EFFECT OF MIST AND GROWTH REGULATORS ON THE ROOTING BEHAVIOUR AND GROWTH OF ORNAMENTAL PLANTS

COLLEGE OF HORTICULTURE
VELLANIKKARA
LIBRARY

By

RITA RAMAKRISHNAN

THESIS

submitted in partial fulfilment of the
requirement for the degree
MASTER OF SCIENCE IN HORTICULTURE
Faculty of Agriculture
Kerala Agricultural University

Department of Horticulture
COLLEGE OF AGRICULTURE
Vellayani, Trivandrum

1988

D E C L A R A T I O N

I hereby declare that this thesis entitled "Effect of mist and growth regulators on the rooting behaviour and growth of ornamental plants" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship, or other similar title, of any other University or Society.

Vellayani

15.10.1988

RITA RAMAKRISHNAN

CERTIFICATE

Certified that this thesis, entitled "Effect of mist and growth regulators on the rooting behaviour and growth of ornamental plants" is a record of research work done independently by Smt. Rita Ramakrishnan under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship, or associateship to her.

Vellayani

15.10.1988

DR. S. RAMACHANDRAN NAIR

Chairman, Advisory Committee
Professor and Head of the
Department of Horticulture

APPROVED BY

CHAIRMAN

DR. S.RAMACHANDRAN NAIR

MEMBERS

1. SRI. P.V.PRABHAKARAN

2. SRI. N.RAMACHANDRAN NAIR

3. DR. K. RAJMOHAN

EXTERNAL EXAMINER

A C K N O W L E D G E M E N T

I wish to express my deep sense of gratitude to Dr. S.Ramachandran Nair, Professor and Head of the Department of Horticulture, Chairman of the Advisory Committee for his valuable guidance given all through the course of work.

I am thankful to Sri. P.V.Prabhakaran, Professor, Department of Agricultural Statistics; Dr. P.Manikantan Nair, Professor, Department of Plant Breeding; and Sri. M.K.Mammen, Professor, Department of Horticulture, for their suggestions and help extended in the preparation of the thesis.

I wish to acknowledge Dr. Alice Abraham, Professor, Department of Agricultural Chemistry and Sri. Abdul Hameed, Professor, Department of Agricultural Chemistry, for their help rendered at different stages of the work.

I am extremely grateful to Sri. C.E.Ajith Kumar, Junior Programmer, Department of Agricultural statistics, for the assistance rendered in computer analysis.

I am deeply indebted to my parents, husband and brothers, for their constant support and inspiration.

I express my sincere thanks to the staff and students of the Department of Horticulture, for their constant help given throughout the course of study.

It would be unfair of me, if I do not express my thanks to Jeejo, Harikrishnan, Rajasekharan, Anitha and Leena who have given valuable advises, encouragements, and immense help at different stages of my study.

Vellayani

. .1988.

RITA RAMAKRISHNAN

C O N T E N T S

L I S T OF T A B L E S

Field conditions

Mist conditions

L I S T O F F I G U R E S

11. Effect of type of cuttings and IBA along with mist on the number of roots in Mussaenda

12. Effect of type of cuttings and IBA along with mist on root length in Mussaenda

13. Effect of type of cuttings and IBA along with mist on the percentage of sprouting in Ficus

14. Effect of type of cuttings and IBA along with mist on the number of roots in Ficus

15. Effect of type of cuttings and IBA along with mist on root length in Ficus

INTRODUCTION

1. INTRODUCTION

Ever since the advent of systematic cultivation, man had always felt the necessity of proper planting materials. This problem was alleviated to a certain degree in the case of perennials by vegetative propagation. Vegetative propagation involves reproduction from vegetative parts of plants and is possible because the vegetative organs of many plants have the capacity for regeneration. By this method the offsprings could inherent all the characters of a desirable mother plant. But the mass scale production of such vegetative propagules are also limited by several physiological and other constraints in rooting, sprouting and establishment in the field.

Although much advancement has been made in the field of mass propagation with the application of tissue culture techniques, it still remains only a dream in the case of many plant species,especially in the third world developing economies, where the proper infrastructure for such work is largely absent. Thus with regard to the Indian conditions, the cheaper alternative of vegetative propagation with stem and root cuttings is more relevant today.

The discovery of plant hormones, especially auxins, and its effect on rooting characters had further encouraged research on better vegetative propagation methods.

Though the auxin group of hormones was discovered long back (Went, 1928), the practical applications of these tryptophan derivatives came to light much later. The main effects of auxins like Indole acetic acid, Indole butyric acid and Naphthalene acetic acid in promoting root growth and cell division in the cambium was found to aid the use of stem cuttings for propagation. But the highly unstable nature of auxins, especially in aqueous media due to photo-oxidation, enzymatic oxidation and inactivation are found to hamper its use in the field conditions. The nature of the unidentified rooting cofactors also influence these changes. The concentration of the hormone to be used in the field is also critical as these hormones are inhibitive in high concentrations, just as they are promotive in low concentrations.

Given the constraints, the best use of auxins (Indole-3-butyric acid) and the size of the cuttings to be used were studied on ornamental horticultural crops, since the maintenance of genetic purity and quick propagation are very important in this field. It is also found that many ornamental shrubs, especially those which originated as bud sports do not root under normal conditions. Three ornamental shrubs namely *Ficus elastica*(Roxb.), *Bougainvillea spectabilis*

(Willd.) var Mahara and _Mussaenda erythrophylla_ (Schum.) were used in this study to determine the rooting characters and growth of the plant. The investigation was done under field conditions and under mist conditions, where beneficial effects like low temperature and high relative humidity are obtained.

