leaf width (cm)	Leaf area(cm^2)	No.of branches/ plant	Colour grade	Plant grade
1	2	3	4	5	6	7	8	9
			Peperomia obtusifolia					
CCC 1000	34.90	39.60	9.78	5.72	32.08	3.40	2.60	3.00
CCC 2000	33.24	34.00	9.58	5.52	31.48	3.40	3.80	3.60
CCC 4000	31.60	33.40	8.93	4.91	27.65	3.60	4.20	3.80
B_9 1000	34.30	25.60	9.63	5.60	30.99	2.80	3.00	3.40
B_9 2000	33.85	31.00	9.43	5.35	29.30	3.60	3.40	3.80
B_9 4000	31.90	34.60	9.39	5.37	29.06	4.20	3.80	4.00
MH 1000	35.38	42.20	10.08	5.16	28.33	5.60	3.00	3.60
MH 2000	33.40	45.40	9.93	5.08	27.37	5.20	3.40	4.40
MH 4000	27.64	45.60	9.75	4.83	22.08	6.00	4.60	4.60
Control	34.26	31.60	10.72	5.26	30.48	2.80	2.20	2.40
S.Em.±	1.44	1.87	0.38	0.24	1.14	0.54	0.49	0.30
C.D.at 0.05 P	4.14	5.36	N.S.	N.S.	3.28	1.56	1.40	0.86

Contd.....

Table-18 Contd...

Treatments (ppm)	Plant height(cm)	No.of leaves/plant	Leaf length(cm)	Leaf width (cm)	Leaf area(cm^2)	No.of branches/plant	Colour grade	Plant grade
1	2	3	4	5	6	7	8	9
			Syngonium podophyllum 'White Butterfly'					
CCC 1000	31.54	25.40	21.15	7.08	59.55	3.00	2.20	2.60
CCC 2000	31.34	25.60	20.75	6.41	58.25	3.00	2.40	2.80
CCC 4000	28.64	29.80	20.34	6.38	58.01	4.00	2.40	3.20
B_9 1000	29.62	30.40	22.50	6.51	62.43	3.80	2.40	3.00
B_9 2000	25.22	30.80	22.45	6.60	65.14	4.20	2.80	3.60
B_9 4000	25.28	38.40	25.05	6.76	66.81	5.40	3.60	4.40
MH 1000	33.08	27.00	21.85	6.28	53.07	2.80	2.60	2.80
MH 2000	26.28	26.00	20.68	6.00	52.50	3.40	3.00	3.40
MH 4000	20.96	23.20	18.50	5.57	51.54	4.20	4.00	3.80
Control	31.54	21.80	22.00	6.96	66.26	2.80	1.60	2.40
S.Em.±	1.31	1.62	0.96	0.24	2.77	0.51	0.32	0.26
C.D.at 0.05 P	3.76	4.65	2.76	0.70	7.95	1.48	0.93	0.76

N.S. = Not significant

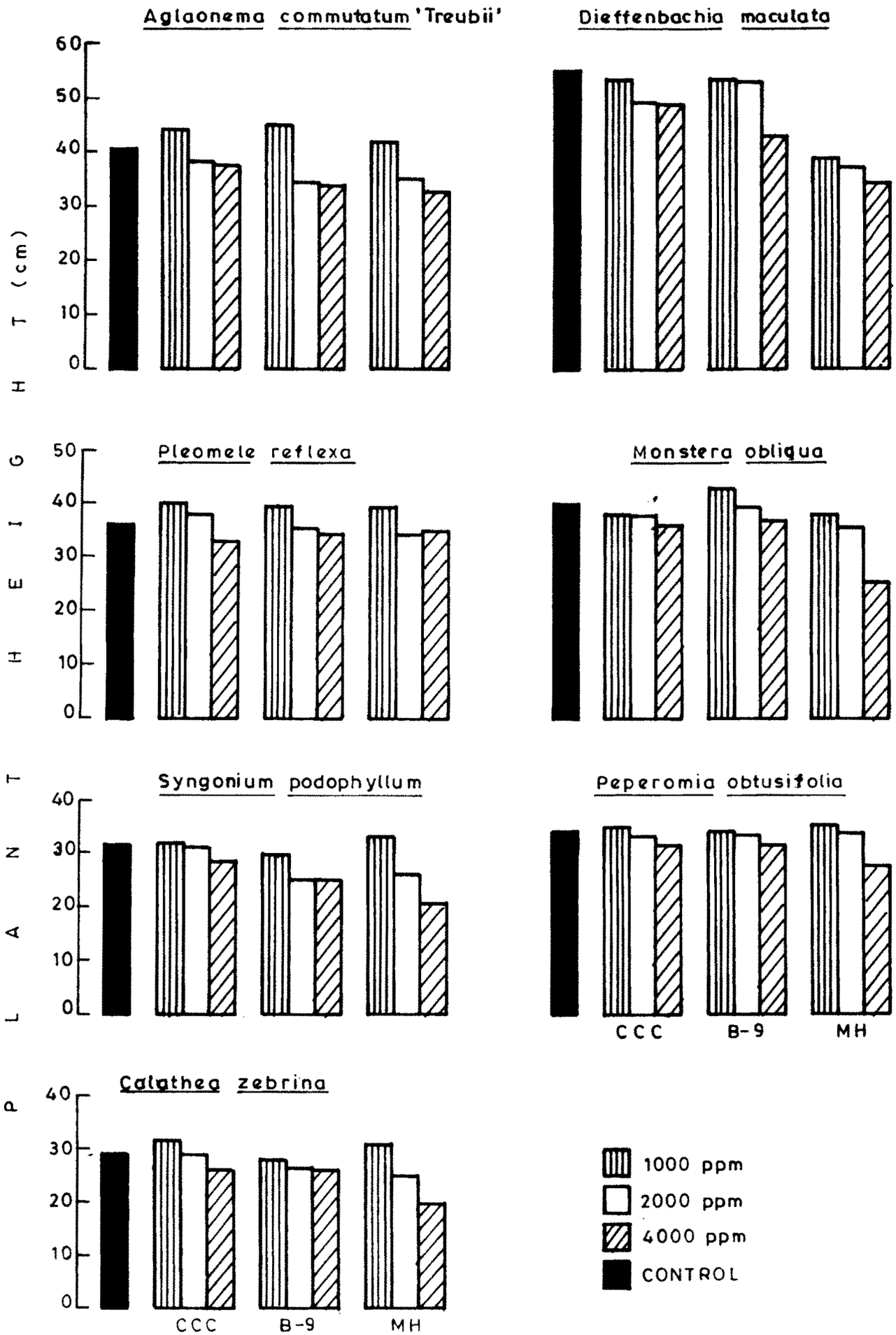


FIG.6: EFFECT OF GROWTH RETARDANTS ON PLANT HEIGHT OF SOME HOUSE PLANTS

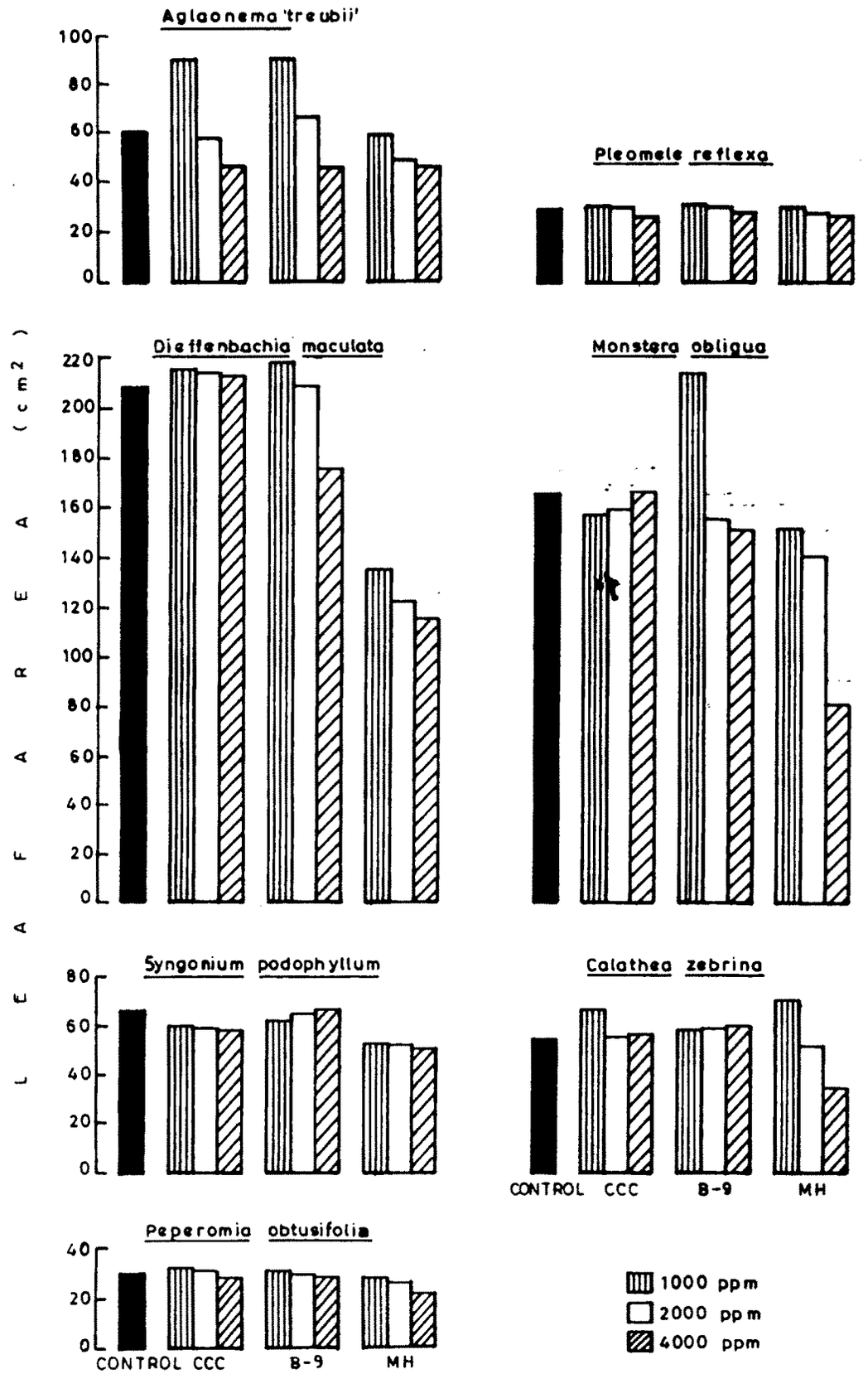


FIG.7. EFFECT OF GROWTH RETARDANTS ON LEAF AREA OF SOME HOUSE PLANTS

Experiment 4.1.1.4 Influence of irrigation frequency on growth and development of house plants.

Effect of irrigation frequency on house plants appeared to be variable under different treatments used in this investigation.

Height of the plant: Pronounced variations in plant heights were observed due to different water regimes. Regular application of water remarkably improved the plant height of Aglaonema commutatum 'Treubii', Calathea zebrina, Dieffenbachia maculata, Monstera deliciosa, M.pertusa, Pleomele reflexa 'Song of India' and Syngonium podophyllum 'White Butterfly' (Table -19 to 22; Fig.8; Plate-6 and 7). The height of plants were markedly suppressed when the plants were grown under maximum water stress condition (i.e.watering at 4 days interval). In case of Aglaonema commutatum 'Silver Queen', Chlorophytum comosum 'Variegatum' and Peperomia obtusifolia watering at one day interval increased plant height significantly compared to rest of the treatments. Gradual reduction in plant height was noted when plants were irrigated with wider frequencies in all plant species used in this experiment.

Number of leaves: As regards to leaf production of house plants, frequency of irrigation played important role in house plants. Significant differences were recorded when plants were cultivated under different levels of soil moisture condition. Maximum production of leaves were obtained when the plants were irrigated

daily in case of Aglaonema commutatum 'Treubii', Calathea zebrina, Dieffenbachia maculata, Monstera deliciosa, M.pertusa, Pleomele reflexa 'Song of India' and Syngonium podophyllum 'White Butterfly'. In case of Aglaonema commutatum 'Silver Queen', Chlorophytum comosum 'Variegatum' and Peperomia obtusifolia, on the other hand, produced maximum number of leaves when plants were watered at one day interval. The number of leaves per plant were 21.2, 51.4 and 16.6 in Aglaonema commutatum 'Silver Queen', Chlorophytum comosum 'Variegatum' and Peperomia obtusifolia respectively when plants were watered at one day interval. Markedly lesser number of leaves per plant (13.6, 30.4 and 9.6) were observed when plants were grown under maximum water stress condition (Table -19 and 21, Fig.8).

Length of leaves: It is evident from the data presented in the Table 19 to 22 that the frequency of irrigation had marked influences on leaf length of Aglaonema commutatum 'Treubii', Calathea zebrina, Dieffenbachia maculata, Monstera deliciosa, M.pertusa, Pleomele reflexa 'Song of India' and Syngonium podophyllum 'White Butterfly'. Similar trends in leaf growth were recorded as noted in case of number of leaves per plant. The largest leaf was obtained when plants were watered regularly. A significant increase in leaf length was obtained when plants of Aglaonema commutatum 'Silver Queen', Chlorophytum comosum 'Variegatum' and Peperomia obtusifolia were irrigated at one day interval. The length of leaf was considerably reduced when plants were watered at 4 days interval.

Width of leaves; The width of leaf was markedly influenced by the frequency of irrigation. Maximum width of leaves were obtained by daily application of water in Aglaonema commutatum 'Treubii' Calathea zebrina, Dieffenbachia maculata, Monstera deliciosa, M.pertusa, Pleomele reflexa 'Song of India' and Syngonium podophylum 'White Butterfly'. Irrigation at one day interval significantly increased the width of leaves of Aglaonema commutatum 'Silver Queen' and Peperomia obtusifolia as compared to rest of the treatments. Width of leaves in Chlorophytum comosum 'Variegatum' did not show any such response under different irrigation frequencies.

Area of leaves: Area of leaves in house plants largely depended on frequency of watering. Maximum leaf areas in Aglaonema commutatum 'Treubii', Calathea zebrina, Dieffenbachia maculata, Monstera deliciosa, M. pertusa, Pleomele reflexa 'Song of India' and Syngonium podophyllum 'White Butterfly' were obtained by the application of irrigation regularly. But in case of Aglaonema commutatum 'Silver Queen' and Peperomia obtusifolia maximum area of leaves were obtained when plants were irrigated at one day interval. Various frequencies of watering did not show marked response on the area of leaves in Chlorophytum comosum 'Variegatum'. However, plants irrigated at wider interval had reduced leaf area.

Number of plantlets or branches: As evident from Table 21

and 22 the number of branches or plantlets were markedly influenced by the soil moisture level. In case of Calathea zebrina,no plantlet was produced under water stress condition (i.e.4 days interval). Maximum number of plantlets in Chlorophytum comosum 'Variegatum' were produced at one day interval. Maximum branches of Peperomia obtusifolia were also obtained under similar irrigation frequency. A significant increase in number of branches in Syngonium podophyllum 'White Butterfly' was obtained when plants were raised under increased irrigation frequency.

Colour grade: Colour of foliage largely depended on the freshness and better growth of leaves. The frequency of irrigation significantly influenced the colour grade of all house plants used in this experiment. Syngonium podophyllum 'White Butterfly' on the other hand, did not show significant response with respect to colour grade of foliage. Generally colour grade was greatly intensified with increasing frequency of irrigation. In Chlorophytum comosum 'Variegatum' and Peperomia obtusifolia watering at one day interval influenced the development of better colour of leaves. Daily watering improved the foliage colour of plants and irrigation frequency at 4 days interval showed poor colour of the foliage of all the plants species used in this experiment.

Plant grade: Quality of house plants largely depended on the soil moisture level. There had been significant differences in plant grade under different frequencies of irrigation. Better plant quality could be obtained when plants were watered regularly. Plants showed poor quality of foliage when grown with wider irrigation frequency in most of the house plants. In case of Aglaonema commutatum 'Silver Queen' Chlorophytum comosum 'Variegatum' and Peperomia obtusifolia, better quality of plants were obtained when plants were watered at one day interval.

Table-19 Influence of irrigation frequency on growth and development of *Aglaonema commutatum* 'Treubii', *A.commutatum* 'Silver Queen' and *Dieffenbachia maculata*.

Irrigation frequency (days)	Plant height (cm)	No.of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area (Cm^2)	Colour grade	Plant grade
			Aglaonema commutatum 'Treubii'				
Daily	**36.70**	**12.80**	**24.90**	**3.28**	**47.90**	**4.20**	**4.60**
1	28.68	10.80	20.16	2.86	32.33	4.20	4.20
2	22.90	9.00	16.98	2.48	21.25	3.40	3.40
3	19.74	8.40	14.54	2.28	17.06	2.20	2.00
4	18.98	7.20	13.98	2.24	16.93	1.40	1.20
S.Em.±	1.56	0.80	0.82	0.14	1.66	0.50	0.25
C.D.at 0.05P	4.68	2.40	2.45	0.41	4.97	1.50	0.75
			Aglaonema commutatum 'Silver Queen'				
Daily	57.62	20.40	33.36	5.80	133.10	4.20	4.20
1	65.62	21.20	36.42	5.90	166.58	4.20	4.40
2	53.86	19.80	32.72	5.44	89.83	3.80	3.40
3	43.74	16.20	31.20	4.90	75.89	3.40	2.40
4	29.26	13.60	20.82	3.78	36.16	2.20	1.80
S.Em.±	1.69	1.07	1.52	0.31	5.88	0.43	0.29
C.D.at 0.05P	5.09	3.21	4.55	0.92	17.65	1.30	0.86
			Dieffenbachia maculata				
Daily	36.20	6.00	24.82	7.24	103.18	4.60	4.60
1	29.22	5.40	21.02	6.04	73.43	4.60	4.40
2	28.30	4.80	20.60	6.02	68.04	3.80	3.20
3	27.20	4.20	18.72	5.84	55.14	2.20	2.80
4	20.70	1.80	15.64	4.12	34.14	1.40	1.40
S.Em.±	1.81	0.48	1.19	0.50	7.15	0.46	0.22
C.D.at 0.05P	5.43	1.45	3.58	1.50	21.44	1.38	0.65

Table-20 Influence of irrigation frequency on growth and development of Monstera deliciosa, M.pertusa and Pleomele reflexa 'Song of India'.

Irrigation frequency (days)	Plant height (cm)	No.of leaves/plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Colour grade	Plant grade
			Monstera deliciosa				
Daily	122.88	13.20	41.56	16.32	311.08	4.60	4.40
1	116.12	12.20	40.78	15.74	292.71	4.20	3.80
2	87.32	10.40	39.78	14.04	219.42	2.60	3.60
3	74.28	9.20	39.50	13.88	177.27	2.20	3.40
4	50.82	6.80	35.50	13.20	153.00	1.80	2.00
S.Em.±	4.41	0.72	1.08	0.72	18.81	0.48	0.25
C.D.at 0.05P	13.24	2.16	3.26	2.16	56.41	1.44	0.75
			Monstera pertusa				
Daily	51.94	12.20	24.28	8.94	68.73	4.60	4.60
1	44.50	10.20	19.02	5.94	54.36	4.20	4.40
2	37.12	8.20	16.34	4.82	52.78	3.40	3.60
3	35.90	6.60	15.48	4.70	47.14	2.60	2.40
4	34.10	5.60	10.72	3.88	36.46	1.40	1.60
S.Em.±	2.55	0.94	1.07	0.36	3.81	0.45	0.23
C.D.at 0.05P	7.66	2.83	3.20	1.09	11.43	1.37	0.68
			Pleomele reflexa 'Song of India'				
Daily	27.64	28.60	14.00	1.88	24.10	4.60	4.80
1	26.80	26.40	13.92	1.86	20.78	4.20	4.20
2	25.38	25.60	13.90	1.82	18.93	3.40	3.80
3	25.20	20.60	10.72	1.64	14.24	1.80	2.20
4	23.00	17.00	10.62	1.52	13.86	1.40	1.40
S.Em.±	1.02	1.44	0.85	0.09	2.23	0.48	0.26
C.D.at 0.05P	3.05	4.33	2.54	0.29	6.69	1.44	0.77

Table-21 Influence of irrigation frequency on growth and development of *Calathea zebrina*, *Chlorophytum comosum*, 'Variegatum' and *Peperomia obtusifolia*.

Irrigation frequency (days)	Plant height (cm)	No.of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	No.of plant-lets/ plant	Colour grade	Plant grade
			Calathea zebrina					
Daily	25.72	11.60	20.64	5.42	47.57	1.60 (1.43)	4.60	4.60
1	22.00	7.40	16.86	3.98	28.86	1.40 (1.36)	4.20	4.40
2	19.52	7.20	16.28	3.92	26.58	1.20 (1.29)	3.40	3.40
3	18.40	6.20	15.82	3.88	26.17	0.80 (1.12)	2.60	2.40
4	11.20	2.80	8.44	2.76	15.37	0.00 (0.71)	1.40	1.60
S.Em.±	2.13	0.83	0.90	0.21	2.91	0.08	0.43	0.26
C.D.at 0.05P	6.39	2.51	2.70	0.62	8.74	0.25	1.30	0.77
			Chlorophytum comosum 'Variegatum'					
Daily	25.20	36.80	18.30	0.98	19.13	3.80	4.20	4.00
1	26.66	51.40	21.20	0.98	19.55	7.40	4.60	4.60
2	25.72	37.60	20.84	0.94	19.42	5.80	3.40	3.60
3	25.28	30.80	20.80	0.92	17.60	4.60	2.20	2.40
4	24.40	30.40	20.46	0.92	18.09	2.80	1.00	1.60
S.Em.±	1.12	2.08	0.91	0.06	0.92	0.95	0.41	0.27
C.D.at 0.05P	3.35	6.25	2.73	N.S.	N.S.	4.87	1.24	0.81
			Peperomia obtusifolia					
Daily	28.22	15.40	8.96	5.08	31.77	2.20	3.80	4.00
1	29.26	16.60	9.80	5.12	33.02	2.80	4.20	4.40
2	23.22	14.80	7.98	4.80	27.76	1.80	2.60	3.20
3	22.50	12.20	7.70	4.80	22.54	1.40	1.80	2.60
4	17.20	9.60	6.86	4.32	17.61	1.00	1.40	1.40
S.Em.±	2.26	0.87	0.27	0.09	1.81	0.26	0.46	0.28
C.D.at 0.05P	6.77	2.60	0.81	0.28	5.42	0.77	1.37	0.85

N.S. = Not significant

Figures in parentheses indicate the square root transformed values.