Keeping the above advantages and constraints in mind, research was done with the following objectives :

1. To find out the optimum thickness of cuttings from selected species for easy rooting.
2. To find out the optimum concentration of growth regulator for easy rooting.
3. To find out the type of cuttings (1, 2 or 3 noded cuttings) suitable for easy rooting under mist.
4. To study the effect of various concentrations of growth regulator along with mist.

REVIEW OF LITERATURE

2. R E V I E W OF L I T E R A T U R E

A brief review from recent literature relating to this study is given below under the following titles :

2.1. Effect of auxins especially IBA on the rooting of cuttings.

2.2. Effect of mist sprays on the rooting of cuttings.

2.3. Effect of type of cuttings on the rooting response.

Rooting in plants are influenced by several factors such as the age of plant parts of the trees from which the cutting is taken (Thimann and Delisele, 1939 ; Mahlstede and Haber, 1957; and Basu *et al*., 1970) position and type of the cutting (Edgerton, 1944; Nambisan *et al*., 1977; and Balakrishnamoorthy, 1978) period of the year in which the cuttings are taken (Wells, 1954 ; Choudhury *et al*., 1963) nutritional status (Mahlstede and Haber, 1957) environmental conditions and medium in which the cuttings are grown (Long, 1932).

In the present investigation, rooting response of the different types of stem cuttings of ornamental shrubs were studied with varying concentrations of rooting hormone (IBA) in field condition and also under a mist chamber.

2.1. Effect of auxins especially IBA on the rooting of cuttings.

The practical use of synthetic auxins in stimulating root formation has been studied with reference to increase in percentage of rooting, hastening root initiation, increasing the number and quality of roots produced per cutting and increasing the uniformity in rooting by several workers (Went, 1934 ; Thimann and Went, 1934 ; Cooper, 1935; Hitchcock and Zimmermann, 1936; Pearse, 1938). Pearse (1948) from a review of works done has opinioned that Indole-3-butyric acid (IBA) is all purpose rooting substance. It had a fairly wide range of effectiveness. The root system formed under its influence was fibrous and well branched which rendered transplantation easy. The disadvantages observed with Naphthalene acetic acid (NAA) were its narrow range of effectiveness and injuries caused to tissues or toxicity just above the optimum concentration. Indole-3-acetic acid was highly unstable and easily deteriorated.

According to Hartmann and Kester (1978) the synthetic root promoting substances that have been found most reliable in stimulating adventitious root formation in cuttings are Indole-3-butyric acid and Naphthalene acetic acid.

Sarkisova (1965) concluded that IBA and to a lesser extent IAA were most effective in promoting both root and top growth than NAA.

In trials with Ficus elastica Kumar (1982) had reported that dipping in IBA at 4000 ppm for 10 seconds gave highest number of primary roots per cutting. Kumar et al. (1984) found that dipping the cuttings in IBA at 4000 ppm for 10 seconds recorded the best rooting in Ficus elastica var Decora (90%) and the highest survival of transplanted plants.

El-Hakim et al. (1962) found that IBA and NAA were more effective than IAA in inducing rooting in Ficus and Phyllanthus. IBA at 100 and 200 ppm for 12 hours gave maximum rooting with Ficus and 25 and 50 ppm were nearly as effective as the highest level in Phyllanthus.

Kale and Bhujbal (1972) observed that IBA at 1500 ppm resulted in most successful (75%) rooting compared with 15 per cent untreated control in Bougainvillea var Mary Palmer. It was also reported by Maura et al. (1974) that hardwood cuttings of Bougainvillea when treated with 400 ppm IAA or NAA for 12 hours showed high rooting percentage, whereas the untreated ones failed to root. According to Singh and Motial (1979) quick dip with IBA at 3000 ppm was the best for rooting of softwood Bougainvillea cuttings and subsequent plant survival. Work done by Philip and Gopalakrishnan (1982) on hardwood cuttings of Bougainvillea cv Mahara, show that quick dip in IBA at 6000 ppm gave the best rooting. The response was lesser with NAA at 1000 to 2000 ppm.

Kumar and Vijayakumar (1984) found that quick dip with IBA at 2000 ppm was best for Mussaenda phillipica cuttings when grown under intermittent mist. The percentage of rooting, number of primary roots and length of longest root decreased with increase in the concentration of IBA.

The efficacy of IAA on rooting of Arabian jasmine (Jasminum sambac) has been reported by El-Hakim (1954). He obtained highest percentage of rooting with very low concentration (25 ppm) of IAA treated for 24 hours. But higher concentration of IAA upto 400 ppm was used by Bajpai and Parmer (1958) and obtained better rooting percentage with hardwood cuttings of jasmine. Pappiah and Muthuswamy (1976) found a significantly high rooting percentage in Jasminum sambac cv Gundumalli by treating with IAA 2000 ppm, Alar 500 ppm or IBA 2000 ppm. Higher concentrations of Alar (1000 ppm) and lower concentration of IAA (1000 ppm) had also recorded good response. All the treatments registered more percentage of rooting than control. Singh (1980) treated hardwood cuttings of *Jasminum sambac* with IAA, IBA and NAA of which IBA at 4000 ppm was superior.

Shanmughavelu (1960) reported that maximum percentage (55) of rooting in *Allamanda cathertica* was observed with IAA at 100 ppm in the soak method and 10,000 ppm in dust method. He also suggested that soak method was superior to other methods, as it produced longer roots in larger numbers.