Table-22 Influence of irrigation frequency on growth and development of Syngonium podophyllum 'White Butterfly'

Irrigation frequency (days)	Plant height (cm)	No.of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	No.of branches/ plant	Colour grade	Plant grade
		Syngonium podophyllum 'White Butterfly'						
Daily	32.86	31.80	20.90	6.90	60.86	3.60	3.80	4.40
1	31.62	31.20	20.50	6.86	60.61	3.20	3.20	4.20
2	27.24	18.40	20.34	6.42	52.26	2.60	3.00	3.60
3	26.08	16.60	20.10	6.06	42.08	2.40	2.80	2.60
4	18.40	16.20	12.72	4.26	25.40	2.00	2.20	1.40
S.Em.±	1.93	2.55	1.76	0.36	3.93	0.33	0.54	0.22
C.D.at 0.05P	5.80	7.65	5.29	1.08	11.79	1.00	N.S.	0.66

N.S. = Not significant

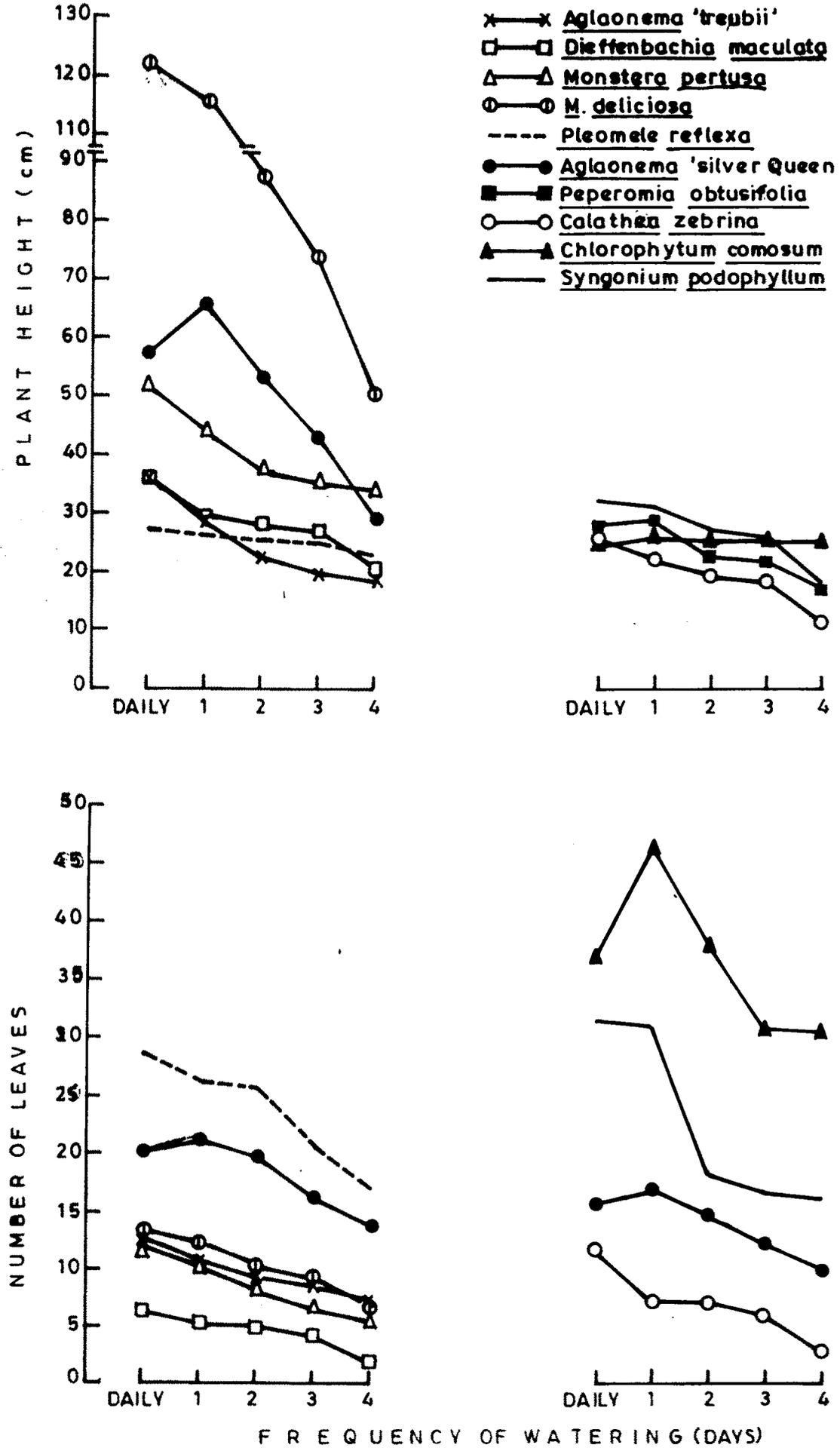


FIG.8: INFLUENCE OF IRRIGATION FREQUENCY ON PLANT HEIGHT AND LEAF NUMBER OF HOUSE PLANTS.



Aglaonema commutatum 'Treubii'



Dieffenbachia maculata



Monstera pertusa

Plate No.6 Influence of irrigation frequency on growth and Development of Aglaonema commutatum 'Treubii', Dieffenbachia maculata and Monstera pertusa.



Calathea zebrina



Chlorophytum comosum 'Variegatum'



Pleomele reflexa 'Song of India'



Syngonium podophyllum 'White Butterfly'

Plate No.7 Influence of irrigation frequency on growth and development of Calathea zebrina, Chlorophytum comosum 'Variegatum', Pleomele reflexa 'Song of India' and Syngonium podophyllum 'White Butterfly'

Experiment 4.1.1.5 Effect of different types of container on growth and development of house plants.

Responses of different house plants to different types of pots were recorded.

Height of the plant: Plant heights of Aglaonema commutatum 'Silver Queen', Calathea zebrina, Chlorophytum comosum 'Variegatum', Dieffenbachia maculata, Monstera deliciosa, Scindapsus aureus 'Marble Queen' and Syngonium podophyllum 'Variegatum' were maximum when plants were grown in plastic pots compared to rest two types of container (Table-23 to 25 and plate 9 to 11). On the other hand, plants grown in wax coated earthen pots produced more plant height in case of Calathea ornata, Cordyline terminalis, Monstera obliqua, and Philodendron erubescens 'Ceylon Gold' as compared to the rest of the treatments. Significant variations in plant height were noted when house plants were grown on different types of pots. Plants when grown in earthen pot were low in plant height compared to those grown in plastic and wax coated earthen pot in all treated house plants.

Number of leaves: Leaf production in Cordyline terminalis, Monstera deliciosa and Philodendron erubescens 'Ceylon Gold' were not significantly affected when plants were grown in different types of pots. Aglaonema commutatum 'Silver Queen' Calathea zebrina, Chlorophytum comosum 'Variegatum', Dieffenbachia maculata, Peperomia obtusifolia, Scindapsus aureus 'Marble

Queen' and Syngonium podophyllum 'Variegatum' produced maximum number of leaves when plants were grown in plastic pots followed by plants grown in wax coated earthen pot. Plants grown in wax coated earthen pot produced maximum number of leaves in Calathea ornata, Monstera obliqua and Philodendron erubescens 'Ceylon Gold'.

Length of leaves: Data presented in Table -23 to 25 indicate that the length of leaves of Aglaonema commutatum 'Silver Queen' Calathea zebrina, Chlorophytum comosum 'Variegatum', Dieffenbachia maculata, Monstera deliciosa and Scindapsus aureus 'Marble Queen' significantly increased when plants were grown in plastic pot, whereas in case of Cordyline terminalis, Monstera obliqua and Philodendron erubescens 'Ceylon Gold' maximum leaf lengths were recorded when plants were grown in wax coated earthen pot. The leaf lengths were more when plants were grown on plastic pot in case of Calathea ornata, Peperomia obtusifolia, and Syngonium podophyllum 'Variegatum'. Reduction in leaf size was noted when plants were grown in earthen pots.

Width of leaves: Aglaonema commutatum 'Silver Queen', Calathea ornata, C.zebrina, Dieffenbachia maculata, Monstera deliciosa, M.obliqua, Scindapsus aureus 'Marble Queen' and Syngonium podophyllum 'Variegatum' produced wider leaves when grown in plastic pots (Table -23 to 25). Plants grown in wax coated earthen pots also produced greater width of leaves in Calathea ornata and Cordyline terminalis. No significant variations in leaf width of Chlorophytum comosum 'Variegatum', Peperomia

obtusifolia and Philodendron erubescens 'Ceylon Gold' were noted under different treatments.

Area of leaves: Leaf area of house plants were also significantly influenced by the use of different types of containers. Maximum area of leaves in Aglaonema commutatum 'Silver Queen', Calathea zebrina, Chlorophytum comosum 'Variegatum', Dieffenbachia maculata, Monstera deliciosa, Peperomia obtusifolia, Scindapsus aureus 'Marble Queen' and Syngonium podophyllum 'Variegatum' occurred when plants were grown in plastic pots followed by wax coated earthen pots (Table - 23 to 25). Calathea ornata, Cordyline terminalis, Monstera obliqua and Philodendron erubescens 'Ceylon Gold', on the other hand, produced maximum area of leaves when plants were grown in wax coated earthen pots.

Number of plantlets or branches: Plantlets or branches production of Calathea ornata, C.zebrina, Chlorophytum comosum 'Variegatum' and Peperomia obtusifolia were studied during the period of investigation. Maximum number of plantlets were produced when plants were grown in plastic containers. In case of Calathea zebrina, though no significant variation was obtained when plants were grown in different types of containers but slight variations were recorded among the treatments. Plants grown in plastic pots were able to produce greater number of plantlets in Calathea ornata and Chlorophytum comosum 'Variegatum' compared to rest of the treatments. Peperomia

obtusifolia also produced maximum number of branches when grown in plastic containers.

Colour grade: As regards to colour intensity of foliage, no marked influence was recorded among the containers used in this experiment. Plastic pots caused better colour grades compared to earthen pots.

Plant grade: There was no significant effect on plant grade of Chlorophytum comosum 'Variegatum', Dieffenbachia maculata and Syngonium podophyllum 'Variegatum', however, the best plant grade was obtained when plants were grown in plastic pot. Most of the house plants used in the experiment except above mentioned three plant species showed best plant grade, when grown in plastic pots and in earthen pots plant grade was lower.

Table-23 Effect of different types of container on growth and development of *Aglaonema commutatum* 'Silver Queen', *Cordyline terminalis*, *Dieffenbachia maculata* and *Monstera deliciosa*.

Treatments	Plant height (cm)	No.of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Colour grade	Plant grade
			Aglaonema commutatum 'Silver Queen'				
Plastic pot	21.24	8.28	15.75	3.01	40.00	3.86	4.00
Wax coated earthen pot	17.52	7.71	13.94	2.85	27.82	3.57	3.71
Earthen pot	17.12	6.85	12.57	2.52	24.46	2.71	2.71
S.Em.±	0.65	0.34	0.54	0.11	1.84	0.32	0.11
C.D.at 0.05P	2.01	1.06	1.65	0.34	5.69	N.S.	0.33
			Cordyline terminalis				
Plastic pot	60.02	37.57	17.45	2.60	42.01	4.14	4.00
Wax coated earthen pot	61.65	37.71	19.61	2.90	51.78	3.57	3.86
Earthen pot	44.50	36.14	16.84	2.30	32.32	2.71	3.00
S.Em.±	2.42	1.12	0.81	0.12	3.97	0.41	0.26
C.D.at 0.05P	7.47	N.S.	2.50	0.35	12.25	N.S.	0.82
			Dieffenbachia maculata				
Plastic pot	59.04	9.28	39.48	12.24	270.93	4.14	4.43
Wax coated earthen pot	55.44	8.00	37.38	11.45	260.15	3.86	4.00
Earthen pot	51.74	7.42	33.48	10.70	195.95	3.28	3.57
S.Em.±	1.33	0.38	1.29	0.22	13.59	0.31	0.22
C.D.at 0.05P	4.09	1.19	3.99	0.66	41.90	N.S.	N.S.
			Monstera deliciosa				
Plastic pot	61.55	9.42	33.48	11.90	251.41	4.43	4.14
Wax coated earthen pot	55.71	8.85	33.21	11.57	209.11	3.86	3.71
Earthen pot	49.37	8.57	30.75	11.11	183.32	3.28	3.28
S.Em.±	1.46	0.36	0.32	0.19	10.27	0.37	0.20
C.D.at 0.05 P	4.51	N.S.	1.56	0.58	31.64	N.S.	0.62

N.S. = Not significant

Table-24 Effect of different types of container on growth and development of *Monstera obliqua*, *Philodendron erubescens* 'Ceylon Gold', *Syngonium podophyllum* 'Variegatum' and *Scindapsus aureus* 'Marble Queen'.

Treatments	Plant height (cm)	No.of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area(cm^2)	Colour grade	Plant grade
			Monstera obliqua				
Plastic pot	44.27	8.00	32.61	10.32	207.11	3.86	3.86
Wax coated earthen pot	47.78	8.10	33.60	10.11	215.57	3.86	4.00
Earthen pot	32.67	5.40	24.77	7.65	114.80	2.43	2.86
S.Em.±	2.47	0.49	1.55	0.63	11.74	0.37	0.23
C.D.at 0.05 P	7.63	1.52	4.80	1.94	36.18	1.15	0.72
			Philodendron erubescens 'Ceylon Gold'				
Plastic pot	52.90	12.28	28.14	7.70	115.03	3.86	4.00
Wax coated earthen pot	53.01	12.57	29.90	8.24	124.77	3.86	4.00
Earthen pot	48.54	11.57	26.88	7.55	102.56	2.71	3.28
S.Em.±	1.27	0.54	0.67	0.23	4.95	0.29	0.19
C.D.at 0.05 P	3.93	N.S.	2.07	N.S.	15.27	0.90	0.58
			Syngonium podophyllum 'Variegatum'				
Plastic pot	204.64	24.42	25.80	15.10	88.61	3.86	3.43
Wax coated earthen pot	188.14	23.00	25.94	13.80	77.60	3.86	3.28
Earthen pot	152.00	19.42	24.31	12.37	76.81	3.00	2.86
S.Em.±	9.62	0.71	0.75	0.39	2.21	0.42	0.20
C.D.at 0.05 P	29.64	2.20	N.S.	1.22	6.82	N.S.	N.S.
			Scindapsus aureus 'Marble queen'				
Plastic pot	83.35	28.28	16.87	6.98	73.11	4.43	4.28
Wax coated earthen pot	58.80	21.42	15.98	5.68	56.86	3.86	3.86
Earthen pot	57.97	21.28	14.14	5.45	50.18	3.28	3.14
S.Em.±	4.17	1.70	0.45	0.27	2.88	0.26	0.28
C.D.at 0.05 P	12.85	5.25	1.40	0.85	8.88	0.82	0.86

N.S. = Not significant

Table-25 Effect of different types of container on growth and development of *Calathea zebrina*, *C.ornata*, *Chlorophytum comosum* 'Variegatum' and *Peperomia obtusifolia*.

Treatments	Plant height (cm)	No.of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	No.of plant-lets/ plant	Colour grade	Plant grade
			Calathea zebrina					
Plastic pot	27.38	14.57	25.04	8.64	99.09	2.42	4.43	4.28
Wax coated earthen pot	26.72	12.71	22.71	7.61	97.97	2.14	3.86	3.71
Earthen pot	21.94	11.71	20.20	7.20	71.78	1.85	3.57	3.14
S.Em.±	0.76	0.55	0.71	0.28	6.58	0.18	0.43	0.20
C.D.at 0.05 P	2.33	1.68	2.19	0.87	20.27	N.S.	N.S.	0.62
			Chlorophytum comosum 'Variegatum'					
Plastic pot	30.24	62.42	26.97	1.21	26.51	7.14	4.14	3.86
Wax coated earthen pot	28.11	61.00	22.14	1.15	22.85	6.71	3.86	3.57
Earthen pot	24.84	42.42	20.02	1.12	19.14	5.00	3.00	3.14
S.Em.±	1.05	4.41	1.35	0.05	1.29	0.52	0.44	0.25
C.D.at 0.05 P	3.25	13.61	4.15	N.S.	3.98	1.59	N.S.	N.S.
			Calathea ornata					
Plastic pot	26.24	13.00	20.60	5.14	79.44	3.00	3.86	3.28
Wax coated earthen pot	28.98	13.30	21.37	5.60	80.95	2.42	3.86	4.14
Earthen pot	24.95	10.50	20.11	5.01	60.99	1.71	2.71	2.86
S.Em.±	0.92	0.59	1.46	0.14	4.85	0.27	0.34	0.23
C.D.at 0.05 P	2.85	1.82	N.S.	0.43	14.95	0.83	N.S.	0.72
			Peperomia obtusifolia					
Plastic pot	20.65	30.00	8.95	5.65	33.96	6.14	4.14	4.43
Wax coated earthen pot	18.37	23.14	8.97	5.55	30.46	4.57	3.57	3.71
Earthen pot	18.64	21.42	9.17	5.47	23.16	4.71	3.00	3.43
S.Em.±	1.07	1.66	0.31	0.27	0.70	0.34	0.40	0.26
C.D.at 0.05 P	N.S.	5.12	N.S.	N.S.	2.15	1.06	N.S.	0.79

N.S. = Not significant





Cordyline terminalis

Scindapsus aureus 'Marble Queen'



Dieffenbachia maculata

Plate No.8 Effect of different types of container on growth and development of Cordyline terminalis, Dieffenbachia maculata and Scindapsus aureus 'Marble Queen'



Calathea zebrina



Chlorophytum comosum 'Variegatum'



Monstera obliqua

Plate No.9 Effect of different types of container on growth and development of Calathea zebrina, Chlorophytum comosum 'Variegatum' and Monstera obliqua.



Philodendron erubescens 'Ceylon Gold'



Monstera deliciosa

Plate No.10 Effect of different types of container on growth and development of Philodendron erubescens 'Ceylon Gold' and Monstera deliciosa.

Experiment 4.1.2 Standardization of propagation of house plants.

Experiment 4.1.2.1 Effect of nodal position on the propagation of house plants.

Days required for shoot emergence: Cuttings of Aglaonema commutatum 'Treubii' which were taken from uppermost nodes required longer time to sprout buds whereas bud sprouting was earlier in cutting from lower node (Table-26 and Fig.9a). The top most nodes of Dieffenbachia maculata and Monstera obliqua required more time for bud sprouting and the lower nodes required less time to bud break. However, cuttings from 5th node of Dieffenbachia maculata required about 14 days and cuttings from 6th node of Monstera obliqua required about 16 days to sprout. Gradual increase in the time of sprouting was recorded in case of Dieffenbachia maculata after 5th node and in case of Monstera obliqua after 6th node (Table -27 and 28). Cuttings from 6th node of Philodendron erubescens required about 10 days for shoot emergence where 2nd to 5th nodes produced shoot within 11 days after planting (Table -29 and Fig.9a). Cuttings from 5th nodes of Scindapsus aureus 'Marble Queen' produced early shoot and more time for shoot emergence required towards the basipetal nodes (from 6th to 10th node cuttings). Node cuttings of Syngonium podophyllum 'Variegatum' emerged shoots from 16 to 23 days. However, early sprouting was recorded in cutting taken from 7th node (Table-31 and Fig.9a).

Days required for root emergence: Both in Aglaonema commutatum 'Treubii' and Dieffenbachia maculata no roots were formed in cuttings

from 1st to 3rd nodes from top even after 80 days of planting. In the 4th node cutting of Aglaonema commutatum 'Treubii' roots emerged after 75 days. Early emergence of roots (i.e.32 days) were recorded in 10th node cuttings. It is interesting to note that early root emergence was observed with 5th node cuttings of Dieffenbachia maculata and root emergence was gradually delayed with cuttings from 6th to 10th node and varied from 37 to 48 days after planting (Table-27 and Fig.9b). Monstera obliqua, on the other hand, recorded root emergence upto 10th node cuttings and required 36 days for root emergence. There had been no significant difference in time for root emergence between 4th to 10th node cuttings. Emergence of roots from 1st node was delayed upto 61 days. In case of Philodendron erubescens both 5th and 6th node cuttings showed early emergence of roots. But in 1st and 2nd node cuttings and in 7th to 10th node cuttings root emergence was delayed. Similarly, early root emergence of Scindapsus aureus 'Marble Queen' was noted with 5th node cutting. But it was delayed upto 60 days when 10th node cuttings were used. Immature 1st node cuttings also delayed root formation (Table-30). It is interesting to note that early emergence of roots of Syngonium podophyllum 'Variegatum' was recorded when cuttings were taken from 2nd to 4th node whereas delayed root emergence was observed in mature node cuttings i.e. from 5th to 10th node cuttings.

Length of shoot: A significant variation in shoot growth was noticed due to different nodal positions of the cuttings in case of different house plants used in this experiment (Table -

26 to 31). The length of shoot in Aglaonema commutatum 'Treubii' and Monstera obliqua increased gradually from the upper most first node cutting to the tenth node cutting (Plate 11&12). It varied from 1.08 to 10.93 cm in plant height in case of Aglaonema commutatum 'Treubii' and the shoot growth of Monstera obliqua varied from 2.43 to 22.33 cm. Maximum shoot length in Dieffenbachia maculata and Philodendron erubescens were recorded with 6th node cuttings. Reduction in shoot growth was observed with immature node cutting (i.e.1st node) but shoot growth slowly increased with mature nodes. The growth of shoot was slightly reduced in cuttings from 8th to 10th node compared to cuttings from 6th node. In Scindapsus aureus 'Marble Queen' maximum length of shoot was recorded in 5th node cutting and the length of shoot decreased gradually upto 10th node cutting. However, in case of Syngonium podophyllum 'Variegatum' length of shoot did not show any distinct variation in cuttings from 3rd to 10th node. Marked reduction in shoot growth was, however, noted in 1st and 2nd node cuttings.

Number of leaves: No marked variation in leaf number was recorded in the different node cuttings of Aglaonema commutatum 'Treubii'. Tenth node cutting produced two leaves after 80 days of planting. Gradual increase in leaf production was noticed from 1st to 6th node cutting and more than two leaves were observed on 6th node cuttings of Dieffenbachia maculata. In case of Monstera obliqua gradual increase in leaf number was recorded upto the 6th node

cutting. No variation in leaf number was recorded from 6th to 10th node cutting. Node cuttings of Philodendron erubescens behaved differently and leaf number increase with node maturity. The leaf growth was suppressed in case of 1st and 2nd node cuttings as compared to the rest. Maximum number of leaves were recorded with 5th node cutting in case of Scindapsus aureus 'Marble Queen' and with 6th node cutting in case of Syngonium podophyllum 'Variegatum', though no significant variation in leaf number occurred between the different nodal positions.

Length of roots: The uppermost 1st to 3rd node cuttings of Aglaonema commutatum 'Treubii' and Dieffenbachia maculata did not produce any roots within 80 days after planting of cuttings. Marked variations in the length of roots were recorded from 4th to 10th node cuttings. The length of root was gradually increased from 4th node to 10th node cutting of Aglaonema commutatum 'Treubii' (Table-26). Root length in Dieffenbachia maculata gradually increased from 4th to 6th node cutting and then decreased upto 10th node cutting. The root length was markedly increased in case of Monstera obliqua from 1st to 5th node cutting and then gradually decreased. In Philodendron erubescens , the maximum length of root was obtained with 6th node cutting(Plate-12). Increasing tendency in root growth were noted from 1st to 6th node cuttings and then root growth decreased. In both Scindapsus aureus 'Marble Queen' and Syngonium podophyllum 'Variegatum', the root length steadily increased upto 6th node cutting and

then gradually decreased from 7th to 10th node cutting. Significant variations in root lengths were recorded among the treatments.

Number of primary root: Apical node cuttings (i.e.from 1st to 3rd nodes of Aglaonema commutatum 'Treubii' and Dieffenbachia maculata did not produce roots within 80 days after planting. In Aglaonema commutatum 'Treubii' the number of primary roots gradually increased with the maturity of the node from 4th to 10th node cuttings. But in case of Dieffenbachia maculata the number of primary roots steadily increased upto 6th node and tended to decrease with the maturity of node cuttings. The number of primary roots gradually increased upto 6th node cutting of Monstera obliqua and Philodendron erubescens and subsequently decreased upto 10th node cutting (Table 28 and 29; Fig.10b). No variation in the root number was recorded between 7th to 10th node cuttings of Monstera obliqua. Number of primary roots of Scindapsus aureus 'Marble Queen' and Syngonium podophyllum 'Variegatum' were not significantly influenced by the difference in the nodal position of the cuttings. However, the number of primary root increased from 1st to 6th node cuttings and thereafter the number of roots decreased.

Number of secondary roots: The maximum number of secondary roots were noted in 6th node cuttings of Dieffenbachia maculata and Philodendron erubescens. The trend in secondary root production was similar to that of primary root production. In Monstera obliqua the number of secondary roots gradually increased from 1st to 5th node and then decreased basipetally. Similarly in case of

Syngonium podophyllum 'Variegatum' 5th node cutting produced maximum number of secondary roots whereas apical and basal node cutting produced less number of secondary roots.

Percentage of rooting: In Aglaonema commutatum 'Treubii' the maximum percentage of rooting was recorded with 8th node cuttings followed by 9th node cutting. Cuttings from upper node (1st to 3rd) did not produce roots, and 4th and 5th node cuttings had lower percentage of rooting success whereas 6th and 7th node cuttings recorded more than sixty per cent rooting success (Fig.10a). Node cuttings of Dieffenbachia maculata taken from 5th to 7th nodes from top recorded highest percentage (73.33) of rooting success but rooting success subsequently declined with lower nodes. Similarly, in case of Monstera obliqua 1st and 2nd node cuttings showed lower percentage of rooting success whereas cent percent rooting was obtained with 5th and 6th node cuttings. The node cuttings from lower nodes (i.e.from 7th to 10th) also had more than 90 per cent rooting success. Sixth node cutting of Philodendron erubescens produced maximum percentage (83.33) of rooting followed by 7th node cutting and rooting success gradually decreased upto 10th node cutting. First node cutting, however, showed lowest percentage (26.67) of rooting success. Cuttings of Scindapsus aureus 'Marble Queen' produced highest percentage of rooting success both in case of 4th and 5th node cuttings and percentage of rooting gradually decreased upto 10th node cutting. Rooting success was less in cuttings from 1st to 3rd node cuttings. Maximum percentage of rooting success occurred with 6th and 7th

node cuttings of Syngonium podophyllum 'Variegatum' followed by 5th, 8th and 9th node cuttings. Both immature and mature node cuttings showed poor percentage of rooting. Similar trend in percentage of rooting was recorded in most of the plant species used in this experiment whereas 5th to 7th nodal cuttings responded well in regenerating roots.

Fresh and dry weight of shoot: Fresh and dry weights of shoots varied significantly with difference in maturity in nodal cuttings in case of Aglaonema commutatum 'Treubii'. Fresh and dry weights of shoot gradually increased from 1st to 10th node cutting of Aglaonema commutatum 'Treubii'. In case of Dieffenbachia maculata, Philodendron erubescens, Scindapsus aureus 'Marble Queen' and Syngonium podophyllum 'Variegatum'fresh and dry weights of shoots were maximum in case of 6th node cuttings and gradually decreased from 7th to 10th node cutting. In contrast, fresh and dry weights of shoots were lowest in 1st node cutting of Monstera obliqua and then gradually increased with maturity of nodes. Maximum fresh and dry weights of shoot were obtained in the 10th node cutting (Table-28).

Fresh and dry weight of root: As regards to fresh and dry weight of roots of Aglaonema commutatum 'Treubii', it was found that maximum fresh and dry weights of roots were noted with 10th node cutting and the trend in the root weight was similar to that in case of shoot weight (Table-26). In case of Dieffenbachia maculata fresh and dry weights of roots were maximum with 6th node cutting

and thereafter weight of root steadily decreased upto 10th position of node cutting. Monstera obliqua, produced maximum fresh and dry weights of root in case of 9th position of node cuttings followed by 10th node cutting. Cuttings taken from 6th position of nodes produced maximum fresh and dry weight of root in case of Philodendron erubescens followed by 5th node cutting. The 1st node cutting,on the other hand,showed poor root growth. Maximum fresh and dry weights of root in Scindapsus aureus 'Marble Queen' and Syngonium podophyllum 'Variegatum' were obtained with 5th node cuttings.

Experiment-4.1.2.2 Regeneration of plantlets from cuttings with varying number of nodes

Days required for shoot emergence: A significant difference in number of days required for shoot emergence was observed in between cuttings with varying number of nodes in case of Aglaonema commutatum 'Treubii', Dieffenbachia maculata and Philodendron erubescens. In three species of house plants shoot emergence was delayed with one node cuttings as compared to two and three node cuttings. Early emergence of shoot was recorded with three node cuttings compared to one and two node cuttings (Table -32 and 33). In case of Monstera obliqua also one node cutting exhibited delayed shoot emergence compared to two and three node cuttings; though no significant differences were recorded among the treatments.

Table-26 Effect of nodal position on regeneration and growth of Aglaonema commutatum 'Treubii'.

Nodal No.	Days required for shoot emergence	Days required for root emergence	Length of shoot (cm)	No.of leaves	Length of root (cm)	No.of primary root	% of rooting	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root (g)
1	45.00	0	1.08	1.00	0	0	0	0.050	0.006	0	0
2	36.67	0	4.40	1.00	0	0	0	0.200	0.020	0	0
3	36.53	0	4.53	1.00	0	0	0	0.262	0.027	0	0
4	33.53	75.33	5.20	1.00	0.40	0.67	13.33 (21.58)	0.267	0.027	0.035	0.002
5	26.10	68.00	5.63	1.00	1.37	1.00	13.33 (21.58)	0.343	0.034	0.055	0.004
6	25.50	56.33	8.17	1.17	2.30	1.50	63.33 (52.48)	0.520	0.060	0.103	0.006
7	25.67	46.33	8.27	1.17	2.63	1.50	66.67 (54.48)	0.723	0.083	0.130	0.008
8	23.53	39.83	9.53	1.33	2.70	1.60	83.33 (65.75)	0.728	0.080	0.117	0.007
9	20.30	36.33	9.80	1.33	5.12	2.17	80.00 (63.08)	0.893	0.095	0.272	0.017
10	18.27	32.00	10.93	2.00	5.30	2.33	73.33 (58.68)	0.990	0.105	0.280	0.017
S.Em.±	1.15	1.19	0.83	0.10	0.30	0.25	2.36	0.085	0.011	0.027	0.0005
C.D.at 0.05 P	3.42	3.69	2.48	0.29	0.92	0.77	7.27	0.254	0.033	0.083	0.006

Figures in parentheses indicate the angular transformed values.

Table-27 Effect of nodal position on regeneration and growth of Dieffenbachia maculata.

Nodal No.	Days required for shoot emergence	Days required for root emergence	Length of shoot (cm)	No.of leaves	Length of root (cm)	No.of primary root	No.of secondary root	% of rooting	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root (g)
1	31.00	0	2.57	0.40	0	0	0	0	0.092	0.010	0	0
2	25.00	0	4.57	1.00	0	0	0	0	0.203	0.018	0	0
3	20.00	0	7.28	1.00	0	0	0	0	0.483	0.049	0	0
4	19.00	37.67	9.33	1.50	5.70	1.18	14.00	66.67 (54.48)	1.508	0.157	0.675	0.060
5	13.67	36.67	14.90	1.83	11.35	1.33	31.67	73.33 (58.68)	1.848	0.205	1.330	0.125
6	14.67	38.67	17.00	2.67	15.70	2.33	41.67	73.33 (58.68)	3.033	0.345	1.675	0.146
7	15.00	40.33	16.57	2.33	13.27	2.00	39.67	73.33 (58.68)	2.573	0.260	1.616	0.128
8	16.67	45.00	15.92	2.17	12.37	1.16	36.67	70.00 (56.48)	2.485	0.217	0.975	0.092
9	17.00	47.00	14.32	2.17	12.83	1.16	35.67	63.33 (52.48)	2.173	0.210	0.946	0.087
10	17.00	47.67	13.28	2.17	13.57	1.00	35.50	66.67 (54.48)	1.710	0.208	0.508	0.047
S.Em.±	1.65	1.54	0.97	0.27	1.14	0.19	3.82	1.99	0.136	0.020	0.141	0.012
C.D.at 0.05 P	4.90	4.74	2.88	0.81	3.51	0.60	11.76	N.S.	0.405	0.059	0.435	0.038

N.S. = Not significant

Figures in parentheses indicate the angular transformed values.

Table-28 Effect of nodal position on regeneration and growth of *Monstera obliqua*

Nodal No.	Days required for shoot emergence	Days required for root emergence	Length of shoot (cm)	No.of leaves	Length of root (cm)	No.of primary root	No.of secondary root	% of rooting	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root (g)
1	48.00	61.00	2.43	0.050	2.27	1.33	2.00	13.33 (21.58)	0.633	0.063	0.126	0.011
2	30.33	48.00	11.35	1.00	6.63	1.83	7.33	30.00 (33.52)	1.966	0.202	0.292	0.027
3	24.40	43.80	15.83	1.17	9.07	2.20	12.57	86.67 (68.42)	2.833	0.288	0.328	0.032
4	19.20	35.33	15.87	1.50	9.93	2.33	15.23	86.67 (68.42)	2.483	0.295	0.475	0.046
5	17.10	35.87	16.00	1.75	13.73	2.47	15.47	100.00 (85.95)	3.366	0.367	0.758	0.072
6	15.67	36.50	17.33	2.00	13.50	2.50	15.00	100.00 (85.95)	3.217	0.335	0.603	0.053
7	16.67	36.50	17.57	2.00	13.00	2.33	14.17	96.67 (80.99)	3.067	0.312	0.665	0.063
8	17.70	35.43	17.63	2.00	12.17	2.33	12.40	96.67 (80.99)	2.950	0.300	0.717	0.068
9	18.43	35.50	21.07	2.00	12.13	2.33	12.10	93.33 (76.04)	3.683	0.400	0.902	0.087
10	18.27	35.50	22.33	2.00	11.80	2.33	11.87	93.33 (76.04)	3.700	0.423	0.830	0.075
S.Em.±	1.32	1.56	0.66	0.29	0.52	0.21	1.09	3.35	0.482	0.059	0.091	0.007
C.D.at 0.05 P	3.92	4.64	1.98	0.86	1.55	0.63	3.25	9.97	1.433	0.175	0.271	0.020

Figures in parentheses indicate the angular transformed values.

Table-29 Effect of nodal position on regeneration and growth of Philodendron erubescens

Nodal No.	Days required for shoot emergence	Days required for root emergence	Lenth of shoot (cm)	No.of leaves	Length of root (cm)	No.of primary root	No.of secon- dary root	% of rooting	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root (g)
1	11.17	41.67	5.73	1.50	4.00	1.16	7.00	26.67 (31.32)	0.128	0.013	0.110	0.011
2	10.00	34.00	8.10	1.67	6.03	1.50	10.00	36.67 (37.52)	0.788	0.078	0.128	0.020
3	10.00	33.33	9.20	2.33	8.67	1.50	15.17	63.33 (52.48)	1.315	0.137	0.557	0.050
4	10.50	31.17	9.37	2.50	8.87	1.67	17.83	76.67 (60.88)	1.423	0.137	0.581	0.055
5	10.33	29.50	9.47	2.67	8.93	2.00	16.50	76.67 (60.88)	1.422	0.138	0.573	0.055
6	9.50	29.17	10.33	3.00	12.03	2.67	26.00	83.33 (65.75)	1.608	0.160	0.595	0.055
7	12.67	39.50	8.93	2.67	9.77	2.33	20.66	80.00 (63.55)	1.420	0.127	0.462	0.043
8	12.83	47.50	9.17	2.83	9.90	2.00	21.17	76.67 (60.88)	1.365	0.120	0.450	0.042
9	12.67	45.33	9.13	3.00	9.83	2.00	18.83	66.67 (54.48)	1.262	0.120	0.405	0.037
10	12.00	39.17	9.57	3.00	9.77	1.67	18.67	63.33 (52.48)	1.040	0.107	0.400	0.037
S.Em.±	1.01	3.55	0.58	0.31	0.56	0.21	1.56	2.47	0.173	0.020	0.051	0.006
C.D.at 0.05 P	N.S.	10.55	1.72	0.91	1.68	0.63	4.65	7.36	0.514	0.061	0.153	0.018

N.S. = Not significant.

Figures in parentheses indicate the angular transformed values.

Table-30 Effect of nodal position on regeneration and growth of Scindapsus aureus 'Marble Queen'

Nodal No.	Days required for shoot emergence	Days required for root emergence	Length of shoot (cm)	No.of leaves	Length of root (cm)	No.of primary root	% of rooting	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root (g)
1	12.00	54.33	4.10	1.67	2.83	1.33	10.06 (18.91)	0.373	0.033	0.100	0.008
2	14.67	52.00	4.33	2.00	3.20	1.33	23.33 (29.12)	0.555	0.055	0.105	0.009
3	14.77	44.33	5.60	2.33	4.40	1.67	33.33 (35.52)	0.613	0.060	0.167	0.013
4	14.97	44.30	5.70	2.77	4.53	1.83	83.33 (65.75)	0.648	0.062	0.177	0.015
5	10.07	41.17	5.97	2.83	4.73	2.00	83.33 (65.75)	0.653	0.067	0.207	0.016
6	12.33	47.00	5.40	2.67	5.23	2.33	76.67 (60.88)	0.655	0.070	0.158	0.012
7	16.67	52.67	5.27	2.33	4.70	2.00	70.00 (56.48)	0.533	0.050	0.143	0.012
8	17.20	56.33	4.77	2.00	4.57	1.93	63.33 (52.48)	0.472	0.047	0.130	0.010
9	18.50	55.33	3.67	2.00	4.43	1.33	53.33 (49.68)	0.453	0.043	0.123	0.008
10	18.66	60.33	3.90	1.67	4.20	1.33	43.33 (42.77)	0.453	0.045	0.130	0.009
S.Em.±	0.94	2.63	0.33	0.32	0.38	0.33	2.13	0.051	0.006	0.029	0.002
C.D.at 0.05 P	2.80	7.82	0.98	N.S.	1.12	N.S.	6.32	0.151	0.017	N.S.	N.S.

N.S. = Not significant.

Figures in parentheses indicate the angular transformed values.

Table-31 Effect of nodal position on regeneration and growth of Syngonium podophyllum 'Variegatum'

Nodal No.	Days required for shoot emergence	Days required for root emergence	Length of shoot (cm)	No.of leaves	Length of root (cm)	No.of Primary root	No.of secondary root	% of rooting	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root (g)
1	23.00	34.33	2.43	0.83	3.97	1.33	16.00	20.00 (26.45)	0.200	0.013	0.107	0.008
2	20.50	32.00	3.08	0.83	4.27	1.67	16.00	30.00 (33.32)	0.197	0.017	0.115	0.008
3	16.83	33.67	5.23	1.00	4.43	1.67	16.67	30.00 (33.32)	0.257	0.028	0.150	0.012
4	16.83	33.67	5.57	1.17	5.07	1.83	18.00	30.00 (33.32)	0.358	0.042	0.200	0.018
5	18.10	36.33	5.60	1.33	6.63	2.17	20.67	63.33 (52.48)	0.400	0.042	0.227	0.019
6	19.03	44.00	5.77	1.67	7.90	2.17	20.33	66.67 (54.48)	0.443	0.052	0.203	0.017
7	16.47	42.83	5.70	1.57	7.67	2.00	19.67	66.67 (54.48)	0.413	0.047	0.190	0.015
8	19.37	46.03	5.63	1.57	7.63	1.83	20.30	63.33 (52.48)	0.410	0.045	0.185	0.013
9	22.63	43.33	5.70	1.33	7.47	1.67	18.17	63.33 (52.48)	0.392	0.045	0.177	0.013
10	17.63	47.63	5.73	1.33	5.36	1.50	13.67	60.00 (50.48)	0.388	0.043	0.130	0.010
S.Em.±	1.21	2.53	0.48	0.19	0.73	0.31	1.47	2.30	0.053	0.006	0.035	0.004
C.D.at 0.05 P	3.59	7.80	1.44	N.S.	2.16	N.S.	4.36	6.84	0.158	0.018	N.S.	N.S.

N.S. = Not significant.

Figures in parentheses indicate the angular transformed values.

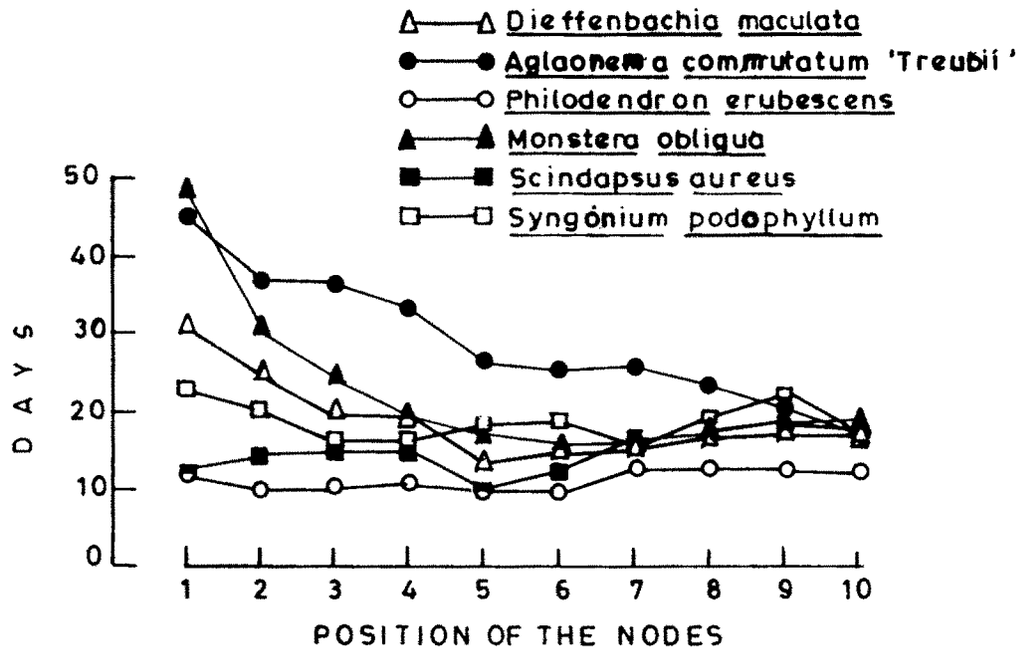


FIG.9a: EFFECT OF CUTTING POSITION ON DAYS REQUIRED FOR SHOOT EMERGENCE OF HOUSE PLANTS

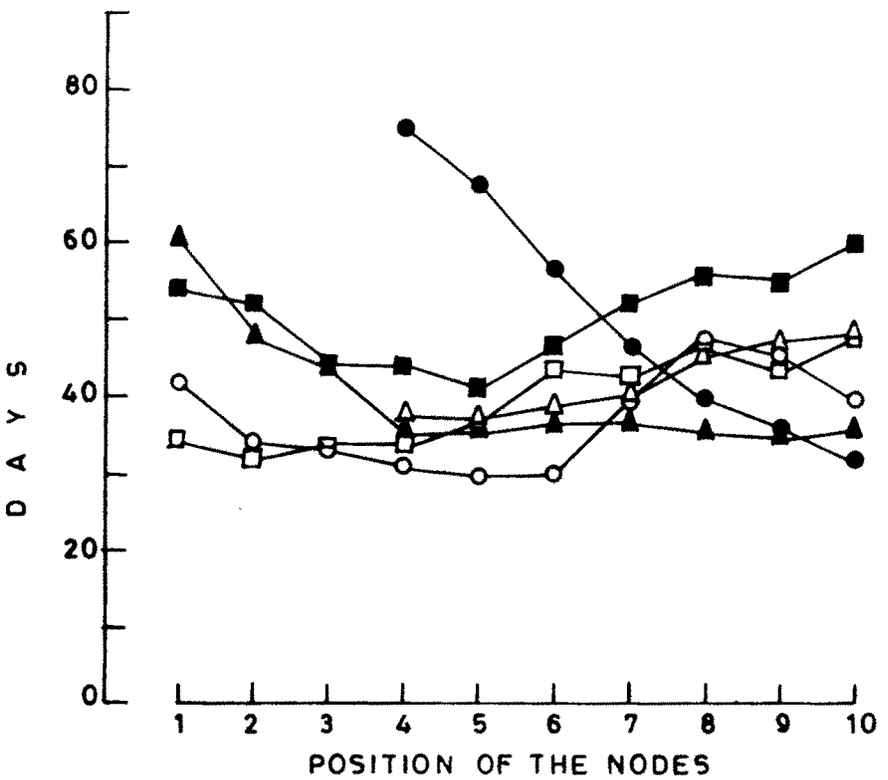


FIG.9b: EFFECT OF CUTTING POSITION ON DAYS REQUIRED FOR ROOT EMERGENCE OF HOUSE PLANTS

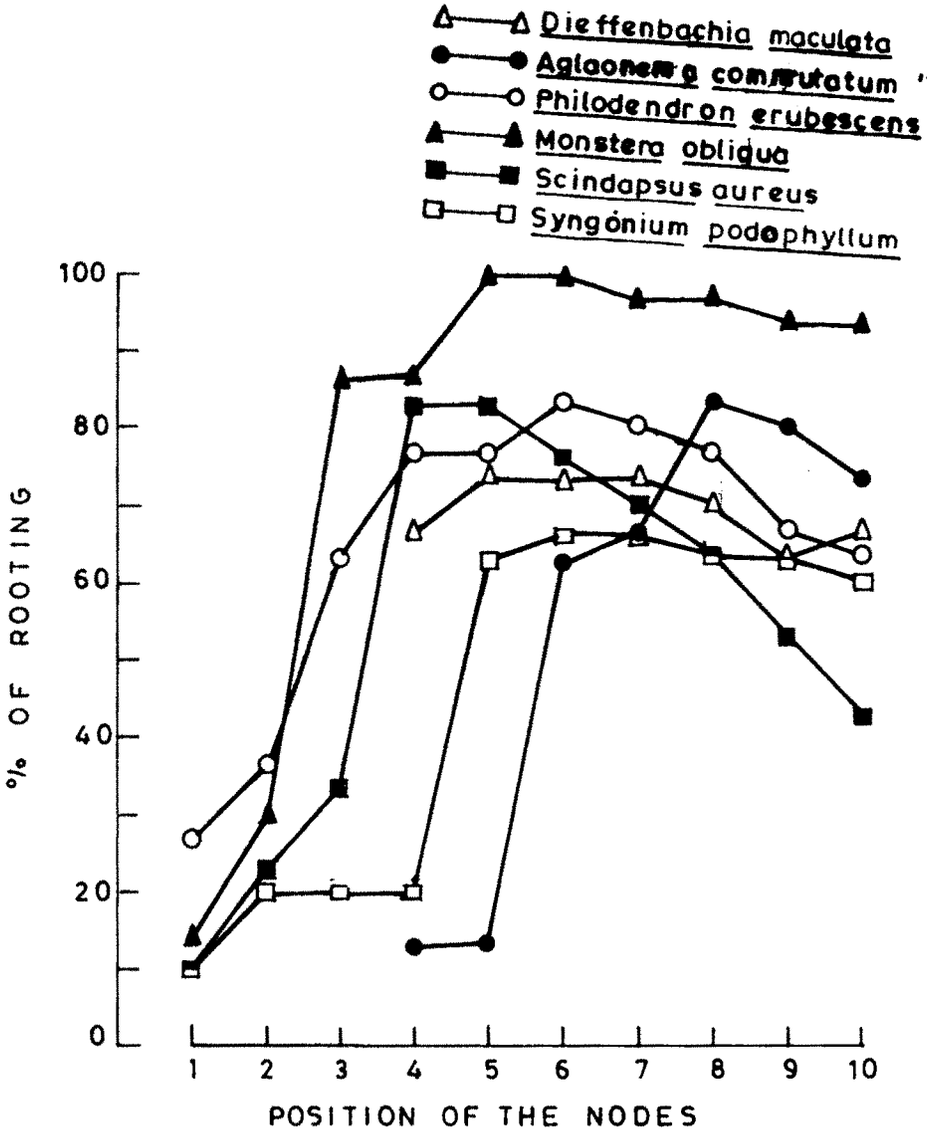


FIG.10a: EFFECT OF CUTTING POSITION ON % OF ROOTING OF HOUSE PLANTS

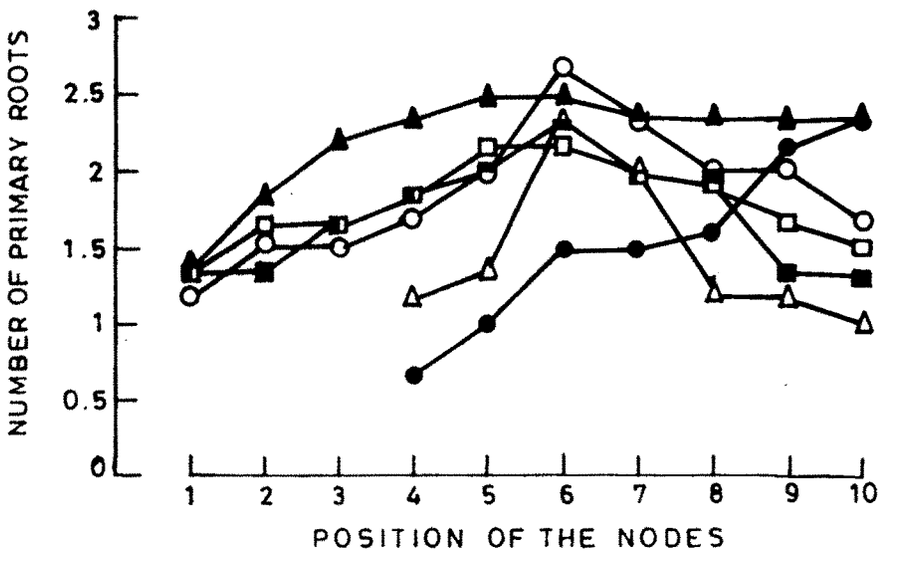


FIG. 10 b: EFFECT OF CUTTING POSITION ON NUMBER OF PRIMARY ROOTS OF HOUSE PLANTS





Plate No.11 Effect of nodal position on propagation of Aglaonema commutatum 'Treubii' and Dieffenbachia maculata(D.picta).





Plate No.12 Effect of nodal position on propagation of Monstera obliqua and Philodendron erubescens.

Days required for root emergence: Root formation was delayed in one node cuttings of Aglaonema commutatum 'Treubii', Dieffenbachia maculata and Monstera obliqua compared to three node cuttings. Two node cuttings also had delayed root emergence compared to three node cuttings. In case of Philodendron erubescens , no significant difference was recorded in the emergence of root from cuttings with varying number of nodes. However, in three node cuttings root emergence was hastened by four days over that in one node cuttings.

Length of shoot: It is evident from Table-32&33 that node number per cuttings had pronounced effect on the length of shoot in case of Aglaonema commutatum 'Treubii', Dieffenbachia maculata, Monstera obliqua and Philodendron erubescens. Longest shoots in case of these four plants were found with three node cuttings whereas shorter shoot growth was noted with one node cuttings. Two node cuttings,on the other hand, showed intermediate height of shoot.