Shanmughavelu (1961) found that in *Hibiscus rosa-sinensis* the highest percentage of rooting was 60 at 20 ppm of IAA, 70 at 20 and 2000 ppm of IBA and 75 at 1000 ppm NAA in the case of softwood cuttings. Thus NAA was found best compared to IBA and IAA. Both IBA and NAA at 6000 ppm in the quick dip method produced 100 per cent rooting in semihardwood cuttings in 44 days. In hardwood cuttings, NAA proved to be the best as it gave 85 to 95 per cent rooting.

Kirkpatrik (1940) observed that IAA favoured rooting of rose cuttings. Kireeva (1967), in a trial with 12 rose varieties showed that treatment of softwood cuttings with heteroauxin or Seradix at 100 mg/litre for 3 hours improved rooting and increased root length. Bhujbal and

Kale (1973) found a combination of IAA + IBA at 1000 ppm gave 90 per cent rooting in Rosa multiflora and IBA 1000 ppm in Rosa bourboniana. IBA at 1500 ppm and IBA + NAA at 500 ppm in Rosa moschata gave the best result.

Treatment of softwood cuttings of Ligustrum with IBA at 40 ppm and 80 ppm gave a higher percentage of rooting than control and Forsythia was slightly injured by 80 ppm of IBA as reported by Fleming (1966). Rousseau (1967) concluded that in general, IBA was most successful in promoting rooting of Protea longifolia and Mimetus hirtus and 0.4 per cent was a more effective concentration than either 0.2 or 0.8 per cent. Fretz and Davis (1971) found that 5000 ppm and 2500 ppm levels of IBA gave maximum response in Ilex cornata and Juniperus horizontalis respectively than SADH treatments. Khromova (1984) reported that cuttings of woody plants treated with IBA at 0.01 per cent rooted better than control.

Singh (1977) obtained highest rooting percentage (97) with terminal cuttings of Ixora banduca treated with IBA at 2000 ppm and kept under intermittent mist. The same author (1981) found that for the multiplication of Ixora banduca by terminal cuttings IBA 2000 ppm, followed by NAA 1000 ppm and IAA 3000 ppm appeared to be the respective optimum concentrations under intermittent mist.

Generally, IBA treatment shortened the time required for roots to form in many ornamental shrubs difficult to root as reported by Yamasaki *et al*. (1982)

2.2. Effect of mist sprays on the rooting of cuttings.

It is well known that an increase in the relative humidity prevents desiccation of cuttings and provides more favourable environmental conditions for root formation. Plants which fail to root or even develop a low percentage of rooting under ordinary conditions have been shown to root satisfactorily under mist. Beneficial effect of mist on rooting in a wide variety of difficult to root plants has been recorded by Erickson and Bitters (1953) ; and Hartmann and Whisler (1956). Higher percentage of rooting under mist in cuttings of hard to root fruit trees and many ornamental plants has been reported by Sen *et al*. (1965) ; Sen *et al*. (1970) ; Bose and Mondal (1970) ; Bose *et al*. (1970) ; and Bose *et al*. (1973).

Kumar and Vijayakumar (1984) found that quick dip with IBA at 2000 ppm followed by intermittent mist conditions improved the percentage of rooting, number of primary roots and length of roots in *Mussaenda phillipica* cuttings. They decreased with increase in the concentration of IBA.

Dorsman (1957); Van Doesburg and Ravensburg (1962) reported improvement in root formation in cuttings of hard to root Conifers, Azaleas and Rhododendron under intermittent mist. Bose and Mondal (1973) found that sixty species of trees, shrubs and climbers which proved difficult to root from cuttings under polythene cover by treatment with root promoting chemicals showed moderate to high percentage of rooting under intermittent mist. Treatment with IBA and NAA not only caused higher percentage of rooting, but also developed larger number of roots on the treated cuttings.

Bose *et. al.* (1973) reported that ten species and cultivars of Ixora and eleven cultivars of Hibiscus and Jasmine which either failed to root from cuttings or showed a low percentage of rooting under ordinary conditions developed roots under intermittent mist. When treated with IBA and NAA and given the same condition rooting percentage was further increased.

Singh (1977) obtained highest rooting percentage (97) with terminal cuttings of *Ixora banduca* treated with IBA at 2000 ppm and kept under intermittent mist.

Singh (1978) treated terminal cuttings of Jasminum sambac cv Madanban with IBA, IAA and NAA at 1000, 2000, 3000, and 4000 ppm by quick dip method and kept under intermittent mist. He observed that treatment with IBA and IAA at 4000 ppm kept under intermittent mist was the most effective in rooting, number of roots, their dry weight and survival of rooted cuttings. According to the same auther (1979) the highest rooting percentage (95) of Jasminum sambac cv Motia was obtained when treated with IBA at 4000 ppm and kept under intermittent mist.

Tarasenko and Ermakov (1966) also studied the effect of mist on rooting in stem cuttings of a number of plants including plum and reported that mist proved superior in terms of percentage and speed of rooting and number of roots per cutting. Similarly Fiorino (1968) reported beneficial effect of mist on vegetative propagation of certain variety of apricot under mist.

Singh and Dhar (1976) observed the behaviour of cuttings of different species of plants under mist technique without giving any pre-treatment with a view to minimise the cost and expenditure required in other methods .The percentage of rooting and the time required for rooting were better than in the other cases. Milbocker

(1983) reported successful rooting of softwood cuttings of woody plants economically with the system which provided a mechanically humidified atmosphere.

Grange and Loach (1984) compared conventional intermittent mist and intermittent mist inside a raised polyethylene tent and found that the species susceptible to water stress rooted better in intermittent mist inside a raised polyethylene tent.

Istas and Meneve (198D) reported on the rooting of cuttings under mist, for *Betula jacquemontii*, *Magnolia sieboldii* and *Magnolia soulangiana*. The wounded cuttings were treated with 2500 ppm NAA or IBA as a quick dip or with 0.2 per cent NAA or IBA in talc. He observed beneficial effects for all the crops used, when growth substances were given under mist conditions.

Nakasone and Bowers (1956); Mukherjee *et al*. (1965) and Sen *et al*. (1968) reported good success with cuttings of some horticultural crops planted under mist without hormonal treatment.

Chauhan and Reddy (1974) proved that intermittent mist application was found to be more desirable than continuous mist, because of the fact that it avoids excess of water in the rooting media.

2.3. Effect of type of cuttings on the rooting response.

The maturity of wood significantly affects the success of cuttings. The stage of maturity of shoots suitable for obtaining the cuttings depends upon the kind or species, since some plants grow best from semihardwood cuttings, whereas some others grow best from basal cuttings. There are also plants which root from softwood cuttings. (Adriance and Brison, 1955).

Hsiung (1945) reported greater percentage of rooting in ornamental plants when six leaves were present on each cutting than with two leaves. Stambera (1974) observed that in *Ficus elastica*, apical cuttings at a relatively dormant state rooted more successfully and produced better plants in alkalized peat saturated with nutrient solution. Pimpini *et al*. (1983) also suggested that maximum percentage of rooting and number of roots were obtained in cuttings taken near the stem apex of *Ficus elastica* cuttings, but apical cuttings rooted poorly. According to Davies (1984) juvenile cuttings rooted easily, whereas only mature cuttings treated with IBA exceeded 30 per cent rooting in *Ficus pumila*.

Poole and Conover (1984) stated that single node propagation of *Ficus elastica* produced many more plants per stock plant than air layering, but the root quality was reduced when 50 per cent or more of the leaf was removed or the entire leaf rolled. Application of commercial rooting hormone did not influence rooting.

Bose *et al*. (1975) reported that for Bougainvillea 100 per cent rooting was obtained with semi-woody mid-shoot cuttings but Mussaenda species rooted best from tip cuttings, both treated with IBA. But Singh and Rathore (1977) found that all the softwood cuttings of Bougainvillea rooted but had lowest survival rate (48 %) compared with 83 per cent rooting and 54 per cent survival for hardwood cuttings. According to Singh and Motial (1979) softwood Bougainvillea cuttings rooted better than semihardwood cuttings and February was the best month for striking. Bhattacharjee and Balakrishna (1983) obtained 100 per cent rooting and survival in apical cuttings of bougainvillea.

Singh (1976) obtained highest rooting percentage with semihardwood cuttings of *Jasminum sambac* cv Motia kept under intermittent mist. Singh (1978) reported that IBA and NAA at 4000 ppm proved significantly most effective in rooting, number of roots, their dry weight and survival of rooted cuttings in *Jasminum sambac* cv Madanban terminal cuttings. The same author (1980) concluded that *Jasminum sambac* cv Motia can also be rooted very successfully by hardwood cuttings under intermittent mist following prior sensitization with auxins, IAA at 6000 ppm and IBA and NAA at 4000 ppm.

Paulas (1980) stated that rooting was highest (100 %) with one noded cuttings with a single leaf and survival after transplanting was highest (98.3 %) with one noded cuttings with a pair of leaves in *Jasminum sambac* cv Gundumalli. Veeraraghavatham *et al*. (1983) noticed increase in the percentage of rooting when etiolated shoots of Parimullai were used.

It was reported by Singh (1980a) that highest percentage (92.5) of rooting in *Allemanda cathartica* was obtained with softwood cuttings with four leaves, treated with 2000 ppm IBA and kept under intermittent mist.

Simgh (1979a) showed that terminal cuttings of Ixora species treated with IBA at 2000 ppm, was found to give more than 90 per cent rooting.

Das *et al*. (1959) reported the superiority of semihardwood cuttings of sweetlime over the hardwood cuttings. Singh *et al.* (1961) observed that hardwood cuttings were better than semihardwood cuttings in respect of the root growth, whereas there was not much difference in the percentage of rooting in phalsa. Gangwar and Singh (1965) reported that semihardwood cuttings gave better rootings than hardwood cuttings of sweetlime. Singh and Singh (1973) noticed that hardwood cuttings of sweetlime and lemon produced better results than semihardwood cuttings though the difference was not significant. According to Porlingis and Greece (1976) adult olive cuttings when compared to juvenile cuttings rooted faster and in higher percentage and formed more roots per rooted cutting.

Goliadze *et al.* (1970) reported that cuttings from the shoots of the current year's growth rooted better (79.2 %) than cuttings from the previous year's growth (74 %) in the case of Meyer lemon.

According to Mukhopadhyay and Bose (1979) leafy cuttings in general produced larger number of rooted cuttings and initiated greater number of roots per cutting, while leafless cuttings failed to produce any root even with the application of IBA. He also observed that rooting in *Mussaenda phillipica* increased appreciably with larger number of leaves in both treated and untreated cuttings.

Read and Hoysler (1968) stated that 2500 ppm of B-9 was effective in producing greater number of roots and weight of roots in dahlia, chrysanthemum and geranium cuttings.

Zimmerman *et al.* (1942, 1944) suggested that auxins when applied in relatively high but actually very low concentrations, exert toxic or lethal effects on plants and so could be employed for the purpose of killing weeds or other noxious plants. The phenoxy acetic acids have proved especially effective as herbicides.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

The experiment was carried out in the nursery attached to the Department of Horticulture, College of Agriculture, Vellayani, under two different conditions. The weather data during the period are given in Appendix I.

3.1. Rooting of cuttings under field conditions.

3.2. Rooting of cuttings under glass house conditions by providing mist.

These were conducted during the period from September 1986 to February 1987 and January to March 1987 respectively.