Number of leaves: It is revealed from the data presented in Table-32 and 33 that the leaf number was influenced significantly by number of node retained per cutting. Maximum number of leaves were recorded in three node cuttings and the lowest number of leaves were produced in one node cuttings.

Length of root: The root lengths of Aglaonema commutatum 'Treubii' and Dieffenbachia maculata were recorded and presented in Table-32. Length of root was significantly influenced by the number of nodes

retained at the time of taking cuttings. One node cuttings produced shortest root lengths compared to three node cuttings and two node cuttings resulted intermediate length of roots. In Monstera obliqua and Philodendron erubescens, three node cuttings developed maximum root length whereas one node cuttings produced shortest root lengths though no significant difference was recorded among the treatments.(Plate-13).

Number of primary roots: As regards to number of primary roots of Aglaonema commutatum 'Treubii', Monstera obliqua and Philodendron erubescens, no significant differences were recorded among the treatments. However, the number of primary roots were more with three node cuttings compared to one node cuttings. In Dieffenbachia maculata, one node cuttings produced lowest (one) number of primary roots compared to three node cuttings which produced highest number (4.71) of roots. Two node cuttings produced more number of roots than one node cuttings.

Number of secondary roots: Among the three types of cutting used in the experiment three node cuttings of Dieffenbachia maculata, Monstera obliqua and Philodendron erubescens proved effective in production of larger number of secondary roots compared to one node and two node cuttings. One node cuttings caused less number of roots in all the three plant species.

Percentage of rooting: It is evident from the Table -32 and 33 that two and three node cuttings showed maximum rooting

percentage. In Aglaonema commutatum 'Treubii' about 81.42 and 88.57 per cent of rooting were recorded with two and three node cuttings respectively whereas in one node cutting recorded 67.14 per cent rooting success. Maximum percentage of rooting was also noted with two node and three node cuttings of Dieffenbachia maculata and Monstera obliqua (above 95% on both crop) while one node cuttings showed only about 64 to 67% rooting success. Three node cuttings of Philodendron erubescens had higher percentage (74.28) of rooting success compared to one node (45.71%) cuttings.

Fresh and dry weight of shoot: Both fresh and dry weight of shoots increased with the increase in the number of nodes retained per cuttings. Maximum fresh and dry weight of shoot of Aglaonema commutatum 'Treubii', Dieffenbachia maculata and Monstera obliqua were recorded with three node cuttings whereas one node cutting produced lowest fresh and dry weight of shoot. One node cuttings of Philodendron erubescens produced less fresh and dry weight of shoot compared to two and three node cuttings.

Fresh and dry weight of root: Fresh and dry weight of root in Aglaonema commutatum 'Treubii', Dieffenbachia maculata and Philodendron erubescens were significantly influenced by different types of node cuttings. Maximum fresh and dry weight of roots were recorded on three node cuttings while one node cuttings produced lowest fresh and dry weight of root. Three node cuttings of Monstera obliqua also recorded highest fresh and dry weight of root. But no significant differences were recorded among the treatments.

Table-32 Response of cutting with varying number of nodes on regeneration and growth of plantlets of Aglaonema commutatum 'Treubii' and Dieffenbachia maculata.

Treatment	Days required for shoot emergence	Days required for root emergence	Length of shoot (cm)	No.of leaves	Length of root (cm)	No.of primary root	No.of secon-dary root	% of rooting	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root (g)
					Aglaonema commutatum 'Treubii'							
One node	31.86	48.43	9.90	1.50	3.06	2.57		67.14 (54.76)	1.190	0.150	0.135	0.009
Two nodes	22.43	44.53	10.33	2.71	5.01	2.57		81.42 (64.42)	1.614	0.180	0.343	0.026
Three nodes	18.57	42.71	13.50	4.00	6.78	2.86		88.57 (70.92)	1.886	0.205	0.390	0.028
S.Em.±	1.84	0.98	0.69	0.17	0.67	0.36		2.31	0.134	0.011	0.047	0.003
C.D.at 0.05 P	5.69	3.04	2.14	0.54	2.06	N.S.		7.11	0.414	0.036	0.145	0.009
					Dieffenbachia maculata							
One node	17.43	40.00	9.70	2.14	10.30	1.00	46.00	64.28 (53.05)	1.450	0.162	0.733	0.069
Two nodes	15.43	28.71	22.17	2.86	11.86	3.28	112.14	95.71 (79.58)	5.970	0.659	1.515	0.133
Three nodes	12.14	24.57	24.86	3.28	15.14	4.71	201.43	98.57 (83.82)	8.820	0.973	2.679	0.235
S.Em.±	0.45	1.14	1.59	0.18	0.66	0.40	10.25	2.58	0.306	0.045	0.149	0.013
C.D.at 0.05 P	1.38	3.51	4.90	0.55	2.04	1.25	31.57	7.95	0.943	0.141	0.459	0.040

N.S. = Not significant

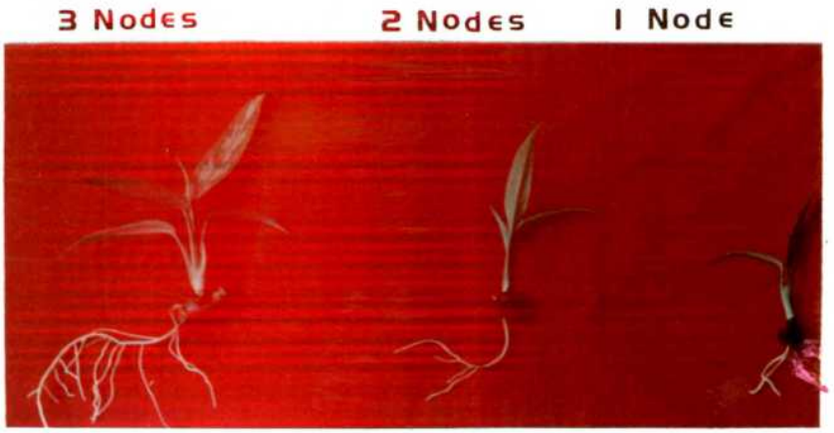
Figures in parentheses indicate the angular transformed values.

Table-33 Response of cutting with varying number of nodes on regeneration and growth of plantlets of *Monstera obliqua* and *Philodendron erubescens*.

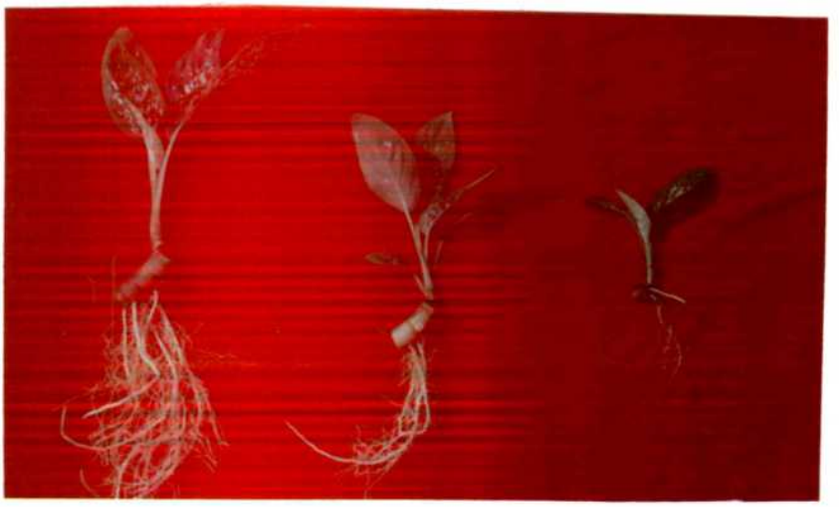
Treatment	Days required for shoot emergence	Days required for root emergence	Length of shoot (cm)	No.of leaves	Length of root (cm)	No.of primary root	No.of secon-dary root	% of rooting	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root (g)
					Monstera obliqua							
One node	20.14	37.28	21.34	1.71	14.90	3.20	19.71	67.14 (54.85)	4.030	0.418	0.592	0.054
Two nodes	17.00	34.14	23.93	2.28	15.41	3.86	23.14	98.57 (83.82)	4.290	0.433	0.624	0.056
Three nodes	16.86	27.14	25.46	3.00	15.60	4.00	27.14	100.00 (85.95)	5.367	0.554	0.669	0.062
S.Em.±	1.31	1.85	0.81	0.22	1.00	0.32	1.80	1.65	0.329	0.030	0.078	0.007
C.D.at 0.05 P	N.S.	5.71	2.48	0.68	N.S.	N.S.	5.57	5.10	1.010	0.093	N.S.	N.S.
					Philodendron erubescens							
One node	18.42	25.71	12.70	2.71	8.47	3.00	20.71	45.71 (42.82)	1.396	0.148	0.233	0.019
Two nodes	14.00	24.00	14.83	2.86	10.14	3.28	27.00	64.28 (53.05)	1.418	0.166	0.288	0.024
Three nodes	13.28	21.71	15.99	3.86	11.46	3.86	33.57	74.28 (59.31)	1.508	0.173	0.330	0.027
S.Em.±	0.85	1.21	0.63	0.88	0.81	0.33	2.17	1.21	0.115	0.007	0.030	0.003
C.D.at 0.5 P	2.63	N.S.	1.95	2.72	N.S.	N.S.	6.70	3.72	N.S.	0.021	0.092	N.S.

N.S. = Not significant.

Figures in parentheses indicate the angular transformed values.



Aglaonema commutatum 'Treubii'



Dieffenbachia maculata



Philodendron erubescens

Plate No.13 Response of number of nodes per cutting on regeneration and growth of Aglaonema commutatum 'Treubii', Dieffenbachia maculata and Philodendron erubescens.

Experiment 4.1.2.3 Regeneration of plantlets from node with leaf, node without leaf and leaf cuttings.

Experiment 4.1.2.3.1 Regeneration of plantlets from node with leaf, node without leaf and leaf cuttings of Scindapsus aureus 'Marble Queen'.

The data presented in the Table-34 shows that node cuttings with leaf regenerated shoots 7 days early as compared to node cuttings without leaf. In case of early emergence of roots it is interesting to note that node cutting with leaf developed roots 17 days earlier than node cutting without leaf.

The node cuttings with leaf produced longer shoot than node cuttings without leaf. The shoot length from node cuttings with leaf was about 10 cm more over shoot length on node cuttings without leaf. As regard to production of leaves, it was found that node cuttings with leaf developed more than three leaves per cutting.

The root length of Scindapsus aureus 'Marble Queen' was maximum in node cuttings with leaf and the differences between the treatments were marked more as compared to shoot length. Marked improvement in the number of both primary and secondary roots were recorded in case of node cuttings with leaf compared to node cuttings without leaf. Production of secondary roots on node cuttings with leaf was also more. It is also noted that higher percentage of rooting success was obtained in case of

node cuttings with leaf as compared to node cuttings without leaf.

As regard to both fresh and dry weight of shoot it was found that node cuttings with leaf produced maximum fresh and dry weights of shoot. Similar trend of development was also recorded in case of root growth. In case of only leaf cuttings of Scindapsus aureus 'Marble Queen' no root and shoot formation were noted and leaves were dried within 7-10 days after planting.

Experiment 4.1.2.3.2 Regeneration of plantlets from node with leaf, node without leaf and leaf cuttings of Peperomia obtusifolia.

A marked variation in days required for shoot emergence was observed due to different types of cutting used in this experiment. In leaf cutting shoot emergence was delayed by more than 87 days compared to node cuttings with leaf whereas in node cuttings without leaf shoot emergence was delayed only by 15 days. Early emergence of root from leaf cutting was noted in case of Peperomia obtusifolia compared to node cuttings with and without leaf. Root formation was delayed by about 37 days in node cuttings without leaf over that in node cuttings with leaf (Table-35).

As regards to length of shoot, maximum shoot length was recorded in node cuttings with leaf whereas lowest shoot length was obtained in node cuttings without leaf. Production of leaf

was highest in leaf cutting while leaf growth was suppressed in node cuttings without leaf. Node cuttings without leaf produced only one shoot per cutting whereas leaf cuttings produced more than two shoots. Longest root was obtained in leaf cuttings while node cuttings without leaf produced smallest root length(Plate-14b).

Node cuttings with leaf and single leaf cutting both produced maximum number of roots while node cuttings without leaf developed few roots. A significant variation in the percentage of rooting was noticed due to different types of cuttings. Node cuttings with leaf showed maximum percentage (99%) of rooting success whereas node cuttings without leaf produced only 47 per cent rooting. In case of leaf cutting higher percentage (94%) of rooting was noted.

Significant variations in the fresh and dry weight of shoots were noted due to different types of treatments. Leaf cutting of Peperomia obtusifolia recorded maximum fresh and dry weights of shoot. Similar trend was also observed in case of root weight.

Table-34 Effect of different types of cutting on regeneration and growth of plantlets from Scindapsus aureus 'Marble Queen'.

	Node with leaf cutting	Node without leaf cutting	T-Value
Days required for shoot emergence	13.10	20.50	19.37
Day required for root emergence	25.80	42.90	6.32
Length of shoot (cm)	15.24	5.96	13.54
No.of leaves	3.80	2.50	5.02
Length of root (cm)	26.62	7.90	10.86
No.of primary root	5.50	1.90	8.04
No.of secondary root	68.20	8.50	10.48
% of rooting	84.00 (66.28)	72.00 (57.86)	4.60
Fresh weight of shoot (g)	2.88	0.69	12.38
Dry weight of shoot (g)	0.30	0.07	16.48
Fresh weight of root (g)	2.13	0.14	28.24
Dry weight of root (g)	0.18	0.01	17.60

Figures in parentheses indicate the angular transformed values.

Table-35 Effect of different types of cuttings on regeneration and growth of plantlets from Peperomia obtusifolia.

	Node with leaf cutting	Node without leaf cutting	Leaf cutting	S.Em.±	C.D.at 0.05P
Days required for shoot emergence	15.00	31.60	102.10	2.10	6.09
Days required for root emergence	17.10	54.60	15.30	1.03	2.99
Length of shoot(cm)	11.63	2.22	6.04	0.28	0.81
No.of shoot	1.20	1.00	2.70	0.19	0.55
No.of leaves	2.60	1.70	3.40	0.22	0.63
Length of root(cm)	11.55	2.96	16.56	0.47	1.36
No.of primary root	24.60	7.80	25.80	1.30	3.77
% of rooting	99.00 (84.46)	47.00 (45.50)	94.00 (77.72)	2.08	6.03
Fresh weight of shoot (g)	3.867	0.236	4.812	0.130	0.378
Dry weight of shoot (g)	0.292	0.014	0.326	0.015	0.043
Fresh weight of root (g)	1.651	0.013	1.880	0.170	0.494
Dry weight of root (g)	0.235	0.003	0.251	0.019	0.057

Figures in parentheses indicate the angular transformed values.

Experiment 4.1.2.4 Effect of rooting media on root regeneration and plant growth in cuttings of some house plants.

Different rooting media showed differential effects on root and shoot formation in node cuttings.

Days required for shoot emergence: Planting of node cuttings in loam + leafmould (1 : 1) medium caused earliest emergence of shoot in case of Aglaonema commutatum 'Treubii' followed by soilrite medium. Shoot formation was delayed upto 26 days with loam medium compared to loam + leafmould (1 : 1) medium (Table-36). In Philodendron erubescens, early emergence of shoot was recorded with sand and was delayed by about 5 days in loam. No marked variation in shoot emergence was recorded among the treatments (Table-37). Dieffenbachia maculata, on the other hand, showed earliest emergence of shoot, when node cuttings were placed in leafmould medium followed by leafmould + sand (1 : 1) medium. Shoot emergence, however, was delayed by about 12 days in loam compared to leafmould (Table-38). Like Philodendron erubescens, Monstera obliqua showed early emergence of shoot in sand and shoot emergence was delayed by about 9 days in vermiculite (Table-39). Uniform vine cuttings of Syngonium podophyllum 'Variegatum' planted in loam + leafmould (1 : 1) medium showed earliest emergence of shoot compared to rest of the media tested in this experiment. A significant difference in shoot emergence of cutting was recorded among the treatments. The shoot emergence of node

cutting was delayed by about 20 days in loam compared to loam + leafmould (1 : 1) medium (Table-40).

Days required for root emergence: The different rooting media used in this investigation affected emergence of roots from cuttings differentially. Loam + Leafmould (1 :1) medium enhanced root formation of the node cuttings of Aglaonema commutatum 'Treubii' while root emergence was delayed by 30 days in loam + sand (1 : 1) medium. Node cuttings of Philodendron erubescens formed root early in sand medium but root formation was delayed by about 25 days in loam. The significant difference in root emergence was recorded among the treatments. In case of Dieffenbachia maculata,it was observed that leafmould + sand(1 : 1) and only leafmould caused early emergence of root from node cutting. In Monstera obliqua root emergence was delayed in vermiculite compared to rest of the media used in this experiment. Early root emergence from node cutting was noted in sand. The node cuttings of Syngonium podophyllum 'Variegatum' formed root early in loam + leafmould (1 : 1) followed by only sand and loam + sand (1 : 1) media. Root formation was delayed by about 6 days in loam compared to loam + leafmould (1 : 1) medium.

Length of shoot: The different rooting media used had also pronounced but variable effects on the length of shoot developed from node cutting. Significant differences in length of shoot on node cuttings of Aglaonema commutatum 'Treubii' were observed due to different rooting media. Node cutting of Aglaonema

commutatum 'Treubii' showed maximum length of shoot in loam + leafmould (1 : 1) medium followed by sand. Marked reduction in shoot length was recorded when node cuttings were placed in loam. Node cuttings of both Philodendron erubescens and Monstera obliqua recorded highest length of shoots in sand followed by leafmould + sand (1 : 1) medium. Shoot growth of Philodendron erubescens and Monstera obliqua were markedly reduced when node cuttings were placed in loam and leafmould media respectively. Leafmould proved most effective rooting medium in promoting shoot length of Dieffenbachia maculata. The second highest shoot growth was found in sand + leafmould (1 :1) medium. Maximum reduction in shoot length of node cutting was observed in vermiculite. Node cuttings of Syngonium podophyllum 'Variegatum' ,on the other hand, developed maximum size of shoot in loam + leafmould (1 : 1) medium. The growth rate of shoot was more than double as compared to loam and sand.

Number of leaves: Number of leaves developed in each node cutting under different rooting media was observed and presented in Table—36 to 40. It was found that no marked variations in number of leaves per node cutting were recorded among the plant species used in this study. Node cuttings of Aglaonema commutatum 'Treubii' on loam + leafmould (1 : 1) medium produced more leaves per cutting compared to rest of the rooting media. In case of Philodendron erubescens and Monstera obliqua, node cuttings on sand medium caused highest leaf production. Node cuttings of Dieffenbachia maculata, on the other hand, produced maximum

number of leaves in leafmould medium. In Syngonium podophyllum 'Variegatum' node cutting on loam + leafmould (1 : 1) medium, produced maximum number of leaves. Node cuttings on loam produced lowest number of leaves in case of most of the house plants used in this experiment.

Length of root: Root growth on node cutting was affected differently under different rooting media. It is clear from the Table-36 that root growth was maximum in loam + leafmould (1 : 1) medium when node cutting of Aglaonema commutatum 'Treubii' were used. Reduced root length was observed when the node cuttings were placed in loam medium. Node cutting of both Philodendron erubescens and Monstera obliqua produced longest root in sand(Plate-14a followed by sand + leafmould (1 : 1) medium. The shortest root growth was noted only in loam. Length of root developed from node cutting of Dieffenbachia maculata was maximum in leafmould followed by leafmould + sand (1 : 1) medium. Node cutting of Syngonium podophyllum 'Variegatum' in loam + leafmould (1 : 1) medium responded well with respect to growth of root followed by loam + sand (1 : 1) medium whereas root growth was suppressed in loam.

Number of primary roots: A significant variation in the production of primary roots per node cutting was noticed among the different rooting media in case of Aglaonema commutatum 'Treubii', Dieffenbachia maculata, Monstera obliqua, Syngonium podophyllum 'Variegatum' and Philodendron erubescens. Node cutting of Philodendron erubescens and Monstera obliqua produced maximum

number of primary roots in sand whereas node cuttings of Aglaonema commutatum 'Treubii' and Dieffenbachia maculata produced maximum number of primary roots in leafmould + sand (1 : 1) and leafmould medium respectively. In case of Syngonium podophyllum 'Variegatum' node cutting developed maximum number of primary roots in mixture containing loam and leafmould (1 : 1). In case of Aglaonema commutatum 'Treubii', Philodendron erubescens and Syngonium podophyllum 'Variegatum' less number of roots were produced in loam.

Number of secondary roots: No marked improvement in the number of secondary roots was found in Aglaonema commutatum 'Treubii' and Philodendron erubescens when node cuttings were placed in different rooting media. Maximum number of secondary roots were obtained in node cuttings of Dieffenbachia maculata grown in leafmould medium. Both sand and sand + leafmould (1 : 1) media resulted maximum number of secondary roots in Monstera obliqua. In case of Syngonium podophyllum 'Variegatum', maximum production of secondary roots per node cutting were recorded in loam + leafmould (1 : 1) followed by loam + sand (1 : 1) medium.

Percentage of rooting: Node cutting of Aglaonema commutatum 'Treubii', Dieffenbachia maculata, Monstera obliqua and Philodendron erubescens responded differently under different media used in this investigation. Highest percentage of rooting of Aglaonema commutatum 'Treubii' and Philodendron erubescens were recorded when node cuttings were placed in leafmould + sand (1 : 1)

medium. Poor percentage of rooting was observed when cuttings were placed in loam only (Table –36, 37 and Fig.11). In Dieffenbachia maculata both sand and leafmould + sand (1 : 1) media proved effective in promoting root formation. Sand was also found beneficial for regenerating maximum percentage of roots per node cutting of Monstera obliqua whereas rooting was adversely affected in loam + leafmould and loam + sand (1 : 1) media. Node cutting of Syngonium podophyllum 'Variegatum' in loam + sand (1 : 1) medium recorded markedly more percentage of rooting compared to rest of the media used. In most of the plant species percentage of rooting success in node cuttings was poor in loam medium (Table-40 and Fig.11).

Fresh and dry weight of shoot: It is evident from the Table-36 that maximum fresh and dry weight in Aglaonema commutatum 'Treubii' was obtained when node cuttings were placed in loam + leafmould (1 : 1) medium followed by soilrite medium. Dieffenbachia maculata, on the other hand, produced maximum fresh and dry weight of shoot in leafmould. In case of Philodendron erubescens and Monstera obliqua both fresh and dry weight of shoot recorded maximum value in sand compared to rest of the treatments. Fresh and dry weights of shoot from node cuttings of Dieffenbachia maculata were maximum in leafmould medium whereas Syngonium podophyllum 'Variegatum' responded well in medium containing loam + leafmould (1 : 1) and leafmould alone. Production of fresh and dry weights of shoot in node cuttings were depressed in loam medium in case of most of the plant species used in this study.

Fresh and dry weight of root: As regards to fresh and dry weights of roots from node cuttings of Aglaonema commutatum 'Treubii' and Monstera obliqua, a significant differences were recorded among the treatments. Maximum fresh and dry weights of roots per cutting of Aglaonema commutatum 'Treubii' were noted in loam + leafmould (1 : 1) medium. Variations in the fresh and dry weights of roots in case of Philodendron erubescens and Monstera obliqua were noted under different rooting media used in this experiment. Maximum fresh and dry weights of roots were obtained when the node cuttings were placed in sand medium whereas lowest fresh and dry weight of roots were noted with loam medium in case of Philodendron erubescens and leafmould in case of Monstera obliqua. Node cutting of Dieffenbachia maculata, on the other hand, responded well with respect to the production of fresh and dry weight of root in leafmould whereas vermiculite resulted lowest fresh and dry weight of root. Highest fresh and dry weights of roots were obtained when node cuttings of Syngonium podophyllum 'Variegatum' were placed in loam + leafmould (1 : 1) medium. Marked reduction in fresh and dry weight of root was noticed when node cuttings were placed in loam.

Experiment 4.1.2.5 In vitro propagation of Philodendron erubescens 'Ceylon Gold'.

Callus induction: In order to select basal nutrient media and to induce callus Murashige and Skoog, and Knudson 'C' supplemented with various growth regulators either alone or in combination were used.

Table-36 Effect of rooting media on regeneration and growth of Aglaonema commutatum 'Treubii' cuttings.