3.1. Rooting of cuttings under field conditions.

The investigation envisaged the study of the effect of thickness of the stem cuttings and the effect of Indole-3-butyric acid in rooting under normal field conditions.

3.1.1. Preparation of cuttings

The cuttings were made into two groups, based on thickness.

Thin cuttings -0.5-1.49 cm diameter

Medium thick cuttings -1.5-2.5 cm diameter

3.1.2. Indole-3-butyric acid and its preparation

The rooting hormone Indole-3-butyric acid (IBA) at different concentrations were used. Treatment with water was taken as control.

A stock solution of 1000 ppm IBA was prepared by dissolving 1 g of the chemical in little quantity of 50 per cent ethanol and made up the volume to 1000 ml with distilled water. The stock solution was furthur diluted to the required concentration and used for the study.

3.1.3. Preparation of the containers for rooting

The rooting medium consisted of sand and loam at 2:1 proportion by volume. Earthenware pots of 18 cms diameter were provided with drainage facilities at the bottom of the pots and filled with the prepared potting mixture.

3.1.4. Treatments

Thickness of stem	IBA in ppm
0.5 - 1.49 cm	250 ppm
1.5 - 2.50 cm	500 ppm
	Water (Control)

3.1.5. Experimental Design

The experiment was laid out in Completely Randomised Design. The treatments comprised of the various possible combinations of the 2 levels of thickness and 3 levels of IBA.

Under each treatment a total of 40 cuttings were tested, which was divided into 4 replications and each consisted of 10 cuttings.

3.1.6. Treatment of cuttings with IBA and planting

The cuttings of the same thickness were grouped together and made into bundles. Each such bundle consisted of 10 cuttings. IBA solutions were taken in a small pan and the cuttings were dipped for a period of twelve hours. Treatment with water was done for the control cuttings.

The cuttings were planted in the prepared rooting medium filled in pots, and the different treatments were distributed at random. The cuttings were irrigated by sprinkling water over it with a rose can. Watering was done very carefully not to over water and drench the soil.

3.1.7. Observations recorded

3.1.7.1. Number of days for the appearance of first sprout:

The number of days taken for the appearance of first sprout in the stem cutting from the date of planting was counted.

3.1.7.2. Percentage of sprouting :

The number of cuttings sprouted under each treatment was counted and the percentage calculated.

3.1.7.3. Number of sprouts produced :

The number of vegetative buds produced in each of the stem cuttings were counted at monthly intervals.

3.1.7.4. Number of shoots developed :

The number of shoots developed in each of the stem cuttings were counted at monthly intervals.

3.1.7.5. Number of roots :

The number of roots produced in each cutting were counted at monthly intervals. For this, one sprouted cutting from any two replications was taken at random, carefully lifted and washed and the roots were recorded. This was repeated for all the treatments.

3.1.7.6. Root length :

The length of the roots were measured and the average was taken.

3.1.7.7. Number of leaves produced :

The number of leaves produced in each plant were counted at fortnightly intervals.

3.1.7.8. Plant height :

The total height of the plants were measured and recorded.

3.1.8. Statistical analysis

The data were analysed using the analysis of Variance technique of Completely Randomised Design. The sum of squares due to the pertinent source of variations were worked out and the analysis of variance table prepared as per the method suggested by Snedecor and Cochran (1967). Critical differences were calculated in all cases where the effects were found to be statistically significant.

3.2. Rooting of cuttings under glass house conditions by providing mist.

The investigation envisaged the study of the effect of intermittent misting of IBA at different concentrations on the different types of cuttings. The control was given intermittent misting with water.

3.2.1. Preparation of cuttings

The cuttings were made into three groups , based on the number of nodes present in them.

Three noded cuttings

Two noded cuttings

Single noded cuttings

One third to half portion of each leaf present were retained in the cuttings used.

3.2.2. Preparation of IBA

A stock solution of 1000 ppm IBA was prepared by dissolving 1 g of the chemical in a small quantity of 50 per cent ethanol and made up the volume to 1000 ml with distilled water. The stock solution was further diluted to the required concentration and used for the study.

3.2.3. Preparation of nursery bed for rooting

The rooting medium consisted of sand and loam at 2:1 proportion. Concrete beds 8" deep were filled with the prepared rooting medium.

3.2.4. Treatments

Types of cuttings	IBA spray (ppm)
Three noded cuttings	10 ppm
Two noded cuttings	1 ppm
Single noded cuttings	0.1 ppm
	Water spray (Control)

3.2.5. Experimental Design

The experiment was laid out in Completely Randomised Design. The treatments comprised of various possible combinations of the three types of cuttings and four levels of IBA. Under each treatment a total of 20 cuttings were tested, which was divided into 2 replications each consisted of 10 cuttings.

3.2.6. Treatment of cuttings with IBA and planting

The cuttings were grouped together based on the number of nodes present and made into bundles. Each such bundle consisted of 10 cuttings.

The concrete bed was divided into 4 compartments and all the three types of cuttings were distributed in each of these compartments at random. The hormone solutions prepared at the required concentrations were taken in different containers and spraying was made through the mist propagation unit, consisting of a monoblock pump connected to a lance with a single nozzle. A timer present controls the time interval of the spray. By means of this timer, intermittent mist was given for 10 to 15 seconds per minute for 6 to 8 hours daily. Likewise hormone solution was used for misting for the first fifteen days and for the next thirty days water alone was used for misting. The quantity of liquid consumed was about two to three litres per hour.

3.2.7. Observations recorded

3.2.7.1. Number of days taken for the appearance of first sprout.

3.2.7.2. Percentage of sprouting.

3.2.7.3. Number of sprouts produced at monthly intervals.

3.2.7.4. Number of shoots developed at monthly intervals.

3.2.7.5. Number of roots produced at monthly intervals.

3.2.7.6. Average length of roots produced at monthly intervals.

3.2.7.7. Total number of leaves produced per plant at fortnightly intervals.

3.2.7.8. Total height of the plant.

3.2.8. Statistical Analysis

The data were analysed using the analysis of Variance technique of Completely Randomised Design. The sum of squares due to pertinent source of variations were worked out and the analysis of variance table prepared as per the method suggested by Snedecor and Cochran (1967). Critical differences were calculated in all cases where the effects were found to be statistically significant.

RESULTS

4. R E S U L T S

The observations made in the present study were statistically analysed and the results obtained are presented under the following titles.

4.1. Rooting of cuttings under field conditions

- 4.1.1. Mussaenda
- 4.1.2. Bougainvillea
- 4.1.3. Ficus

4.2. Rooting of cuttings under glasshouse conditions by providing mist

- 4.2.1. Bougainvillea
- 4.2.2. Mussaenda
- 4.2.3. Ficus

4.1. Rooting of cuttings under field conditions

Stem cuttings with 0.5-1.49 cm and 1.5-2.5 cm thickness (denoted as thin and medium thick respectively) were used. They were given IBA treatment at 250 and 500 ppm concentrations. Control cuttings were treated with water.

4.1.1. Mussaenda

4.1.1.1. Effect of treatments on the number of days taken for sprouting

Thin cuttings recorded minimum number of days for sprouting than medium thick cuttings. But there was no significant difference between them. Similarly there was no significant difference among the different levels of IBA with regard to number of days taken for sprouting. (Table 1.1)

Even though the control thin cuttings recorded the least number of days for sprouting, the interaction effects were also not significant. (Appendix II)

4.1.1.2. Effect of treatments on the percentage of sprouting

The results of analysis showed that there was significant difference among the different levels of IBA with regard to the percentage sprouting. Cuttings treated with IBA at 250 ppm gave the highest percentage of sprouting (52.5), followed by treatment with IBA at 500 ppm and lastly by control which recorded the lowest percentage (19.46). All the differences were statistically significant.

Table 1.1. Effect of treatments on the number of days taken for sprouting

Levels of thickness (cm)	Levels of IBA (ppm)			Mean
	Control A_1	IBA 250 A_2	IBA 500 A_3	
0.5-1.49 (B_1)	3.29	3.52	3.52	3.45
1.5-2.50 (B_2)	3.44	3.34	3.65	3.48
Mean	3.37	3.43	3.59	

$CD_{(0.05)}$

A - N S B - N S AB - NS

Table 1.2. Effect of treatments on the percentage of sprouting

Levels of thickness (cm)	Levels of IBA (ppm)			Mean
	Control A_1	IBA 250 A_2	IBA 500 A_3	
0.5-1.49 (B_1)	29.87	56.92	44.98	43.92
1.5-2.50 (B_2)	22.49	35.98	29.72	29.40
Mean	26.18	46.45	37.35	

$CD_{(0.05)}$

A - 8.325 B - 5.886 AB - N S

Note : Data given are the transformed values.

There was also significant difference among the different levels of thickness. Thin cuttings recorded better sprouting (48.1 %) and was significantly superior to medium thick cuttings which recorded only 24.1 per cent sprouting. (Table 1.2). Figure 1. gives a graphical representation.

The interaction effects were found to be not significant. (Appendix II)

4.1.1.3. Effect of treatments on the number of sprouts produced per cutting at monthly intervals

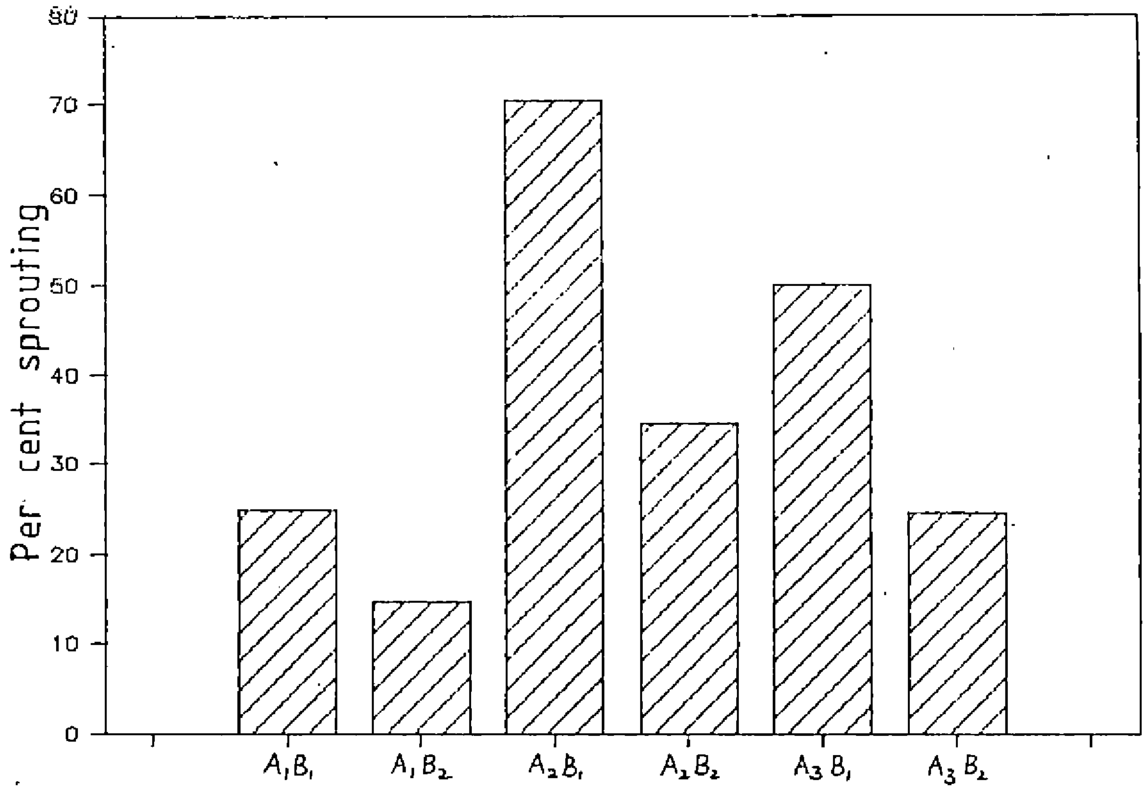
The experimental results had not indicated any significant difference among the different levels of thickness or IBA on the number of sprouts produced per cutting. (Table 1.3)