Treatment	Days required for shoot emergence	Days required for root emergence	Length of shoot (cm)	No.of leaves	Length of root (cm)	No.of primary root	% of rooting	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root (g)
Loam	47.90	66.00	5.80	1.00	1.73	1.16	30.00 (33.32)	0.550	0.105	0.055	0.004
Leafmould	46.23	68.00	8.83	1.33	2.63	1.33	50.00 (46.43)	0.908	0.168	0.173	0.010
Soilrite	24.76	52.33	9.66	1.50	2.20	2.33	40.00 (40.77)	1.329	0.173	0.238	0.013
Vermiculite	35.53	62.67	7.80	1.26	3.03	1.50	63.33 (52.48)	0.738	0.126	0.161	0.012
Sand	31.86	48.43	9.90	1.33	3.06	2.16	66.67 (54.48)	1.200	0.155	0.135	0.009
Loam + leafmould (1:1)	21.86	38.13	10.63	1.57	5.26	2.50	46.67 (46.03)	1.511	0.228	0.390	0.017
Loam + sand(1:1)	30.86	68.50	8.03	1.16	2.30	1.66	56.67 (50.08)	0.916	0.122	0.215	0.010
Leafmould + sand (1:1)	29.00	47.33	8.60	1.33	3.30	2.66	73.33 (58.68)	0.975	0.113	0.300	0.014
S.Em.±	1.30	2.30	0.33	0.20	0.27	0.28	2.88	0.161	0.014	0.050	0.003
C.D.at 0.05 P	3.97	6.99	1.02	N.S.	0.81	0.86	8.75	0.490	0.042	0.154	0.010

N.S. = Not significant.

Figures in parentheses indicate the angular transformed values.

Table-37 Effect of rooting media on regeneration and growth of Philodendron erubescens cuttings.

Treatment	Days required for shoot emergence	Days required for root emergence	Length of shoot (cm)	No.of leaves	Length of root (cm)	No.of primary root	% of rooting	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root (g)
Loam	22.00	51.33	2.70	1.00	1.70	1.00	23.33 (29.12)	0.315	0.023	0.033	0.003
Leafmould	18.00	34.33	8.57	2.00	3.87	1.00	36.67 (37.52)	0.622	0.057	0.053	0.003
Soilrite	21.00	32.66	6.77	1.33	3.07	1.66	33.33 (35.52)	0.368	0.025	0.062	0.004
Vermiculite	18.33	33.66	10.57	2.33	6.10	1.66	36.67 (37.52)	0.953	0.075	0.126	0.011
Sand	17.33	25.66	12.70	2.66	8.47	3.00	50.00 (45.29)	1.396	0.153	0.233	0.020
Loam +Leafmould (1 : 1)	19.66	42.00	6.90	1.66	3.67	1.33	23.33 (29.12)	0.578	0.038	0.068	0.004
Loam + sand(1:1)	18.67	35.67	5.90	1.66	5.27	1.66	46.67 (43.36)	0.558	0.037	0.108	0.009
Leafmould + sand (1 : 1)	18.33	33.50	10.63	2.50	6.43	2.67	60.00 (50.48)	1.361	0.096	0.183	0.019
S.Em.±	1.81	2.89	0.98	0.36	0.68	0.35	1.85	0.140	0.014	0.041	0.004
C.D.at 0.05 P	N.S.	8.69	2.96	N.S.	2.05	1.05	5.62	0.428	0.045	0.125	0.011

N.S. = Not significant

Figures in parentheses indicate the angular transformed values.

Table-38 Effect of rooting media on regeneration and growth of Dieffenbachia maculata cuttings.

Treatment	Days required for shoot emergence	Days required for root emergence	Length of shoot (cm)	No.of leaves	Length of root (cm)	No.of primary root	No.of secon-dary root	% of rooting	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root (g)
Loam	26.00	42.33	11.20	1.83	15.50	2.33	63.67	30.00 (33.32)	4.900	0.550	0.866	0.081
Leafmould	13.83	32.67	15.20	2.67	17.13	4.00	87.33	36.66 (37.52)	9.200	1.050	2.440	0.230
Soilrite	16.16	34.00	8.83	1.67	15.50	2.33	80.00	33.33 (35.52)	5.060	0.563	1.733	0.143
Vermiculite	18.16	35.00	7.00	1.33	12.66	1.00	24.67	36.66 (37.52)	1.350	0.152	0.366	0.030
Sand	17.33	40.00	9.70	1.33	10.30	2.00	46.00	63.33 (52.48)	1.450	0.162	0.733	0.070
Loam + Leafmould (1:1)	15.00	38.33	8.77	2.17	13.66	1.00	53.33	40.00 (40.77)	4.533	0.558	1.783	0.143
Loam+Sand(1:1)	16.50	35.00	12.40	2.00	12.46	2.00	76.66	56.67 (50.08)	3.570	0.520	1.590	0.145
Leafmould + Sand(1:1)	14.66	33.00	14.10	2.17	16.46	3.33	81.33	63.33 (54.08)	5.450	0.760	1.800	0.186
S.Em.±	1.00	1.98	1.36	0.26	0.99	0.42	7.78	2.79	0.420	0.111	0.310	0.030
C.D.at 0.05 P	3.05	6.02	4.14	N.S.	3.03	1.26	23.61	8.49	1.260	0.339	0.940	0.092

N.S. = Not significant.

Figures in parentheses indicate the angular transformed values.

Table-39 Effect of rooting media on regeneration and growth of Monstera obliqua cuttings.

Treatment	Days required for shoot emergence	Days required for root emergence	Length of shoot (cm)	No.of leaves	Length of root (cm)	No.of primary root	No.of secon-dary root	% of rooting	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root (g)
Loam	28.76	39.50	14.80	1.00	9.70	2.33	6.00	36.67 (37.52)	2.933	0.306	0.383	0.033
Leafmould	26.33	46.33	10.93	1.00	6.06	1.33	1.33	43.33 (41.44)	2.008	0.276	0.133	0.011
Soilrite	21.50	42.00	11.23	1.00	7.76	2.00	9.33	56.66 (48.75)	2.500	0.293	0.163	0.015
Vermiculite	29.70	53.80	14.80	1.00	10.26	2.26	16.33	66.67 (54.68)	2.566	0.286	0.833	0.071
Sand	20.10	36.43	21.33	1.33	14.87	3.33	23.16	80.00 (63.55)	4.033	0.414	1.458	0.113
Loam + Leaf-mould(1:1)	23.30	38.50	15.50	1.00	10.90	2.33	17.33	36.67 (37.44)	3.800	0.383	0.592	0.055
Loam + sand (1:1)	26.03	37.26	13.96	1.00	12.33	2.50	19.60	33.33 (35.52)	3.435	0.341	0.658	0.066
Leafmould + Sand (1:1)	20.33	37.00	18.00	1.00	12.63	3.03	23.00	70.00 (56.68)	3.880	0.411	0.850	0.081
S.Em.±	1.33	1.33	0.63	0.12	0.68	0.22	1.38	3.29	0.370	0.034	0.110	0.014
C.D.at 0.05 P	4.02	4.06	1.90	N.S.	2.08	0.67	4.20	9.99	1.140	0.100	0.335	0.043

N.S. = Not significant.

Figures in parentheses indicate the angular transformed values.

Table-40 Effect of rooting media on regeneration and growth of Syngonium podophyllum 'Variegatum' cuttings.

Treatment	Days required for shoot emergence	Days required for root emergence	Length of shoot (cm)	No.of leaves	Length of root (cm)	No.of primary root	No.of secondary root	% of rooting	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root (g)
Loam	37.33	36.17	7.30	1.33	5.07	1.50	15.33	40.00	0.467	0.076	0.290	0.022
Leafmould	20.70	35.50	11.86	2.00	8.33	1.67	34.33	43.33	2.356	0.258	0.690	0.073
Soilrite	25.00	33.50	10.20	2.33	10.00	2.17	20.33	46.67	1.730	0.183	0.588	0.086
Vermiculite	30.50	35.33	8.16	2.67	11.30	2.17	26.67	46.67	1.430	0.132	0.742	0.063
Sand	25.66	30.33	7.43	2.00	11.03	2.00	39.50	43.33	1.150	0.110	0.516	0.060
Loam + Leaf-mould(1:1)	17.46	30.00	17.20	3.33	18.50	3.83	61.33	50.00	2.770	0.303	1.366	0.123
Loam + Sand (1:1)	19.17	30.33	12.63	3.17	16.43	2.67	49.00	63.33	2.350	0.292	0.880	0.110
Leafmould + Sand (1:1)	22.33	30.60	10.73	3.00	11.03	2.67	39.50	40.00	1.566	0.172	0.875	0.070
S.Em.±	1.76	0.91	1.05	0.37	0.95	0.40	3.61	4.62	0.23	0.046	0.124	0.007
C.D. at 0.05 P	5.33	2.75	3.20	1.11	2.89	1.21	10.95	N.S.	0.70	0.142	0.378	0.021

N.S. = Not significant.

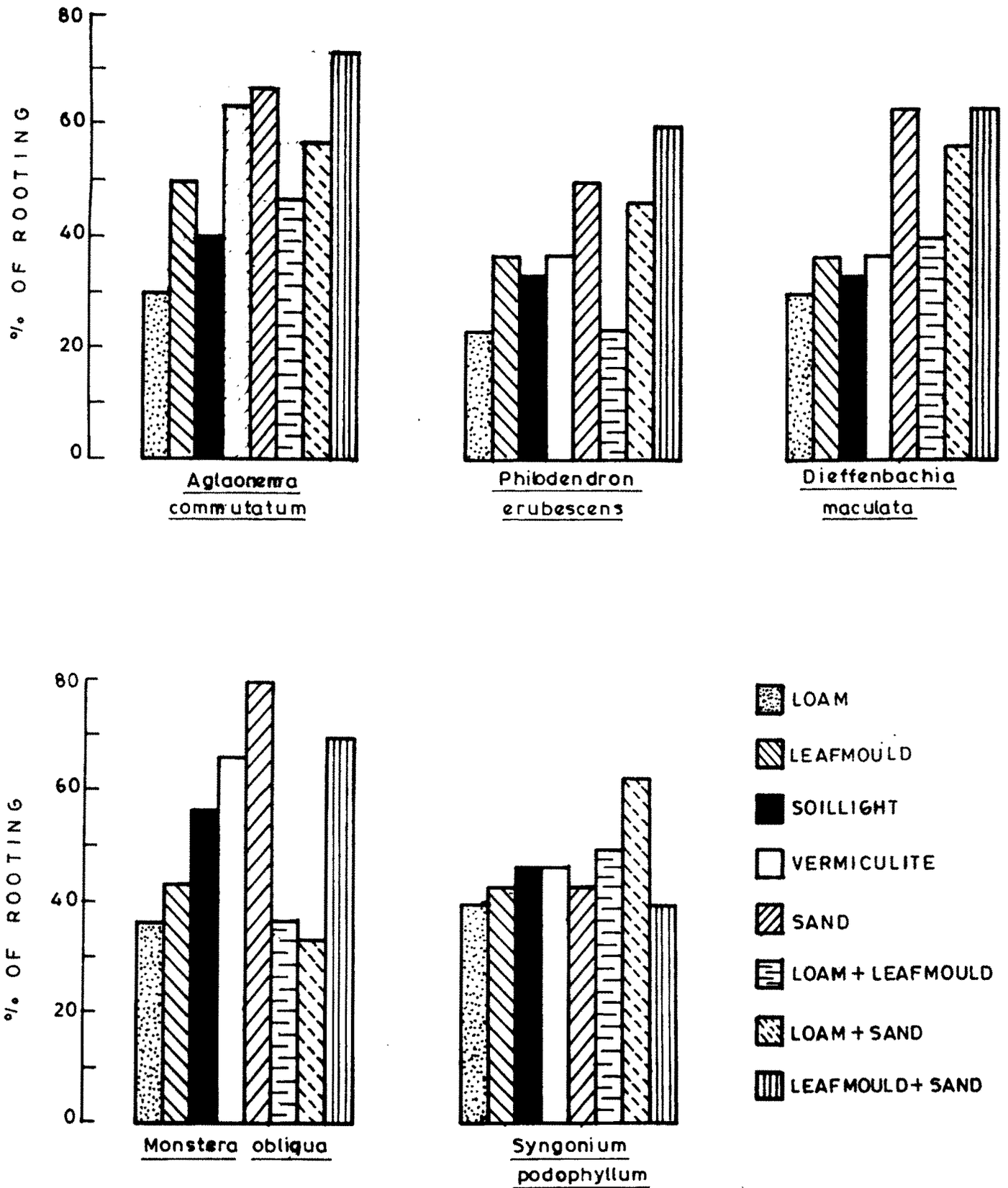


FIG.11 : THE EFFECT OF ROOTING MEDIA ON PERCENTAGE OF ROOTING OF NODE CUTTING OF FIVE HOUSE PLANTS

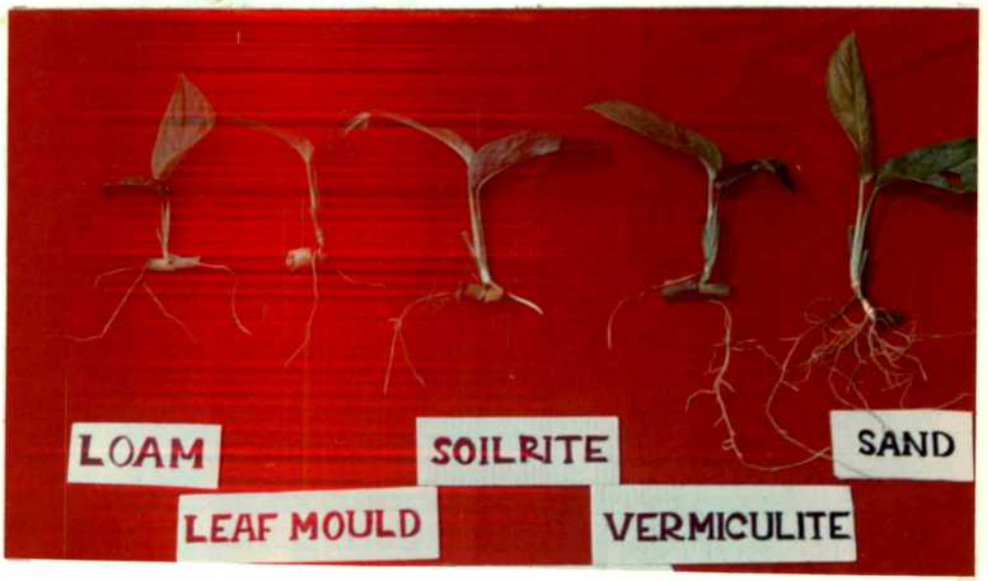


Plate No.14 (a) Effect of rooting media on regeneration and growth of Monstera obliqua.



Plate No.14 (b) Effect of different types of cutting on regeneration and growth of Peperomia obtusifolia.

Callus induction from stem on Knudson 'C' medium: In order to induce callus stem pieces were used. 2,4-D at its different concentrations (0.5 - 4.0 mg/l) were found unresponsive except at very low concentration (0.25 mg/l) where very poor callus was formed. Callus formation was readily increased by the application of NAA and BAP into the Knudson 'C' basal medium. It is evident (Table-43) that moderate to low callus yield was obtained when the medium contained 0.5 - 1.0 mg/l of NAA and 0.5 - 2.0 mg/l of BAP. Higher concentrations of NAA (2.0 mg/l or more) with BAP appeared unresponsive for *in vitro* induction of callus. No induction of callus was noted when stem pieces were placed in Knudson 'C' basal medium supplemented with BAP (0.5 - 2.0 mg/l).

Callus induction from stem on MS medium: Stem pieces were used to induce callus by applying 2,4-D, NAA, BAP. Among the growth regulators tested 2,4-D was appeared ineffective at higher concentrations (0.5 - 4.0 mg/l) whereas moderate callus yield(Table-15a)was obtained at lower concentration (0.25 mg/l). About 80 per cent callus was formed. NAA alone ,on the other hand, were ineffective in all concentrations used in this experiment; however, in combination with BAP callus was readily formed. It is clear (Table-41) that 0.5 - 1.0 mg/l of NAA along with BAP (0.5 - 1.0 mg/l induced profuse callus with fast *in vitro* growth was obtained, and cent per cent explant exhibited callusing while higher concentration of NAA (2.0 mg/l) with BAP (0.5 mg/l) were inhibitory. Poor callus yield was recorded at 2.0 mg/l of BAP and NAA (0.5 mg/l). Inclusion of BAP into the MS medium were tested for

the induction of callus and it was found that in no case at any concentration of BAP (0.5 - 2.0 mg/l) alone were effective and the explant was unresponsive at 4.0 mg/l BAP (Table-41). Morphologically calli were very soft, friable, creamy-white in colour which appeared 7-8 days after incubation.

Maintenance of calli: For better growth and perpetuation of callus, stem induced calli were transferred into fresh medium regularly. About 100 mg calli were taken as initial inoculum and subcultured at every 21 days. It was found that 2,4-D at its lower concentration induced very poor callus formation while repeated subculture at the same medium with same hormonal concentrations induced poor callus upto 3-4 passages. The callus growth declined rapidly and turned brown without showing organogenetic responses. On the other hand, NAA in combination with BAP which had a significant effect on callus induction were appeared effective for the maintenance of calli. Fresh cream-white calli were readily formed from the old callus tissues and fast in vitro growth was observed in MS medium+NAA (1.0 mg/l) + BAP (0.5 mg/l). Similar growth response was also observed in MS along with NAA (0.5 mg/l) and BAP (0.5 mg/l). In all the cases, however, the calli turned brown after 6-8 weeks of culture without giving any morphogenetic responses. Early subculturing or addition of charcoal dust (100 mg/l) could not prevent browning.

Regeneration of plantlet from callus: Stem derived calli grown

on different basal media were placed both in hormone free and hormone supplemented medium for plant regeneration. Callus tissues originating from stem pieces did not show any response in shoot bud differentiation when transferred to hormone free MS medium. Stemcalli of 3-4 weeks old were placed on different regenerating media containing various concentrations of growth hormones either singly or in combinations. Experimental results clearly indicate that BAP at various concentrations(0.05 - 4.0 mg/l) failed to initiate shoot bud. Among the various treatments of NAA (0.5, 1.0, 2.0 and 4.0 mg/l) with BAP (0.5-2.0 mg/l) calli were unable to produce shoot bud and were highly non-caulogenic and recalcitrant.

Knudson 'C' medium with the same hormonal concentrations and combinations when applied for plant regeneration similar results were obtained and no shoot bud differentiation was noted.

Direct shoot bud differentiation : The culture of stem pieces on MS medium supplemented with different plant growth regulators was investigated for the induction of shoot bud directly from the explant. Under no circumstances 2,4-D at its different concentrations (0.25 -2.0 mg/l) induced shoot bud from the explant. Among the various concentrations of BAP used lower concentrations (0.5 - 2.0 mg/l) favoured shoot formation directly from the explant(Table-15b) while higher concentration (4.0 mg/l or more)were inhibitory for the induction of shoot bud. It has been noticed that in all the cases only single shoot bud was differentiated from individual

explant (Table-42); in some cases multiple shoot bud regenerations were noticed. Use of NAA in BAP added medium were also examined for direct plant regeneration programme. It was found that NAA (0.5 - 2.0 mg/l) along with BAP (0.5 - 4.0 mg/l) were found ineffective for shoot bud differentiation, but in most of the cases the explant experienced callus formation.

Knudson 'C' basal medium was tested for plant regeneration and was observed that like MS medium BAP at lower concentrations (0.5 - 2.0 mg/l) were effective for direct shoot bud regeneration, while higher concentrations were inhibitory for shoot formation. Incorporation of NAA and BAP into Knudson 'C' medium induced poor callus instead of forming shoot.

In vitro root formation: Plants regenerated from stem pieces were transferred to different root differentiating media containing different growth regulators. It was observed that among the different growth regulators tested IBA (0.5, 1.0 and 2.0 mg/l) were not effective for root induction while incorporation of NAA at the three concentrations gave similar response. In all the cases explant died at higher concentrations (2.0 mg/l or more) without forming root. Long period of culture of regenerated shoot was also appeared unresponsive for in vitro root formation.

Ex vitro root formation: Ex vitro rooting was attempted as an alternative path-way for rhizogenesis. The process involved the selection of regenerants. Plants about 2-3 cm in height

were transferred directly to the moist sand in mist chamber. It was revealed that ex vitro rooting was observed about 12-15 days after transfer. Ex vitro rooting with much success was recorded by the use of IBA and NAA at 100 ppm.

Table-41 Effect of MS medium supplemented with growth regulators on Philodendron erubescens 'Ceylon Gold'.

Hormone concentration(mg/l)			Percentage of callusing	Response
2,4-D	NAA	BAP		
4.0	-	-	-	-
2.0	-	-	-	-
0.5	-	-	-	-
0.25	-	-	80	++
-	2.0	0.5	-	-
-	1.0	0.5	100	+++
-	0.5	0.5	100	++
-	0.5	1.0	100	+
-	0.5	2.0	100	+
-	1.0	2.0	66.5	+
-	-	0.5	-	-, sh
-	-	1.0	-	-, sh
-	-	2.0	-	-, sh
-	-	4.0	-	Died

Symbols used: - = No response; + = Poor callusing; ++ = Moderate callusing; +++ = Profuse callusing; sh = Shoot regeneration.

Table-42 Effect of MS medium supplemented with growth regulators on shoot bud formation of Philodendron erubescens 'Ceylon Gold'.

Growth regulator BAP		Number of shoot bud formed
0.05	-	Single bud formed
0.5	-	Single shoot
1.0	-	Single shoot
2.0	-	Single shoot
4.0	-	Explant died

Table-43 Effect of Knudson 'C'medium supplemented with growth regulators of Philodendron erubescens 'Ceylon Gold'.

Hormone concentration			Response
2,4-D	NAA	BAP	
4.0	-	-	-
2.0	-	-	-
0.5	-	-	-
0.25	-	-	-
-	2.0	0.5	-
-	1.0	0.5	++,sh
-	0.5	0.5	++
-	0.5	1.0	++,sh
-	0.5	2.0	++, sh
-	-	0.5	- , sh
-	-	1.0	- , sh
-	-	2.0	-
-	-	4.0	-

Symbol used: - = No response; + = Poor callusing; ++ = Moderate callusing; sh = Shoot regeneration.



Plate No.15(a) Callus induced on MS medium + 2,4-D(0.25 mg/l) in Philodendron erubescens 'Ceylon Gold'.

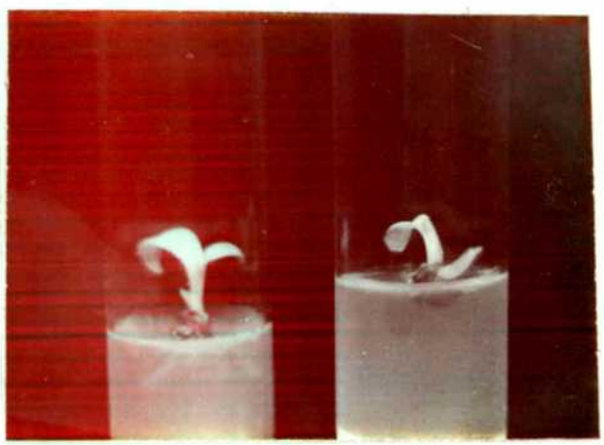


Plate No.15(b) Shoot regeneration on MS supplemented with BAP (0.5 mg/l) in Philodendron erubescens 'Ceylon Gold'.

DISCUSSION

The results of the investigations presented in the foregoing pages reveal that the vegetative growth and development of house plants are markedly influenced by light intensity, mineral nutrition, growth retardants, frequency of irrigation, type of containers and methods of propagation.

Experiment 4.2.1 Standardization of agrotechniques for culture of house plants.

Experiment 4.2.1.1 Influence of light intensity on growth and development of house plants.

It was noticed that the plant height, leaf number, size and area of leaves increased with increasing light intensity in case of all the tested house plants. Plants of Calathea zebrina, Dieffenbachia maculata, Monstera obliqua, Pleomele reflexa and Syngonium podophyllum 'White Butterfly' grown under 8,000-22,000 lux light intensity had largest plant heights, maximum number, size and area of leaves. Light intensity of 3,500-9,000 lux produced tallest plants in Calathea ornata and Philodendron erubescens 'Ceylon Gold' but Aglaonema commutatum 'Treubii' and Scindapsus aureus 'Marble Queen' could be grown well in 10,000-23,000 lux light intensity. In Monstera deliciosa, maximum plant height (65 cm) was obtained under low light intensity (1,600-3,000 lux), whereas highest light intensity caused reduction in the height of the plant. These results agree with the findings of some workers in this field. Conover and Poole (1981a) found that plant growth in Brassaia actinophylla and

Dieffenbachia maculata cv. Perfection increased with increasing levels of light intensities varying from 0.5 K lux to 2 K lux. Collins and Blessington (1981) found that Peperomia obtusifolia plants were taller with increase in light intensity from 15 K lux to 30 K lux whereas taller and heavier plants of Ficus elastica were obtained under 15 K lux light intensity. The growth of Aglaonema commutatum 'Silver Queen' was increased by increasing light intensity from 150 to 1,250 lux (Sandved,1983). Internode length of Monstera deliciosa was maximum (7.08 cm) under low light intensity (1,600-3,000 lux), whereas Philodendron erubescens 'Ceylon Gold' and Scindapsus aureus 'Marble Queen' produced longer internodes under light intensity of 3,500-9,000 lux. Internodes of vine in above mentioned three plants was reduced under highest light intensity. The similar trend of result was obtained in Ficus elastica when grown in 15 K lux light (Collins and Blessington, 1981). Rioux and Dansereau (1981) also obtained shorter internodes in Dieffenbachia amoena, Ficus benjamina and Codiaeum variegatum at light intensity of 2,700 lux. Diameter of vine in Monstera deliciosa, Philodendron erubescens 'Ceylon Gold' and Scindapsus aureus 'Marble Queen' increased with the increase in light intensity. Fresh weight of Ficus and Schefflera increased by 20-30% in response to increase in light intensity from 300-3,000 lux but in Cissus growth was maximum at 2,000 lux (Horn and Huber, 1983). Fresh weight of Peperomia obtusifolia also increased with increasing light intensity from 15 to 30 K lux (Collins and Blessington, 1981). The number of side shoots or branches increased with increase in

light intensity. Rioux and Dansereau (1981) found that the growth of secondary stem was best at 2,700 lux in case of Dieffenbachia amoena, Ficus benjamina and Codiaeum variegatum.

Plant growth and development of most of the house plants were adversely affected by low light intensity. Low light intensity (450 to 1,500 lux) reduced plant height, leaf number, size and area of leaves of the house plants. Chase and Poole (1987b) observed that Syngonium podophyllum 'Butterfly' produced few leaves under 80% shade and fresh weight of shoot was low. Fresh and dry weight of shoot of Peperomia obtusifolia decreased with reduction in the light intensity (Shen and Seely,1983). There is a direct relationship between the rate of photosynthesis and the intensity of light, provided that the other factors are limiting. Low light levels are frequently responsible for foliage plant degradation. When the intensity of light incident on a photosynthesizing organ is increasing beyond a certain point, the cell of that organ become vulnerable to chlorophyll- catalyzed photooxidations.

Colour grade and quality of house plants were profoundly affected by the intensity of light. The colour grade and plant grade were better under high level of light intensity in case of all the house plants. Largest plants with the best grades were obtained in areca palm at 40% shade level under approx 6,000 to 7,000 ft candle maximum light (Poole and Conover, 1975). Preissel et al.,(1980) reported that colour intensity and contrast of Codiaeum variegatum var.Pictum cv.Philipp Geduedig were best under

3,000 lux light intensity and 8,000 lux light intensity checked the growth of young leaves and red markings appeared over yellow colour. Reduction in light intensity (about 73%) increased the relative amount of non-green area/leaf (variegation) (Shen and Seely, 1983). Leaf colour in Dieffenbachia amoena, Ficus benjamina and Codiaeum variegatum was enhanced at 2,700 lux light intensity (Rioux and Dansereau, 1981). The best quality of plants in case of Dracaena angustifolia cv.Honoriae could be produced under 26 K lux light intensity (Conover and Poole, 1980a). Chase and Poole (1987b) found that low quality of plants of Syngonium podophyllum 'Butterfly' were obtained when plants were grown under 80% shade. Plant grades of Peperomia obtusifolia and Ficus elastica 'Decora' were greater with 30 K lux and 15 K lux light intensity respectively (Collins and Blessington,1981).

Experiment 4.2.1.2 Studies on the effect of mineral nutrition on growth and development of house plants.

Experiment 4.2.1.2.1 Effect of different levels of nitrogen and potassium on growth and development of house plants in sand culture.

In sand culture trial different levels of nitrogen displayed marked effect on growth of house plants. The plant vigour in terms of height, leaf number, size and area of leaves was promoted at lower levels of nitrogen. At nitrogen concentration of 200 mg/l plants responded well with respect to plant height, leaf number, size and area of leaves, fresh and dry weights of root and shoot,

colour and plants grades while highest concentration of nitrogen (600 mg/l) suppressed plant growth. Similar results were reported by many a research worker. Pimpini (1971) noted that application of N at 280 or 420 ppm increased the plant height and diameter of stem in Scindapsus aureus. Rodriguez and Cibes (1977) found that number of leaves, plant height and weight of plants in Dracaena deremensis 'Warneckii' were significantly affected by nitrogen level and maximum of 164 to 210 ppm depending on the shade intensity. Plant height and number of shoots/plant were increased and leaf colour improved in Aglaonema commutatum cvs. Fransher and Pseudobracteatum with increase in nitrogen levels from 80 mg to 240 or 320 mg/15 cm pot (Poole and Conover,1977). Top weight, leaf area and number of fronds in Nephrolepis exaltata 'Roose-veltii' increased with increasing nitrogen concentration upto 200 ppm N, but all the three parameters decreased with 300 ppm N treatment (Morgan and Hipp, 1979). Poole and Conover (1982) also found that N at 1200 kg $ha^{-1}y^{-1}$ in Dieffenbachia maculata and 1800 kg $h^{-1}y^{-1}$ in Brassaia actinophylla caused increase in top growth of plants.

Low level of potassium (200 mg/l) markedly improved plant height, leaf number, size and area of leaves, fresh and dry weight of shoot and root, colour intensity and plant quality of Aglaonema commutatum 'Treubii', Cordyline terminalis, Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen' compared to the other levels. Beel and Schelstraeta (1979) found that optimum level of K at 150-180 mg/litre improved plant height, leaf number and number

of side shoots in Dieffenbachia picta and D.exotica cv.Perfecta. Bell and Schalstraete (1980a)also obtained best result in case of Calathea ornata when K was applied at 150 mg/litre substrate as a basic dressing and 75 mg as a top dressing.

The interaction effect of nitrogen and potassium failed to show any significant improvement in the plant height, leaf number, size and area of leaf, dry weight of shoot and root, colour grade and plant grade of Aglaonema commutatum 'Treubii' and Scindapsus aureus 'Marble Queen'. However, lowest level of nitrogen and potassium both at 200 mg/l caused significant increase in all the growth parameters of house plants used in this experiment. Cordyline terminalis showed improved plant growth with nitrogen at 400 mg/l and potassium at 200 mg/l while in Dieffenbachia maculata 'Exotica' nitrogen and potassium both at 200 mg/l responded better growth of plant. Highest level of nitrogen and potassium, on the other hand, suppressed the growth of all tested plants. As the fertilizer rate increased, dry weight of all the house plants used in this experiment decreased, probably due to the excess soluble salts. Highest doses of fertilizer showed toxic symptoms of all the plants. Poole and Henley (1981) observed that NPK levels of 500 : 200 : 400 or 750 : 330 : 600 mg/litre reduced the plant growth of Brassaia actinophylla, Chamaedorea elegans and Peperomia obtusifolia cv. variegata in 15 cm tubs compared to 250 : 110 : 200 mg/litre but had no effect on Philodendron scandens oxycardium and Maranta leuconeura erythroneura. At high concentration of 800 : 360 : 680

mg/litre reduced the fresh weight and root system of P.obtusifolia and B.actinophylla. The high level of fertilizer was detrimental to both plants. Lower concentration improved the plant height, top fresh weight and root grade of P.obtusifolia and B.actinophylla. Khattab et al.(1987) also noticed that high rates of K and P reduced fresh weight of stem and leaf of Monstera deliciosa. Ficus benjamina, on the other hand, responded best to liquid fertilizer application at 19 : 6 : 10 of NH_4NO_3, P_2O_5 and KNO_3 with regards to plant grade and foliage colour (Conover and Poole, 1985).

Experiment 4.2.1.2.2 Response of organic and inorganic fertilizers on growth and development of house plants.

Manures from barnyards, stables, or feedlots are sources of essential plant nutrients. Other sources of organic or natural fertilizers include bone, castor bean, cotton seed or fish meal, dried blood, sewage sludge and garbage tankage.

Plant height, number, size and area of leaves, colour grade and plant grade of Aglaonema commutatum 'Silver Queen' and Dieffenbachia maculata were increased when grown in medium containing bloodmeal. Dieffenbachia maculata 'Exotica', Monstera deliciosa and Philodendron erubescens, on the other hand, showed best growth in sterameal compared to control. Bonemeal improved the growth, colour and plant quality of Scindapsus aureus 'Marble Queen'. In Calathea zebrina and Syngonium podophyllum 'White Butterfly' bonemeal improved plant growth but more number of side shoots or branches, colour grade and plant grade were obtained when Calathea zebrina and Syngonium podophyllum 'White Butterfly' were grown in bloodmeal and bonemeal respectively.

Cordyline terminalis and Chlorophytum comosum 'Variegatum' produced maximum plant height, number, size and area of leaves when grown in media containing NPK (1 : 1 : 1) at 2.5 g/pot but colour intensity and plant quality were more when grown in media containing bonemeal. Pleomele reflexa grown on charcoal dust enriched media exhibited more growth, improved colour and plant quality. Slow-release and/or organic fertilizer release nutrients slowly, but a portion is available immediately ; therefore good quality plants can be grown using liquid fertilizer or slow release fertilizers exclusively if both are properly applied (Langhans et al., 1972 and Trapp, 1973). Considerable variation exists in nutritional needs of foliage plants and rates that may be excessive for one species may not adequate to produce quality in other species. In an experiment with Peperomia obtusifolia, Poole and Chase (1987b) found that plant height increased with an increase in Osmocote (19-6-12) rates upto 2.5 g/4" pot and then decreased. Chamaedorea elegans and C.constricta gave best growth performance when NPK (28 : 9 : 19) fertilizer was applied at the lowest rate i.e. 2.5 g (Badawy et al.,1987). Chase (1989) noticed that plant height, leaf number and good quality of plants were high in Calathea species when fertilized with Osmocote (19-6-12) at rates between 5 to 14 g/pot.

Experiment 4.2.1.3 Effect of growth retardants on growth and development of house plants.

Treatment with growth retardants as foliar spray, in general,

proved more effective in suppressing plant height and also improved foliage production. Growth retarding chemicals at the highest concentration (4,000 ppm) markedly influenced plant heights. Cycocel, B-9 and Maleic hydrazide as foliar sprays at 4,000 ppm reduced plant height in Aglaonema commutatum 'Treubii', Calathea zebrina, Dieffenbachia maculata, Monstera obliqua, Pleomele reflexa, Peperomia obtusifolia and Syngonium podophyllum 'White Butterfly'. All these chemicals at the lowest concentration (1,000 ppm) slightly increased the plant height of Aglaonema commutatum 'Treubii', Pleomele reflexa and Peperomia obtusifolia. Cycocel and Maleic hydrazide at 1,000 ppm slightly increased the plant height in Calathea zebrina. According to Sachs et al.1960, SADH, CCC, Phosphon-D and Amo-1618 retard stem elongation by preventing cell division in the subapical meristem, usually without similarly affecting the apical meristem. Plant growth retardants can induce plants having a tall growth habit to develop with a rosette type of growth. The effect of plant growth retardants on inhibition varies greatly with the chemical compounds and plant species. Poole (1970) obtained 50% reduction of growth in Philodendron oxycardium, Scindapsus aureus and Syngonium podophyllum cv.Emerald Gem by applying B-9. The plant height of Raderonachera sinica was controlled by spraying B-9 at 2500 to 7,500 ppm (Broschat et al.,1987). Cycocel had little effect on plant growth of Philodendron oxycardium, Scindapsus aureus and Syngonium podophyllum (Poole, 1970). Schenk and Brundert (1981) noticed that triple spray with 0.5% ∝ CCC every three weeks

considerably inhibited plant growth of Philodendron erubescens Cv.Red Emerald, Pseudoeranthemum atropurpureum, Schefflera arboricola and Syngonium podophyllum. In Philodendron oxycardium and Scindapsus aureus spray application of Maleic hydrazide mostly checked plant growth. Spray application of ancymidol, phosphon-D, ethrel and paclobutrazol were found to control the growth of house plants by several research workers. Ancymidol reduced the height of Peperomia obtusifolia, Dieffenbachia maculata cv.Camille and Epipremnum aureum plants at various concentrations upto 1 mg/pot (Mansour and Poole, 1987a, 1987b). Rodriguez et al.(1972)noticed that ethrel at 4,000 and 8,000 ppm caused a marked reduction in height of Cordyline terminalis cv.Baby Doll. Paclobutrazol at 0.6 to 2 mg/plant suppressed the plant height of Syngonium podophyllum cv.White Butterfly (Wang and Blessington, 1990). In Aglaonema commutatum 'Treubii' and Monstera obliqua spray application of Cycocel, B-9 and Maleic hydrazide at higher concentrations reduced the number of leaves over control, and Cycocel and Maleic hydrazide both at 2,000 and 4,000 ppm reduced number of leaves in Dieffenbachia maculata. These results find support from earlier investigations made various workers with different growth retarding chemicals. Soil drenching with Paclobutrazol at 0.125 to 8.0 mg/10 cm pot retarded plant height, leaf production, internode length and leaf size of Ficus benzamina. The number of new leaves were slightly reduced in ancymidol (0.25 to 1 mg/pot) treated plants in case of Syngonium podophyllum 'White Butterfly' (Wang, 1987b). The number of leaves of Dieffenbachia x'Victory' were reduced by the

application of XE-1019 (Sumagic) but leaf number in Dieffenbachia maculata 'Camille' were not affected by paclobutrazol and ancymidol (Mansour and Poole, 1987a). Spraying with growth retarding chemicals (CCC, B-9 and MH) at 4,000 ppm caused increase in the number of leaves in Calathea zebrina, Pleomele reflexa, Peperomia obtusifolia and Syngonium podophyllum 'White Butterfly'. Application of B-9 at 4,000 ppm increased the number of leaves of Dieffenbachia maculata. Brazzocchi et al.(1987) found that single spray with 25 ppm of paclobutrazol was sufficient to cause more leaf production in Syngonium podophyllum 'White Butterfly'. In an experiment, Mansour and Poole (1987b)also found that XE-1019 treated Peoperomia obtusifolia plants produced more number of leaves compared to control.

Length and width of leaves of tested house plants were also significantly affected by Cycocel, B-9 and Maleic hydrazide. In Syngonium podophyllum 'White Butterfly', length and width of leaves were increased with increase in concentration of B-9 (1,000 to 4,000 ppm). Cycocel and B-9 at all concentrations and Maleic hydrazide at 1,000 ppm increased leaf length and width of Monstera obliqua. These observations are in agreement with Wang (1987b) who has shown that ancymidol increased length and width of uppermost fully expanded leaf of Syngonium podophyllum 'White Butterfly'. Soil drenching with uniconazole and paclobutrazol were equally effective in increasing width of leaf of Syngonium podophyllum 'White Butterfly' (Wang and Blessington, 1990). Leaf length and

width of Aglaonema commutatum 'Treubii', Dieffenbachia maculata, Pleomele reflexa and Peperomia obtusifolia were reduced with increase in concentration of growth retardants (Cycocel, B-9 and Maleic hydrazide). Leaf length of Pleomele reflexa, and both leaf length and width of Peperomia obtusifolia were not significantly affected by the application of growth retarding chemicals. The results corroborate the findings of Mansour and Poole (1987b). They found that leaf length and width were not affected by daminozide in Philodendron scandens oxycardium. Both leaf length and width were reduced in XE-1019 treated plants of Peperomia obtusifolia. XE-1019 also caused reduction in leaf length and width of Dieffenbachia x'Victory' plants.

Leaf area in Aglaonema commutatum 'Treubii',Dieffenbachia maculata, Pleomele reflexa and Peperomia obtusifolia plants decreased with increase in the concentration of growth retarding chemicals. In Calathea zebrina and Syngonium podophyllum 'White Butterfly'leaf area increased with increase in the concentration of B-9; while Cycocel and Maleic hydrazide caused reverse effect. Maleic hydrazide reduced the leaf area in case of Monstera obliqua compared to control. In an experiment with Paclobutrazol, LeCain et al.(1986) found that treated plants had reduced leaf size in Ficus benjamina. Paclobutrazol and ancymidol reduced leaf area in Dieffenbachia maculata 'Camille' (Mansour and Poole,1987a).

Cycocel, B-9 and Maleic hydrazide caused significant increase in branch number of Peperomia obtusifolia and Syngonium

podophyllum 'White Butterfly'. It may be noted here that Mansour and Poole (1987b) obtained enhanced branching in Peperomia obtusifolia with XE-1019. Ancymidol at 0.625 to 2.5 mg/sq.ft increased in the growth of axillary vegetative shoots of Alternanthera and Wandering jew (Frank and Donnan, 1975).

Colour grades and plant grades were improved by the application of growth retarding chemicals. It was also revealed that both these characters were increased with increase in the concentration of B-9, Cycocel and Maleic hydrazide. It was also observed that treated plants had darker green foliage and much better visual appearance than control. Colour grade of Aglaonema commutatum 'Treubii', Calathea zebrina, Dieffenbachia maculata and Pleomele reflexa were not significantly different, though application of chemicals improved colour of foliage. These observations are in agreement with the following earlier findings. Spraying of Cycocel and Alar (daminozide) caused compact plant growth with improvement in leaf colour of Philodendron erubescens cv.Red Emerald, Pseudoeranthemum atropurpureum, Schefflera arboricola and Syngonium podophyllum plants (Schenk and Brundert, 1981). Blessington and Link (1980) found that ancymidol caused compact plant growth and more intense leaf colour in Fatshedera lizei, Philodendron scandens oxycardium and Tradescantia fluminensis. LeCain et al. (1986) obtained darker green leaves in Ficus benjamina by applying paclobutrazol. Joiner et al. (1978)reported good quality plants in Dieffenbachia maculata 'Bara quiniana'by application of ancymidol.

Experiment 4.2.1.4 Influence of irrigation frequency on growth and development of house plants.

Irrigation frequency varied with size of plants and containers, potting mixture, soil and air temperatures, solar radiation, humidity and air movement. Growth and development of the house plants were influenced by frequency of irrigation. Plant height, number and size of leaves increased with increase in the level of water frequency. Daily watering increased the plant height, leaf number, size and area of leaves of Aglaonema commutatum 'Treubii', Calathea zebrina, Dieffenbachia maculata, Monstera deliciosa, M.pertusa, Pleomele reflexa 'Song of India' and Syngonium podophyllum 'White Butterfly'. Under water stress condition the plant growth was significantly reduced. Similar results were obtained by various workers. Spooner et al. (1978) noticed that daily watering increased the growth of Jade plant (Crassula argentea) compared to weekly watering. Further work by Conover and Poole (1977a) showed that Aphelandra squarrosa Nees cv.Dania watered daily or two times a week were larger than those watered weekly. Water acts as a carrier of essential nutrients and carbohydrates and permits reaction between molecules in solution and between enzymes and substrata. Excess irrigation results in poor aeration, waste of water and fertilizer, reduced plant growth, and eventual death. Water stress is an important factor in the induction of leaf abscission when plants grown under various shade levels.

Irrigation of potted house plant at one day interval improved

the plant height, number, size and area of leaves in Aglaonema commutatum 'Silver Queen', Chlorophytum comosum 'Variegatum' and Peperomia obtusifolia. It may be pointed out that according to Poole and Conover (1977), plant heights in Brassaia actinophylla and Aglaonema commutatum were greater when plants were irrigated 3 times and 2 times per week respectively. Johnson et al. (1981) found less number of leaves under maximum water stress condition in Ficus benjamina compared to control. He also noticed that leaf area of F.benjamina increased with increasing irrigation frequency. Size and number of leaf were increased with the increase in irrigation frequency in most of the experimental plant. Fresh weight of tops and roots of Brassaia actinophylla were more when plants were irrigated 3 times per week (Poole and Conover,1979). In Chlorophytum comosum cv. Variegatum, Hipp et al.(1979) obtained best plant growth with frequent watering (3 times per week) rather than once per week. Poole and Chase (1987a) found that one irrigation/2 weeks was insufficient for Brassaia actinophylla but the rest of the treatment (2, 3 or 4 times/week) gave equally satisfactory result. Conover and Poole (1977) found that growth of Dieffenbachia maculata 'Exotica' and Philodendron scandens oxycardium plants were generally better when hand watered 3 times/week. The best growth of Cissus rhombifolia, Dracaena surculosa cv.Florida Beauty and Syngonium podophyllum 'White Butterfly' were obtained with higher frequency of irrigation, i.e. 4 times/week (Poole and Conover, 1986). McConnell and Host (1980) found that stem

elongation and number of new leaves were reduced with decreasing watering frequency in lemone vine.

Colour and plant grade of the experimental house plants were also influenced by irrigation frequency. It was found that colour and plant grade were improved with increase in the irrigation frequency. High quality of plants were obtained with increase in irrigation frequency. These observations were also noted by some workers. Poole and Conover (1979) obtained high quality plants by applying irrigation twice a week in Aglaonema commutatum. Poole and Conover (1981, 1986c) also found that the best quality plants of Cissus rhombifolia, Dracaena sureulosa cv.Florida Beauty, Dieffenbachia maculata 'Perfection' and Nephrolepis exaltata 'Bostoniensis'and Syngonium podophyllum 'White Butterfly'were obtained with irrigation at 4 times per week. Plant grade of Calathea makoyana was inpaired slightly as irrigation increased. In Peperomia obtusifolia high quality plants were obtained by applying 3-4 irrigations per two weeks during warm season (Poole and Chase, 1987a).

Experiment 4.2.1.5 Effect of different types of container on growth and development of house plants.

In the present investigation, foliage plants grown in different types of container exhibited differential responses. House plants are commonly grown in earthen pots. In the present investigation, plants grown in plastic pots responded well in respect of foliage growth compared to plants potted in earthen

pots. Plants of Aglaonema commutatum 'Silver Queen', Calathea zebrina, Chlorophytum comosum 'Variegatum', Dieffenbachia maculata, Monstera deliciosa, Scindapsus aureus 'Marble Queen' and Syngonium podophyllum 'Variegatum' grown in plastic pots produced maximum plant height, leaf number, size and area of leaves and had improved colour intensity and better plant quality as compared to plants grown in earthen pots. It is clear from the present investigation that plants grown in wax coated earthen pots exhibited improved plant height, leaf number, size and area of leaves, colour intensity and quality of plant in case of Calathea ornata, Cordyline terminalis, Monstera obliqua and Philodendron erubescens 'Ceylon Gold'. Similarly, Hedera canariensis and Codiaeum variegatum plants potted in plastic pots showed good growth compared to clay pot (Christensen, 1971 and 1974). Plastic pot retains more moisture in media than earthen pot which favours better growth and development of the house plants. Tesi (1983) in his experiment on Maranta tricolor, recorded the beneficial effects of plastic pots on plant growth. Plastic pots retained moisture better than clay pots in summer and favoured species with high water requirement. Bose and Chowdhury (1991) opined that plastic and non-porous pots are ideal for house plants which flourish in moist compost.

Experiment 4.2.2 Standardization of propagation of house plants.

Experiment 4.2.2.1 Effect of nodal position on the propagation of house plants.

Nodal position affected shoot and root growth from cuttings.

Early emergence of root and shoot occurred with tenth nodal cuttings of Aglaonema commutatum 'Treubii' whereas Dieffenbachia maculata and Scindapsus aureus 'Marble Queen' showed early shoot and root emergence in case of 5th node cuttings from the top. But in Monstera obliqua and Philodendron erubescens, on the other hand, sixth nodal cutting responded well with respect to early formation of shoot and root. Cuttings of Aglaonema commutatum 'Treubii' from tenth node produced leaves faster and had longer shoots than those with upper node cuttings. However, highest percentage of rooting was found in 8th node cuttings. There were marked differences in fresh and dry weight of root and shoot among the treatments. Recently mature stem are better for propagating purposes than the older cutting materials, due to incapability of sprouting old axillary bud or young cutting materials, due to lack of carbohydrate accumulation. Basal cuttings in Hedera helix developed longer shoots and more roots than apical cuttings (Poulsen and Anderson, 1980). Hansen (1986a) found that single node Schefflera arboricola cuttings from uppermost fully expanded leaf performed poorly. Such cuttings required a longer time to break lateral buds, had lower rooting percentages and fewer roots and did not grow as fast as cuttings from lower nodes. This difference may be related to the maturity of the tissues in the relatively young leaf and internode. The 6th node cuttings of Dieffenbachia maculata, Monstera obliqua and Philodendron erubescens produced maximum number and length of shoots and roots, fresh and dry weight of root and shoot. The 5th nodal cuttings

of Scindapsus aureus 'Marble Queen' also produced maximum length of shoot and number of leaves. Higher percentage of rooting and maximum fresh and dry weight of root and shoot were obtained when 5th node cuttings of Scindapsus aureus were used. Early emergence of root and shoot in Syngonium podophyllum 'Variegatum' was noted with 3rd and 4th nodal cuttings but maximum number of leaf, length of shoot and root, percentage of rooting, and both fresh and dry weight of shoot and root were obtained in case of 6th nodal cutting. Wang and Boogher (1988), in this experiment with Golden Pothos, opined that accelerated shoot growth and increase in leaf number, stem length, leaf area and fresh weight of shoot were associated with cuttings from the apical nodes.