There was also no significance for the interaction effects (Appendix III).

4.1.1.4. Effect of treatments on the number of shoots produced per cutting at monthly intervals

There was significant difference among the different levels of IBA on the number of shoots produced.

FIG.1. EFFECT OF IBA AND THICKNESS OF CUTTINGS ON THE PERCENTAGE OF SPROUTING IN MUSSAENDA —FIELD CONDITIONS



A_1 - Control B_1 - Thin cuttings

A_2 - IBA 250 ppm B_2 - Medium thick cuttings

A_3 - IBA 500 ppm

Table 1.3. Effect of treatments on the number of sprouts produced per cutting taken at monthly intervals

Treatments	1	2	3	4	5
Levels of IBA (ppm)					
Control (A_1)	1.31	1.32	1.25	1.24	1.19
IBA 250 (A_2)	1.34	1.45	1.44	1.40	1.40
IBA 500 (A_3)	1.32	1.45	1.38	1.31	1.31
C $D_{(0.05)}$ A - N S	0.214	0.166	0.204	0.199	0.213
Thickness (cm)					
0.5-1.49 (B_1)	1.34	1.44	1.38	1.38	1.34
1.5-2.50 (B_2)	1.31	1.37	1.34	1.25	1.25
C $D_{(0.05)}$ B - N S	0.175	0.135	0.166	0.162	0.174
A x B interaction					
A_1 B_1	1.32	1.37	1.29	1.27	1.16
A_1 B_2	1.31	1.26	1.21	1.21	1.21
A_2 B_1	1.28	1.39	1.44	1.45	1.45
A_2 B_2	1.39	1.51	1.44	1.34	1.34
A_3 B_1	1.42	1.57	1.41	1.41	1.41
A_3 B_2	1.22	1.34	1.35	1.20	1.20
C $D_{(0.05)}$ AB - N S	0.304	0.236	0.289	0.282	0.301

Note : Data given are transformed values.

Treatment with IBA at 250 ppm gave the best results throughout, and except during November it was significantly superior to IBA at 500 ppm and control which were on par. (Table 1.4)

But no significant difference was noticed among the different levels of thickness on the number of shoots produced. (Appendix IV)

The interaction effect was also found to be not significant.

4.1.1.5. Effect of treatments on the number of roots produced per cutting

The treatments varied significantly on the number of roots produced per cutting. Maximum number of roots were produced when thin cuttings were treated with 250 ppm IBA (12.36). This was on par with thin cuttings treated with 500 ppm IBA, and medium thick cuttings treated with 250 ppm IBA. These three treatments were superior to the rest of the treatments. The next best treatment was medium thick cuttings treated with 500 ppm IBA, which was on par with control thin cuttings, but was superior to control medium thick cuttings. (Table 1.5)

Table 1.4. Effect of treatments on the number of shoots produced per cutting at monthly intervals

Treatments	1	2	3	4
Levels of IBA (ppm)				
Control (A_1)	1.183	1.315	1.315	1.315
IBA 250 (A_2)	1.264	1.489	1.489	1.489
IBA 500 (A_3)	1.282	1.316	1.316	1.316
$CD_{(0.05)}$ A	N S	0.152	0.152	0.152
Thickness (cm)				
0.5-1.49 (B_1)	1.263	1.386	1.386	1.386
1.5-2.50 (B_2)	1.223	1.361	1.361	1.361
$CD_{(0.05)}$ B	N S	NS	N S	N S
A x B interaction				
$A_1 B_1$	1.151	1.263	1.263	1.263
$A_1 B_2$	1.215	1.367	1.367	1.367
$A_2 B_1$	1.273	1.488	1.488	1.488
$A_2 B_2$	1.256	1.491	1.491	1.491
$A_3 B_1$	1.366	1.409	1.409	1.409
$A_3 B_2$	1.198	1.301	1.301	1.301
$CD_{(0.05)}$ AB	N S	N S	N S	N S

Note : Data given are transformed values.

Table 1.5. Effect of treatments on the increment in root number during different periods

Treatments		A_1	A_2	A_3	Mean
Levels of IBA (ppm) and thickness (cm)					
Control, 0.5-1.49	(B_1)	1.86	2.55	2.09	2.17
Control, 1.5-2.50	(B_2)	1.36	1.98	1.82	1.72
IBA 250, 0.5-1.49	(B_3)	5.19	3.15	2.21	3.52
IBA 250, 1.5-2.50	(B_4)	3.74	3.16	2.31	3.24
IBA 500, 0.5-1.49	(B_5)	4.58	2.83	2.55	3.32
IBA 500, 1.5-2.50	(B_6)	1.93	2.98	2.64	2.52
Mean		3.11	2.77	2.35	

C $D_{(0.05)}$

A - 0.39 B - 0.551 AB - 0.995

A_1 - Increment in root number during the period November to December. (Second to third month after planting)

A_2 - Increment in root number during the period December to January. (Third to fourth month after planting)

A_3 - Increment in root number during the period January to February. (Fourth to fifth month after planting)

Data given above are transformed values.