Experiment 4.2.2.2 Regeneration of plantlets from cuttings with varying number of nodes.

All cuttings used in this experiment developed axillary shoots, probably due to initial selection of good propagating material. Leaf number and shoot length of house plants used in this experiment increased with increasing size of node cuttings. Three node cuttings of Aglaonema commutatum 'Treubii', Dieffenbachia maculata, Monstera obliqua, and Philodendron erubescens developed early root and shoot growth, longest length of root and shoot, maximum number of root and leaf, highest percentage of rooting, more fresh and dry weights of root and shoot. Single node cuttings of all the plant species used in this experiment responded poorly in respect of plant growth. Rodrigues and Rivera-Lopez (1977b)

found that 13.5 inch long cutting of Dracaena sanderiana showed better response to growth than 4-6 inch cuttings. Rooting success, number of roots per cutting, percentage of bud break and shoot length increased with the increase in the length of stem in Schefflera arboricola (Hansen and Andersen, 1987). Three node cuttings might have triggered faster shoot and root growth due to more stored nutrients in the longer cut pieces. Three node cuttings should therefore be used for most rapid shoot and root development.

Experiment 4.2.2.3 Regeneration of plantlets from node with leaf, node without leaf and leaf cuttings of Scindapsus aureus 'Marble Queen' and Peperomia obtusifolia.

Leaf influenced the formation of roots on cutting of house plants. Node cuttings with leaf in Scindapsus aureus 'Marble Queen' and Peperomia obtusifolia showed early emergence of root and shoot and produced longest root and shoot lengths, maximum number of root, and leaf, more fresh and dry weight of root and shoot and also higher percentage of rooting compared to node cuttings without leaf. Similarly, Wang (1987a)noted in Epipremnum aureum that shoots developed from leaf bud cuttings had longer stems, more leaves and total leaf area and heavier dry matter than shoots from stem cuttings. Hansen (1986b), in his experiment with Schefflera arboricola, reported that with 2 or 3 fully developed leaves rooting was much better giving more stronger

and longer roots than smaller cuttings with one leaf. Their subsequent growth was also more vigorous.

In leaf cutting of Peperomia obtusifolia shoot formation was delayed by about 70 days though root formation was enhanced by about 40 days compared to node cuttings with leaf. In case of Scindapsus aureus 'Marble Queen' leaf cutting did not form root and shoot. The leaf cuttings of Peperomia and Sedum produced new shoots and roots in callus tissue which developed over cut surface through the activity of secondary meristem (Yarborough, 1936). There were considerable supporting experimental evidences (Cooper, 1938; Rapport, 1940 and Went, 1929) that the presence of leaves on cutting exerts a strong stimulating influence on root initiation.

Experiment 4.2.2.4 Effect of rooting media on root regeneration and plant growth in cuttings of some house plants.

Rate of root formation on cutting was directly affected by different rooting media. Use of loam + leafmould (1 : 1) potting medium caused early emergence of shoot and root in Aglaonema commutatum 'Treubii' and Syngonium podophyllum 'Variegatum'. Cutting of Philodendron erubescens and Monstera obliqua, on the other hand, showed early emergence of shoot and root in sand medium. In an experiment with Aglaonema and Dieffenbachia, Joiner and Nell (1980) observed that rooting was delayed in solite medium with production of poor quality plants. Higher percentage of rooting was recorded in Aglaonema commutatum

'Treubii' , Dieffenbachia maculata and Philodendron erubescens with leafmould and sand (1 : 1) media whereas Monstera obliqua showed higher percentage of rooting in sand and Syngonium podophyllum 'Variegatum' in loam + sand (1 : 1) medium. As regards to root and shoot growth of foliage plants, loam + leaf-mould (1 : 1) medium proved better in Aglaonema commutatum 'Treubii' and Syngonium podophyllum 'Variegatum'. Philodendron erubescens and Monstera obliqua plants,on the other hand, showed good growth in sand medium. But in Dieffenbachia maculata,initial growth of both root and shoot were better in leafmould + sand (1 : 1) medium. Rodriguez et al. (1973) found that muck soil, spent coffee and tobacco industry residues were best rooting media for Dracaena sanderiana. Higaki (1981) noted that one node cuttings of Dracaena goldeana rooted equally well in peat moss, perlite, black cinder or vermiculite under intermittent mist. Peat/perlite mixture was better than in fired monmorillonite clay, solite or Gro-sorb for propagation of Aglaonema and Dieffenbachia (Joiner and Nell, 1980). Root growth of Aphelandra squarrosa was improved by addition of dolomite to rooting media, but subsequent plant growth after transplanting into pot was unaffected (Conover and Poole, 1972b).

Experiment 4.2.2.5 In vitro propagation of Philodendron erubescens 'Ceylon Gold'.

The members of different families of dicotyledons can readily undergo callusing and subsequent regeneration in vitro

and monocotyledonous plants have been considered difficult materials for *in vitro* cloning. However, an increasing number of monocotyledons have been successfully propagated by the induction of MS and B_5 medium with high salt concentrations and with the use of myo-inositol in the medium (Evans *et al.*, 1981). In the present investigation, two different basal media were used for the successful induction of callus. From the result it was clear that both MS and KC media were effective for initial establishment of culture and MS medium proved superior than the other media tested. This was probably due to its high salt concentration in the medium. Most plant tissues require hormonal factors for initial cell division and 2,4-D was found more active than other auxins tested and possibly the difference in activity was due to the fact that 2,4-D was much more stable and less inactivated. The differential result can also be attributed to their different metabolism of these compounds, in particular to their ability to form conjugates (Gamburg, 1976). In most cases, dicotyledons require cytokinins for initial induction of callus, but in monocotyledons the requirement of exogeneous cytokinins is relative and in many cases specially in cereals monocotyledons do not require cytokinins at all. In the present investigation, it may be pointed out that the necessity of the presence of cytokinin with auxin for better callusing was rather obligatory and found that NAA in combination with BAP at lower concentrations induced profuse callusing irrespective of media. Similar findings were also observed in many ornamentals as well (Sahavacharin, 1982, Muralidhar and Mehta, 1986b ; Chen, 1983).

It was found that long term callus culture in both the media could not induce shoot bud and callus turned brown after 3-4 passages without exhibiting organogenetic responses and therefore the callus was considered to be recalcitrant and non-caulogenic.

Adventitious bud formation has been achieved in both MS and KC media and unlike callus induction, BAP singly had direct influence on shoot bud production and the hormone concentrations necessary, appeared to vary from 0.5 mg/l to 2.0 mg/l. Addition of NAA at lower concentrations helped in shoot bud formation to some extent. Higher concentrations in all the cases were inhibitory.

In the present investigation, in vitro rooting was attempted and it was found that IBA and NAA at three different concentrations (0.5, 1.0, 2.0 mg/l) were ineffective for root induction. Higher concentrations were lethal for the plants. However, ex vitro rooting has been achieved with fair success as an alternate pathway. Furthermore, it was found that IBA and NAA at 100 ppm improved rooting. Similar phenomenon of ex vitro rooting was also observed by many other workers (Debergh, 1981 ; Levy, 1985 ; Mujib and Jana, 1990).

Therefore, the present investigation contributed at least to some extent the basic scheme for the micropropagation of Philodendron erubescens 'Ceylon Gold'. However, further informations are needed for their large scale multiplication and application in tissue culture industry.

Chapter 5

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

Experiments were carried out at the Agri-Horticultural Society of India, Calcutta and Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia in order to standardize some of the agrotechniques and propagation methods to obtain good quality foliage plants. The important findings recorded in each of the experiment are summarised below.

Experiment 5.1 Standardization of agrotechniques for culture of house plants.

Experiment 5.1.1 Influence of light intensity on growth and development of house plants.

Variation in the intensity of sunlight markedly influenced the growth of foliage in Aglaonema commutatum 'Treubii', Calathea ornata, C.zebrina, Dieffenbachia maculata, Monstera deliciosa, M.pertusa, Pleomele reflexa, Philodendron erubescens 'Ceylon Gold', Scindapsus aureus 'Marble Queen' and Syngonium podophyllum 'White Butterfly'. High light intensity (8,000-22,000 lux) increased the plant height, leaf number, size (length and width) and area of leaves and improved the foliage colour and plant quality in Calathea zebrina, Dieffenbachia maculata, Monstera pertusa, Pleomele reflexa and Syngonium podophyllum 'White Butterfly'. Similarly, Aglaonema commutatum 'Treubii' and Scindapsus aureus 'Marble Queen' responded well in respect of plant growth to light intensity between 10,000 to 23,000 lux. Reduction in light intensity (3,500-9,000 lux) markedly improved the plant growth and quality in Calathea ornata,

Monstera deliciosa and Philodendron erubescens 'Ceylon Gold' while the lowest light intensity (450-1,000 lux) suppressed the plant growth and adversely affected the foliage colour and quality in general.

Experiment 5.1.2 Studies on the effect of mineral nutrition on growth and development of house plants.

Experiment 5.1.2.1 Effect of different levels of nitrogen and potassium on growth and development of house plants in sand culture.

In order to find out the optimum levels of N and K on growth and quality of house plants, experiment was carried out in sand culture. Three levels of N and K (200, 400 and 600 mg per litre each) were applied at every alternate day and continued for 75 days. Treatment with lower dose of nitrogen (200 mg/l) showed maximum beneficial effect on the height of plants, number, size and area of leaves and quality of plants in Aglaonema commutatum 'Treubii', Cordyline terminalis, Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen' compared to higher doses of nitrogen. Increased level of nitrogen led to significant decrease in plant height, leaf number, size and area of leaves, fresh and dry weight of shoot and root, and also plant grade in Aglaonema commutatum 'Treubii', Cordyline terminalis, Dieffenbachia maculata'Exotica' and Scindapsus aureus 'Marble Queen'. The adverse effect of high levels of nitrogen (600 mg/l) appeared at the early

state of growth and production of quality plants was severely affected. Low level of potassium (200 mg/l) also proved most effective in improving the growth and quality of above mentioned plants. High levels of potassium suppressed the growth and quality of plants in all plant species used in this experiment.

The lowest levels of both nitrogen and potassium (200 mg/l) improved the plant growth and quality of plants in Aglaonema commutatum 'Treubii', Dieffenbachia maculata 'Exotica' and Scindapsus aureus 'Marble Queen' whereas high level of nitrogen and potassium (600 mg/l) suppressed growth and resulted poor quality plants. Higher dose (400 mg/l) of nitrogen and the lowest dose (200 mg/l) of potassium in Cordyline terminalis increased plant height, leaf number, size and area of leaves, fresh and dry weight of shoot and root, colour intensity and plant grade.

Experiment 5.1.2.2 Response of organic and inorganic fertilizers on growth and development of house plants.

An experiment was conducted to study the influence of organic and inorganic fertilizers on the growth of some house plants. Effect of 50 gm each of like bonemeal, bloodmeal, sterameal and charcoal dust, and 2.5 gm of NPK (1 : 1 : 1) per plant were recorded in case of Aglaonema commutatum "Silver Queen', Calathea zebrina, Chlorophytum comosum 'Variegatum', Cordyline terminalis, Dieffenbachia maculata, D.maculata 'Exotica', Monstera deliciosa,

Peperomia obtusifolia, Pleomele reflexa 'Song of India', Philodendron erubescens, Scindapsus aureus 'Marble Queen' and Syngonium podophyllum 'White Butterfly'. Bloodmeal (proved to be highly beneficial as they improved the height, number, size and area of leaves, colour intensity and quality of plants almost all the under study) in Aglaonema commutatum 'Silver Queen', Peperomia obtusifolia and Dieffenbachia maculata. Bloodmeal also increased the plant height and leaf number of Scindapsus aureus 'Marble Queen' while bonemeal effectively increased size, and area of leaves, colour intensity and plant grade. Plants of Dieffenbachia maculata 'Exotica', Monstera deliciosa and Philodendron erubescens treated with sterameal enriched media responded well in plant height, number, size and area of leaves, colour intensity and quality of plants. Application of bonemeal 50 gm/pot caused significant increase in all respects of growth in Calathea zebrina, Syngonium podophyllum 'White Butterfly'. Treatment with charcoal dust resulted maximum plant height and increased number, size and area of leaves, colour intensity and quality of plants in case of Pleomele reflexa 'Song of India' while Aglaonema commutatum 'Silver Queen', Dieffenbachia maculata, and Peperomia obtusifolia did not show any response with respect to growth and quality of plants. Application of inorganic fertilizer mixture NPK (1 : 1 : 1) improved the plant height, number, size and area of leaves in Cordyline terminalis and Chlorophytum comosum 'Variegatum'.

Experiment 5.1.3 Effect of growth retardants on growth and development of house plants.

Spray application of growth retardants at different concentrations twice at an interval of 30 days on some house plants caused differential response with respect to plant growth, foliage colour and quality of plants. Treatment with higher concentrations of Cycocel, B-9 and Maleic hydrazide suppressed the height of plants but lower concentrations, in general, proved very effective in increasing the number, size and area of leaves of Aglaonema commutatum 'Treubii', Calathea zebrina, Dieffenbachia maculata, Monstera obligua, Peperomia obtusifolia, Pleomele reflexa and Syngonium podophyllum 'White Butterfly'. Treatments with Cycocel and B-9 were less effective compared to Maleic hydrazide. Application of Maleic hydrazide at 4,000 ppm markedly reduced the plant height, improved foliage colour and quality of plants but the lowest concentration (1,000 ppm) promoted the number, size and area of leaves over untreated plants. B-9 at 4,000 ppm reduced the plant height, but increased the number of leaves, size and area of leaves, number of branches and improved plant grade of Syngonium podophyllum 'White Butterfly'.

Experiment 5.1.4 Influence of irrigation frequency on growth and development of house plants.

Growth and production of quality house plants were markedly influenced by frequency of irrigation. Ten foliage plants were

grown in glass houses with maximum temperatures varying between 38 to 44°C during May to October. Plants were hand watered daily and at intervals of 1, 2, 3, 4 days. Good quality of plants and better foliage colour in Aglaonema commutatum 'Treubii', Dieffenbachia maculata, Monstera deliciosa, M.pertusa, Pleomele reflexa 'Song of India' Calathea zebrina and Syngonium podophyllum 'White Butterfly' were obtained when plants were irrigated daily. Plant quality of all house plants used in this experiment were reduced by wider irrigation frequency. But good plant growth in Aglaonema commutatum 'Silver Queen', Chlorophytum comosum 'Variegatum' and Peperomia obtusifolia could be achieved when plants were generally hand watered on alternate days. Increased soil moisture stress reduced all growth parameters of the house plants tested in this experiment.

Experiment 5.1.5 Effect of different types of container on growth and development of house plants.

To study the effect of different types of container on growth and development of house plants, twelve house plants were grown in plastic pot, wax coated earthen pot and earthen pot. Aglaonema commutatum 'Silver Queen', Calathea zebrina, Chlorophytum comosum 'Variegatum' , Dieffenbachia maculata, Monstera deliciosa, Peperomia obtusifolia, Scindapsus aureus 'Marble Queen' and Syngonium podophyllum 'Variegatum' plants exhibited maximum plant height, leaf number, size and area of leaves, number of

branches or plantlets, colour grade and plant quality when planted on plastic pots. Four house plants, namely Calathea ornata, Cordyline terminalis, Monstera obliqua and Philodendron erubescens 'Ceylon Gold' grown in wax coated earthen pots showed maximum plant height, leaf number, size and area of leaves, number of branches or plantlets, best colour intensity and plant quality as compared to plants on other containers. Most of the house plants grown on earthen pot was less responsive as compared to plastic or wax coated earthen pot plants.

Experiment 5.2 Standardization of propagation of house plants.

In order to develop improved method of vegetative propagation of house plants, several experiments were carried out.

Experiment 5.2.1 Effect of nodal position on the propagation of house plants.

In the first experiment, ten nodal (from apical to basal 10th position) cuttings were planted in the sand medium in ten pots and it was found that tenth nodal cuttings of Aglaonema commutatum 'Treubii' produced root and shoot, earlier with maximum length of root and shoot, number of leaf and root, fresh and dry weight of shoot and root while maximum percentage of rooting (83.33%) was noticed in case of 8th nodal cuttings.

In Dieffenbachia maculata and Scindapsus aureus 'Marble Queen' 5th nodal cuttings had early emergence of root and shoot. Root and shoot

length, root number, percentage of rooting, fresh and dry weight of shoot and root were maximum with 6th nodal cuttings of 'Marble Queen' Dieffenbachia maculata. But in Scindapsus aureus, 5th nodal cutting produced maximum shoot length, leaf number, percentage of rooting, fresh and dry weights of root.

Early emergence of shoot in Monstera obliqua was noted in 6th nodal cuttings whereas root emergence was earlier in 4th nodal cuttings. Shoot lengths were maximum in 10th nodal cuttings. Cuttings from 5th nodal position produced maximum length of root, highest percentage of rooting and improved fresh and dry weights of shoot and root. But in Philodendron erubescens, cuttings from 6th nodal position proved best.

In case of Syngonium podophyllum 'Variegatum', early emergence of root was noted in case of 3rd and 4th nodal cuttings. Sixth nodal cuttings proved most effective in vegetative propagation of house plants giving rise to maximum shoot and root length, leaf number, root number, fresh and dry weight of shoot and highest rooting success.

Experiment 5.2.2 Regeneration of plantlets from cuttings with varying number of nodes.

In order to study the effect of retention of number of node per cutting one, two and three node cuttings were used and planted in sterilized sand medium. Three node cutting produced maximum taken from Aglaonema commutatum 'Treubii', Dieffenbachia maculata, Monstera obliqua and Philodendron erubescens had early root and shoot emergence and developed longest length of root and shoot ,

maximum number of root and leaf, higher percentage of rooting and also fresh and dry weight of root and shoot. On the other hand, one node cuttings were lagging behind in all parameters tested in the experiment.

Experiment 5.2.3 Regeneration of plantlets from node with leaf, node without leaf, and leaf cuttings of Peperomia obtusifolia and Scindapsus aureus 'Marble Queen'.

Three types of cutting materials such as leaf cutting, node cuttings with leaf and node cuttings without leaf were used in Peperomia obtusifolia and Scindapsus aureus 'Marble Queen'.

Node cuttings with leaf in Peperomia obtusifolia and Scindapsus aureus 'Marble Queen' developed root and shoot earlier, had longest root and shoot, maximum number of root and leaf, and also more root and shoot fresh and dry weights showed improved growth compared to node cuttings without leaf. While leaf cuttings of Peperomia obtusifolia developed roots early, shoot development was too late compared to node cuttings with leaf.

Experiment 5.2.4 Effect of rooting media on root regeneration and plant growth in cuttings of some house plants.

Eight types of media viz.loam, leafmould, sand,vermiculite, soilrite, loam + leafmould (1 : 1),loam + sand (1 : 1) and

leafmould + sand (1 : 1) were ~~used~~ also tested to identify suitable medium for propagation of Aglaonema commutatum 'Treubii', Dieffenbachia maculata, Monstera obliqua, Philodendron erubescens and Syngonium podophyllum 'Variegatum'.

In Aglaonema commutatum 'Treubii' and Syngonium podophyllum 'Variegatum', early root and shoot emergence occurred with loam + leafmould medium while sand caused early emergence of root and shoot in Philodendron erubescens and Monstera obliqua. Early emergence of root and shoot was noted in Dieffenbachia maculata when cuttings were planted in leafmould medium. Cuttings of Aglaonema commutatum 'Treubii', Dieffenbachia maculata and Philodendron erubescens produced highest percentage of rooting in leafmould + sand (1 : 1) medium while Monstera obliqua showed maximum percentage of rooting in sand and Syngonium podophyllum 'Variegatum' in loam + sand (1 : 1) medium. The root and shoot growth of Aglaonema commutatum 'Treubii' and Syngonium podophyllum 'Variegatum' cuttings were better in loam + leafmould medium. Cuttings of Philodendron erubescens and Monstera obliqua showed good growth in sand medium, but leafmould + sand medium caused good root and shoot growth of Dieffenbachia maculata cuttings.

Experiment 5.2.5 In vitro propagation of Philodendron erubescens 'Ceylon Gold'.

In the present investigation, MS medium was found superior

to the other tested media for the initial establishment of culture. Among the growth regulators , 2,4-D was most active at lower concentrations, although the synthetic auxin, NAA with BAP at lower concentrations induced profuse callusing. Unlike 2,4-D containing media NAA and BAP combinations favoured long term culture of callus. However, the callus appeared noncaulogenic and recalcitrant. Adventitious bud formation was noticed in both the media (MS and KC). The media containing BAP (0.5 - 2.0 mg/l) induced shoot bud formation. In most cases, shoot bud acceleration was largely dependent on NAA/BAP balance in the culture media. In vitro root induction could not be obtained by the application of two root promoters individually into the culture media. However, ex vitro rooting with much success has been attained by direct transfer into the field. Use of different root hormones improved ex vitro rooting.

Chapter 6

FUTURE SCOPE OF RESEARCH

FUTURE SCOPE OF RESEARCH

The effect of light intensity, organic and inorganic sources of nutrients, growth retardants, frequency of irrigation, types of growing container and methods of propagation on growth and good quality of house plant have been studied to some extent. For better use of indoor environment effect of various intensities of artificial light in living room need to be studied. Influence of temperature and humidity on the growth of house plants need to be thoroughly investigated for production of quality plants.

Studies to determine the optimum levels of nutrients and their organic and inorganic sources should be included in future plan of work. Further, the effect of micronutrients particularly Zinc, Boron, Copper, Magnesium, Manganese etc.on growth and development of house plants should also be investigated. Foliar application of nutrients at various concentrations on these plants may be included in future trial. The effect of different slow releasing fertilizers on house plants may be considered in future plan of work.

In the present investigation, effect of foliar applications of Maleic hydrazide, Cycocel and B-9 on the house plants were studied. Some more growth retarding chemicals both as foliar and soil drench may be included in future trial for attractive, bushy and glossy growth of foliage plants. Studies on different growth regulators like auxin, gibberellin, cytokinins,

ethylene can also be included in future trial for faster growth of slow growing foliage plants.

The frequency of irrigation on growth of some house plants were studied in the present trial. More number of house plants need to include in the study of frequency of irrigation and methods of application. Study on the effect of surface, capillary and drip irrigation alongwith application of fertilizers on growth of foliage plants should also be undertaken in future.

Three types of container (earthen, wax coated earthen and plastic) were used in the present study in case of some house plants. More containers such as ceramic, cemented,wooden, tin, glass etc.may be included in future trial.

Propagation of plants by vegetative means in different growing media may be included in future. Micropropagation in some valuable house plants needs to be undertaken to develop large number of plants within a short period and with less production cost.

Post harvest physiology of foliage plant during shipment needs to be included in the future investigation.

Chapter 7

BIBLIOGRAPHY

BIBLIOGRAPHY

Badawy, E.M.; Dahab, A.M.A.; Sarhan, A.Z. and Mansour, H.A.(1987) Effect of growth location and NPK fertilization rate on growth of Chamaedorea elegans and C.constricta. Acta Hort., 205: 257-65.

Bazzocchi, R.; Dalpasso, P. and Giorgioni, M.E. (1987) The effects of paclobutrazol and a number of substrates on Syngonium podophyllum. Colture Protette, 16 (5): 45-50.

Bazzocchi, R. and Gambini, F. (1985) The effect of Paclobutrazol and ancymidol on Philodendron. Colture Protette, 14(2): 45-52.

Beel, E. and Schelstraete, A. (1979) Dieffenbachia culture and fertilizer trials. Verbondsnieuws Voor de Belgische Sierteelt, 23 (13): 515-18.

Beel, E. and Schelstraete, A. (1980a) The culture of and fertilizer trials on Calathea ornata. I. Verbondsnieuws Voor de Belgische Sierteelt, 24(19): 763-64.

Beel, E. and Schelstraete, A. (1980b)The culture of and fertilizer trials on Calathea ornata. II. Verbondsnieuws Voor de Belgische Sierteelt, 24(21): 847-50.

Blessington, T.M. and Link, C.B. (1980) Influence of ancymidol on four species of tropical foliage plants under different artificial light intensities. J. Amer. Soc. Hort.Science, 105 (4): 502-4.

Blessington, T.M.; Srithavaj, A.A.and Sengletary, C.C. (1980) Influence of watering methods and ancymidol on the tropical foliage species held in a stimulated interior environment. J. Amer. Soc. Hort. Sci., 105(6):785-87.

Bose, T.K. and Chowdhury, B. (1991) House plants pp.214-15. In : Tropical Garden plants in colour. Horticulture and Allied Publishers, Calcutta.

Broschat, T.K.; Donselman, H. and Verkade, S.D. (1987) Control of height in Radermachera sinica with growth retardants. Foliage Digest, 10(2): 5.

*Cathey, H.M. and Stuart, N.W. (1961) Comparative plant growth retarding activity of Amo-1618, Phosfon and CCC. Botan. Gaz., 123: 51-7.

Chase, A.R. (1989) Fertilizing calatheas with slow release fertilizer. Foliage Digest, 12 (10): 1-3.

Chase, A.R. and Poole, R.T. (1987a) Effect of fertilizer rate on growth of fibrous rooted Begonia. HortScience, 22(1): 162.

Chase, A.R.and Poole, R.T. 1987b) Effect of fertilizer, temperature and light level on growth of Syngonium podophyllum 'White Butterfly'. J. Amer. Soc. Hort. Sci., 112(2): 296-300.

*Chen,W.M. (1983) Plantlet regeneration from bulb scales and seedlings of Lilium brownii var.vividulum in vitro. Plant Physiology communications, 3 : 46.

Christensen, O.U.(1971) Standardized growing of pot plants. I. Hedera canariensis Gloire de Marengo. TidssKrift for planteavl, 75 (3): 322-36.

Christensen, O.U.(1974) Standardized growing of pot plants. II. Codiaeum variegatum Geduldig. Tidsskrift for Planteavl, 78(2): 217-29.

Chua, B.U.; Kunisaki, J.T. and Sagawa, Y. (1981) In vitro propagation of Dracaena marginata 'tricolor'. Hortscience, 16 (4):494.

Collins, P.C.and Blessington, T.M. (1981) Influence of production light and ancymidol on foliage plants. Hortscience, 16(2): 215-16.

Conover, C.A. and Poole, R.T. (1972a) Influence of shade and nutritional levels on growth and yield of Scindapsus aureus, Cordyline terminalis 'Baby Doll' and Dieffenbachia exotica. Proc. Amer. Soc. Hort. Sci. Tropical Region, 16: 277-81.

Conover, C.A. and R.T. Poole (1972b) Influence of propagation bed nutritional amendments on selected foliage plants. Proc. Fla. State Hort. Soc., 85: 392-94.

Conover, C.A. and Poole, R.T. (1974a) Influence of shade and fertilizer source and level on growth, quality and foliar content of Philodendron oxycardium Schott. J. Amer. Soc. Hort. Sci., 99: 150-52.

Conover, C.A. and Poole, R.T. (1974b) Influence of shade level and soil temperature on forcing Caladium bicolor. Proc. Fla. State Hort. Soc., 86: 369-72.

Conover, C.A. and Poole, R.T. (1975) Influence of shade and fertilizer levels on production and acclimatization of Dracaena marginata. Proc. Fla. State Hort. Soc., 88: 606-08.

Conover, C.A. and Poole, R.T. (1976) Influence of nutrition on yield and chilling injury of sansevieria. Fla. State Hort. Soc. Proc., 89: 305-07.

Conover, C.A. and Poole, R.T. (1977a) Influence of fertilization and watering on acclimatization of Aphelandra squarrosa Nees Cv.Dania. HortScience, 12: 569-70.

Conover, C.A. and Poole, R.T. (1977b) Influence of irrigation method and fertilizer source and level on growth of four foliage plants. Proc. Fla. State Hort. Soc., 90:312-13.

Conover, C.A. and Poole, R.T. (1980a) Interior quality of Dracaena angustifolia Roxb. 'Honoriae' as influenced by light and fertilizer during production. HortScience, 15 (1): 24-26.

Conover, C.A. and Poole, R.T. (1980b) Effect of light and fertilizer levels on cut foliage production. Proc. Fla. State Hort. Soc., 93: 210-12.

Conover, C.A. and Poole, R.T. (1981a) Influence of light and fertilizer levels and fertilizer sources on foliage plants maintained under interior environments for one year. J. Amer. Soc. Hort. Sci., 106 (5): 571-74.

Conover, C.A. and Poole, R.T. (1981b) Light and fertilizer levels and slow release fertilizer sources influence growth of Brassaia actinophylla Endl. Proc. Fla. State. Hort. Soc., 94: 109-11.

Conover, C.A. and Poole, R.T. (1985) Composition of a liquid fertilizer source with several slow release fertilizers on Brassaia actinophylla and Ficus benjamina. Foliage Digest, 8 (6): 1-3.

Conover, C.A. and Poole, R.T. (1986a) Nitrogen source effects on growth and tissue content of selected foliage plants. HortScience, 21 (4): 1008-09.

Conover, C.A. and Poole, R.T. (1986b) Effect of nitrogen source and potting media on growth of Chamaedorea elegans, Dieffenbachia maculata 'Camelle' and Peperomia obtusifolia. Proc. Fla. State Hort.Soc., 99: 282-84.

Conover, C.A. and Poole, R.T. (1987) Growth of Dieffenbachia maculata 'Perfection' as affected by air and soil temperatures and fertilization. HortScience, 22(5): 893-95.

Conover, C.A.; Poole, R.T. and Nell, T.A.(1982) Influence of intensity and duration of cool white fluorescent lighting and fertilizer on growth and quality of foliage plants. J. Amer. Soc.Hort.Sci., 107(5):817-22.

*Cooper, W.C. (1938) Hormones and root formation. Bot.Gaz., 99: 559-614.

*Culbert, J.R. and Hickman, D. (1966) African violets. Univ. of Ill. Coop. Ext. Circ, 695, 32 pp.

Debergh, P. (1975) Intensified vegetative multiplication of Dracaena deremensis. Acta Hort., 54: 83-92.

Debergh, P.C. and Maene, L.J. (1981) A scheme for commercial propagation of ornamental plants by tissue culture. Scientia Hort., 14: 335-45.

Djurhuus, R. and Gislerod, H.R. (1985) Frequency of watering and growing media for Aphelandra and Begonia x hiemalis. Gartneryrket, 75(6): 132-33.

Donselman, H. and Broschat, T.K. (1985) High light intensity promotes basal branching of Dracaena marginata. Foliage Digest, 8(4): 1-2.

Evaldssor, I.E. and Welander, N.T. (1985) The effects of medium composition on in vitro propagation and in vivo growth of Cordyline terminalis cv.Atoom. J. Hort. Sci., 60(4): 525-30.

*Evans, D.A.; Sharp, W.R. and Flick, C.E. (1981) In: Plant tissue culture, methods and applications in agriculture (Ed.T.A.Thorpe) pp.68. Academic Press, London, USA.

Fitzpatrick, G. (1980) Water budget determination for container grown ornamental plants. Proc. Fla. State Hort. Soc., 93 :166-68.

Fitzpatrick, G. (1983) Relative water demand in container grown ornamental plants. HortScience, 18(5): 760-62.

Fonnesbech, A. and Fonnesbech, M. (1980) In vitro propagation of Monstera deliciosa. HortScience, 15(6): 740-41.

Frank, D.F. and Donnan, A.J. (1975) Influence of AREST on tropical foliage plants. Proc. Fla. State Hort.Soc., 88 : 531-34.

Freeman, R.N. and Cinque, M.T. (1970) Relative humidity - a review. Focus on Floriculture. N.Y.State Coop.Ext. Serv.January, 1975, 2 pp.

*Gamburg, K.Z.(1976) The Biochemistry of Auxin and its effect on plant cell. Novosibirsk (In Russian).

Gertsson, U.E. and Andersson, E. (1985) Propagation of chrysanthemum x hortorum and Philodendron scandens by tissue culture. Rapport, Institutionen for Tradgardsvetenskap, Sveriges Lantbruksuniversitet No.4, 17 pp.

Hansen, J. (1986a) Influence of cutting position and stem length on rooting of leaf bud cuttings of Schefflera arboricola. Scientia Hort., 28 (1/2): 177-86.

Hansen, J. (1986b) Growing Schefflera arboricola from top cuttings. Gartner Tidende, 102 (22): 711-13.

Hansen, J. and Andersen, E.E. (1987) Propagating Schefflera arboricola from single node cuttings. Garten Tidende, 103 (25): 709-11.

Hendriks, L. and Ludolph, D. (1988) Assimilation lighting of foliage plants. Gb + Gw, 88 (37): 1582-85.

Henny, R.J. (1978) In vitro propagation of Peperomia 'Red Ripple' from leaf discs. HortScience, 13(2):150-51.

Henley, R.W. and Poole, R.T. (1974) Influence of growth regulators on tropical foliage plants. Proc. Fla. State Hort. Soc., 87: 436-38.

Higaki, T. (1981) Single node propagation of Dracaena goldieana Bull. Plant Propagator, 27(1): 8-10.

Hipp, B.W.; Colbavgh, P.F. and Dileo, M. (1979) Influence of fertility and moisture level on growth of chlorophytum. HortScience, 14(1): 65-66.

Horn, W. and Huber, J. (1983) Light experiments with foliage plants in hydroculture. Deutscher Gartenbau, 37(26): 1191-92.

*Humphries, E.C. (1956) In"modern method of plant analysis". Vol.1, Springler Verlag Berlin.

Ignasse, J.F. (1983) Technical data on Dieffenbachia. Horticulture Franscaise, No.151.16.

Johnson, C.R.; Ingram, D.L. and Barrett, J.E. (1981) Effect of irrigation frequency on growth, transpiration and acclimatization of Ficus benjamina L. HortScience, 16(1):80-81.

Johnson, C.R.and Joiner, J.N. (1978) Influence of ancymidol and ethephon on growth of Ficus benjamina L. Proc. Fla. State Hort. Soc., 91: 204-05.

Johnson, C.R.; Krantz, J.K.; Joiner, J. N. and Conover, C.A.(1979a). Light compensation points and leaf distribution of Ficus benjamina as affected by light intensity and nitrogen potassium nutrition. J. Amer. Soc. Hort. Sc., 104 (3): 335-38.

Johnson, C.R.; McConnell, D.B. and Joiner, J.N.(1982a) The influence of ethephon and light intensity on growth and acclimatization of Ficus benjamina. HortScience, 17(4):614-15.

Johnson, C.R.; Nell, T.A.; Joiner, J.N.and Kranz, J.K.(1979b) Effect of light intensity and potassium on leaf stomatal activity of Ficus benjamina L. HortScience, 14:227-28.

Johnson, C.R.; Nell, T.A.; Rosenboum, S.E.and Lauritis (1982b) Influence of light intensity and drought stress of Ficus benjamina L. J. Amer. Soc. Hort. Sci., 107: 252-55.

Joiner, J.N. and Nell, T.A. (1980) Fired monmortllonite clays as a propagation and hydroponic growing medium. Proc. Fla. State Hort. Soc. ,93:214-15.

Joiner, J.N.; Poole, R.T.; Johnson, C.R. and Ramcharam, C. (1978) Effects of ancymidol and N, P, K on growth and appearance of Dieffenbachia maculata 'Bara quiniana'. HortScience, 13(2): 182-84.

Joiner, J.N. and Waters, W.E. (1970) The influence of cultural conditions on the chemical composition of six tropical foliage plants. Proc. Amer. Soc.Hort. Sci. Tropical Region, 14 :254-67.

*Kitson, R.E. and Mellon, M.C. (1944) Colorimetric determination of Phosphorus as molybdovanadate Phosphoric acid. Ind. Engng. Chem. Analyst Edn., 16: 379-83.

Khattab, M.; Kamel, H. and Yacout, M. (1987) Nitrogen and potassium nutrition of Monstera deliciosa Liebm. Alexandria J.Agril. Res., 32(2): 277-88.

Kristensen, L.N. (1984) Light acclimatization of seven foliage pot plants. Garten Tidende, 100 (44): 1395-97.

Kunisaki, J.T. (1975) In vitro propagation of Cordyline terminalis (L) Kunth. HortScience, 10(6):601-02.

Langhans, R.W.; Mott, R.C.; Kumpt, J.H. and Hammer, P.A. (1972) Osmocote used successfully with foliage plants. Florists Rev., October 19, 1972, pp.35,49.

Larsen, R. (1979) The tolerance of ornamental foliage plants to low light intensities. Swedish J. Agri.Res., 9(4): 169-72.

LeCain, D.R.; Schekel, K.A. and Wample, R.L. (1986) Growth retarding effects of paclobutrazol on weeping fig. HortScience, 21 (5): 1150-52.

Leinfeder, J. and Rober, R.(1986) Growth of Palms and foliage plants in hydroculture. Deutscher Gartenbau, 40(48): 2242-45.

Levy, D. (1985) Propagation of potato by direct transfer of in vitro proliferated shoot cuttings into the field. Scientia Hort., 26: 105-109.

*Long, J.C. (1932) The influence of rooting media on the character of the roots produced by cuttings. Proc. Amer. Soc. Hort. Sci.,352-55.

Mansour, H. and Poole, R.T. (1987a) Growth retardants- how can they help ? Foliage Digest, 10(16): 1-3.

Mansour, H.A. and Poole, R.T. (1987b) Trial with growth retardants on ornamental foliage plants. Proc. Fla. State Hort. Soc., 100 : 375-78.

Marlatt, R.B. (1969) Propagation of Dieffenbachia. Econ. Bot., 23: 385-88 (illus).

McConnell, D.B. and Host, J. (1980) Influence of watering frequency on growth and anatomy of lemone vine. Proc. Fla. State Hort. Soc. 91: 164-65.

McConnell, D.B. and Poole, R.T. (1972) Vegetative growth modification of Scindapsus aureus by ancymidol and PBA. Proc. Fla. State Hort. Soc. ,85: 387-89.

Morgan, D.L. and Hipp, B.W. (1979) Nitrogen requirement for Nephrolepis exaltata (L) Schott 'Rooseveltii'. HortScience, 14(5): 619-20.

Morgan, D.L.; Hipp, B.W. and Jones, R.W. (1981) Use of tensiometers in irrigation management of Roosevelt fern. Publication, Texas Agril.Expt.Sta. No.PR-3879, 6 pp.

Mortensen, L.M.(1988) High temperatures increase the growth of foliage plants. Gartneryrket, 78(11): 359.

Mortensen, L.M. and Larsen, G. (1989) Effects of temperature on growth of six foliage plants. Scientia Hort., 39(2): 149-59.

Moschini, E.; Tosi, D. and Graifenberg, A. (1985) The effect of type of fertilization on raising of Monstera deliciosa Leib and Ficus benjamina L. in hydroculture. Rivista della Ortoflorofrutticulture Italiana, 69(6):397-411.

Mujib, A. and Jana, B.K. (1990) In vitro callus induction and plantlet regeneration in Carnation. Experimental Genetics, 6 (1 & 2): 52-56.

Muralidhar, C.E.and Mehta, A.R. (1986) Plant regeneration from bulb segments of tuberose. HortScience, 21: 859-60.

Pimpini, F. (1971) Preliminary results of a study on the nitrogen fertilizing of Pothos (Scindapsus aureus). Rivista della Ortoflorofrutticolture Italiana, 55(5):438-45.

Pimpini, F. and Arcella, C. (1987) Preliminary results on the use of Paclobutrazol and cycocel in Scindapsus aureus Lind. Colture Protette, 16(1): 69-74.

Piper, C.S. (1944) In soil and Plant analysis. Inter Science Publishers Inc. N.Y.

Poole, R.T.(1970) Influence of growth regulators on stem elongation and rooting response of foliage plants. Proc. Fla. State Hort.Soc., 83:497-502.

Poole, R.T.and Chase, A.R. (1987a) Response of foliage plants in an interior environment to irrigation frequencies. Foliage Digest, 10(6): 1-3.

Poole, R.T. and Chase, A.R. (1987b) Relationship of height to elemental content of peperomia. Foliage Digest, 10(11): 4-5.

Poole, R.T. and Chase, A.R. (1987c) Response of foliage plants to fertilizer application rates and associated leachate conductivity. HortScience, 22 (2): 317-18.

Poole, R.T. and Conover, C.A. (1975) The importance of maintaining vigorous stock plants. Florida Foliage Grower, 12(5): 4-5.

Poole, R.T. and Conover, C.A. (1976) Propagation and growth characteristics of Ficus elastica 'Decora' in Central Florida. Proc. Trop. Reg. Amer. Soc. Hort. Sci., 20: 438-48.

Poole, R.T. and Conover, C.A. (1977) Nitrogen and potassium fertilizer of Aglaonema commutatum Schott Cvs.Fransher and Pseudobracteatum. HortScience, 12 (6): 570-71.

Poole, R.T. and Conover, C.A. (1981) Influence of maximum air temperatures and irrigation frequencies during high temperature periods on growth of four foliage plants. HortScience, 16(4): 556-57.

Poole, R.T. and Conover, C.A. (1982) Influence of leaching, fertilizer source and rate and potting media on foliage plant growth, quality and water utilization. J.Amer. Soc. Hort. Sci., 107(5): 793-97.

Poole, R.T. and Conover, C.A. (1985) Summer temperature for foliage plants. Foliage Digest, 8(4): 8.

Poole, R.T. and Conover, C.A. (1986a) Growth of foliage plants at infrequent low night temperature. Foliage Digest, 9 (2): 7-8.

Poole, R.T. and Conover, C.A. (1986b) Response of Schefflera to vaciations in irrigation procedure. Foliage Digest, 9 (7): 7-8.

Poole, R.T. and Conover, C.A. (1986c) Growth of Cissus, Dracaena and Syngonium at different fertilizer, irrigation and soil temperature. Proc. Fla. State Hort.Soc., 99:268-69.

Poole, R.T. and Conover, C.A. (1987) Heat stress of foliage plants. Foliage Digest, 10 (7): 3-5.

Poole, R.T.; Conover, C.A. (1989) Production of ornamental foliage plants. Acta Hort., 246: 145-53.

Poole, R.T.; Conover, C.A. and Joiner, J.N. (1976) Chemical composition of good quality tropical foliage plants. Proc. Fla. State Hort. Soc.,89: 307-08.

Poole, R.T. and Henley, R.W. (1981) Constant fertilization of foliage plants. J. Amer. Soc. Hort.Sci., 106(1):61-63.

Poulsen, A. and Anderson, A.S. (1980) Propagation of Hedera helix: Influence of irradiance to stock plants, length of internode and topophysis of cuttings. Physiol. Plant, 49: 359-65.

Preissel, H.G.; Schmidt-Stohn, G. and Krebs, O. (1980) Effect of temperature and light on growth and colouring of codiaeum. Deutscher Gartenbau, 35(51/52): 2214-17.

*Rappaport, J. (1940) The influence of leaves and growth substances on the rooting response of cuttings. Natuurw Tijdschr, 21 : 356-59.

Rioux, J.A. and Dansereau, B. (1981) Artificial light for ornamental foliage plant production. In Cahier des Journees Horticoles Ornamentales Saint-Hyacinthe, 51-56.

Rodriguez, S.J. and Cibes, H.R. (1977) Effect of five levels of nitrogen at six shade intensities on growth and leaf nutrient composition of Dracaena deremensis 'Warneckii', Engler, J. Agri. Univ. Puerto Rico, 61(3): 305-13.

Rodriguez, S.J. and Rivera-Lopez, C. (1977a) Effect of six levels of N on the growth of sander's Dracaena (Dracaena Sanderiana Hort.) at a 47% shade. J. Agri. Univ.Puerto Rico, 61(3): 314-18.

Rodriguez, S.J. and Rivera-Lopez, C. (1977b) Effect of size of propagating material and planting distance on production of sander's Dracaena (D.sanderiana Hort.) at five shade intensities. J. Agri. Univ. Puerto Rico, 61(4):479-83.

Rodriguez, S.J. and Rivera-Lopez, C. (1979) Effect of three levels of N, P, K on the growth of Sander's Dracaena (Dracaena sanderiana). J. Agri.Univ. Puerto Rico, 63(2):229-35.

Rodriguez, S.J. ; Rivera-Lopez, C. and Santiago, A. (1973) Performance in different potting and rooting media. J.Agri. Univ.Puerto Rico, 53(4):314-19.

Rodriguez, S.J.; Santiago, A. and Rivera-Lopez, C. (1972) Dwarfing effect of Ethrel (2-chloro ethyl phosphonic acid) on Cordyline terminalis var.Baby Doll. J. Agri. Univ.of Puerto Rico, 56(4):439-44.

*Sachs, R.M.; Lang, A.; Bretz, C.F. and Roach, J. (1960) Shoot histogenesis : Subapical meristematic activity in the caulescent plant and the action of gibberellic acid and Amo-1618. Amer. J. Bot., 47: 260-66.

Sahavacharin, O. (1982) Rapid propagation of caladium through tissue culture. In : Fujiwara, pp.699-700.

Sandved, G.(1975) Further research on the effect of temperature on growth of foliage plants during the winter. Gartneryrket, 65(24/25): 441-45.

Sandevd, G. (1983) Aglaonema. Gartneryrket, 73(1): 14-16.

Schenk, M. and Brundert, W. (1981) Growth regulators in hydroculture. Effect of CCC and Alar on green plants. Gb + GW, 81(19): 445-47.

Serra, G. and Carrai, C. (1989) The effect of different temperature programmes on the growth of Dieffenbachia cultivar 'Tropic White'. Colture Prototte, 18(2): 85-88.

Shen, G.W. and Seely, J.G. (1983) The effect of shading and nutrient supply on variegation and nutrient content of variegated cultivars of Peperomia obtusifolia. J. Amer. Soc.Hort.Sci., 108(3): 429-33.

Son, K.H. and Yeam, D.Y. (1987) Effect of light intensities and temperatures in various indoor situation on growth of some foliage plants. J.Korean Soc.Hort.Sci., 28(2): 173-84.

Spooner, J.; Daley, L.; Ware, G. and Vines, M.(1978) Determination of irrigation and fertilizer practices for jade plant (Crassula argentea (L) Thumb). J. Amer. Soc. Hort. Sci., 103(3): 306-08.

Tesi, R. (1983) Studies on the irrigation of ornamental pot plants. Colture Protette, 12(5): 21-31.

Thomas, M.B. and Teoh, S.L. (1983) Culture of container grown F.macrophylla I. Influence of nutrition on foliage growth. Royal Newzealand Ins.Hort.Annual J.,11:67-76.

*Trapp, J.A. (1973) Growing Philodendron oxycardium in soilless media with slow release fertilizer. Pennsylvania Flower Growers Bulletin No.261.

Vienrevee, K. and Rogers, M.N.(1974) Growth control of terrarium plants with ancymidol. Florists' Rev., 155(4008): 24-5, 67-71.

Voyatzi, C. and Voyatzis, D.G. (1989) In vitro shoot proliferation rate of Dieffenbachia exotica cultivar 'Marianna' as affected by cytokinin, the number of recultures and temperature. Scientia Hort., 40(2):163-69.

Wang, Y.T. (1987a) Effect of warm medium, light intensity, BA and parent leaf on propagation of golden pothos. HortScience, 22 (4): 597-99.

Wang, Y.T. (1987b) Influence of ancymidol on growth and interior quality of Syngonium podophyllum 'White Butterfly'. HortScience, 22(5): 959-60.

Wang, Y.T. and Blessington, T.M. (1990) Growth of four tropical foliage species treated with paclobutrazol or uniconazol. HortScience, 25(2): 202-04.

Wang, Y.T. and Boogher, C.H. (1988) Effect of nodal position, cutting length and root retention on the propagation of golden pothos. HortScience, 23(2): 347-49.

Wang, Y.T. and Boogher, C.A. (1989) Hydrophilic polyacrylamide and fertilizer affect growth and water relations of Chlorophytum comosum and Ploctranthus australis during winter production. J. Rio Grande Vally Hort. Soc., 42: 51-8.

*Went, F.W. (1929) On a substance causing root formation. Proc. Kon. Ned. Akad. Wet., 32: 35-9.

Wiedenfeld, R.P. (1985) Nitrogen loss and plant responses of Ficus benjamina to different fertilizer sources applied preplant. HortScience, 20(4): 720-22.

Will, H. (1977) Use of growth regulators with Elatior begonias. Gb + Gw, 77 (35): 840-41.

*Yarborough, J.A. (1936) Regeneration in the foliage leaf of sedum. Amer.J. Bot., 23: 303-7.

Zimmer, K. (1977) Growth of green plants under artificial light. Deutscher Gartenbau, 31(38): 1535-37.

---

* Literature not consulted in original.