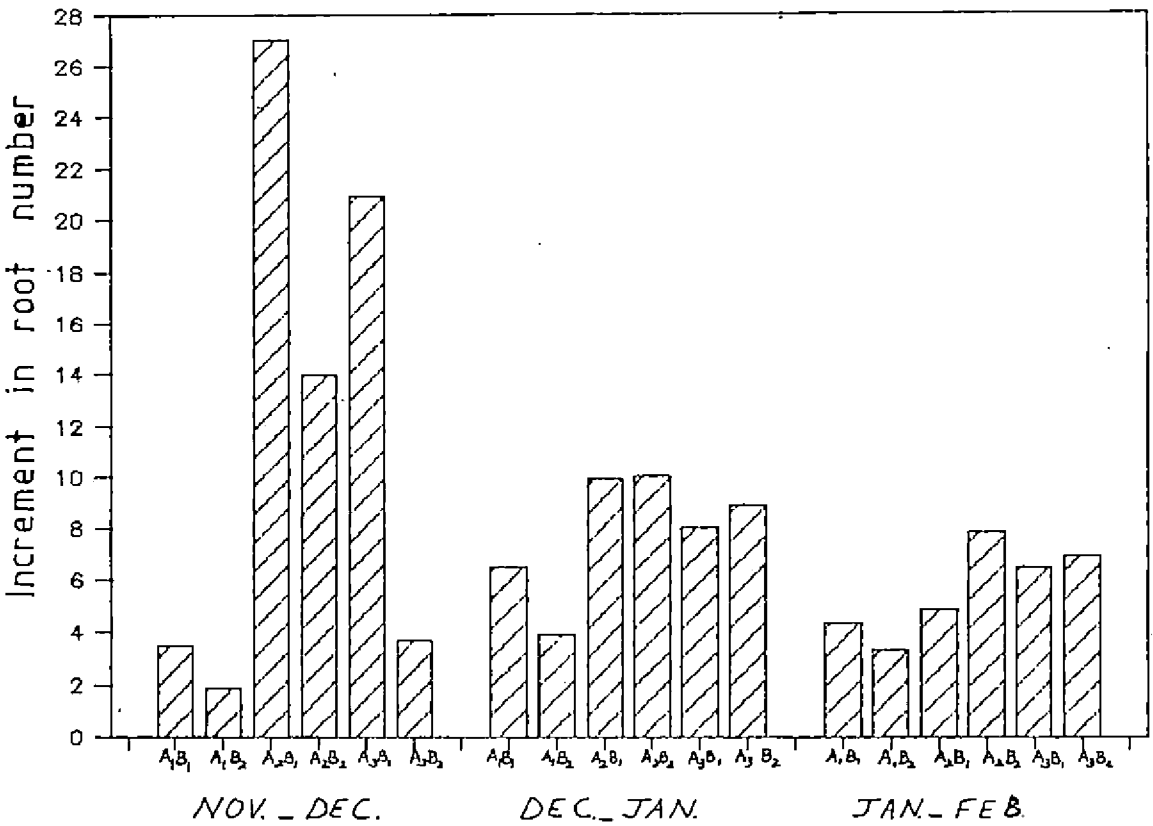
Significant differences were also noticed among the different periods on the number of roots produced. The average number of roots produced during the period from November to December was the maximum (9.69), but it was on par with the period from December to January. Both these treatments were superior to the period from January to February. (Appendix VI)

The interaction effects were also found to be significant. Maximum number of roots was obtained during the period November to December and for thin cuttings treated with 250 ppm IBA. This treatment was found to be superior to all other treatments. Figure 2. shows the graphical representation.

4.1.1.6. Effect of treatments on the length of roots produced

The effect of treatments on the length of roots produced were statistically significant. Maximum root length was obtained for thin cuttings treated with 250 ppm IBA. This was on par with thin cuttings treated with 500 ppm IBA and medium thick cuttings treated with 250 ppm IBA. Both thin and medium thick, control treatments were on par with each other and inferior to the rest

FIG. 2. EFFECT OF IBA AND THICKNESS OF CUTTINGS ON THE INCREMENT IN ROOT NUMBER IN MUSSAENDA – FIELD CONDITIONS



A_1 - Control

A_2 - IBA 250 ppm

A_3 - IBA 500 ppm

B_1 - Thin cuttings

B_2 - Medium thick cuttings

of the treatments. (Table 1.6)

There was also significant difference among the different periods on the length of roots produced. Maximum length was produced during the period from November to December. This period was significantly superior than the other two periods which were on par with each other. (Appendix VI)

It was also noticed that the interaction effects were statistically significant. Maximum length (10.9 cm) was recorded during the period November to December and for thin cuttings treated with 250 ppm IBA. This treatment combination was more effective in increasing root length than all other treatment combinations. Figure 3. shows the graphical representation.

4.1.1.7. Effect of treatments on the number of leaves produced per cutting at fortnightly intervals

The experimental results showed that there was significant difference among the different levels of IBA on the number of leaves produced. IBA at 250 ppm gave the best results, during all the observation periods, followed by IBA 500 ppm and then control. All the differences were statistically significant during all periods except

Table 1.6. Effect of treatments on the increment in root length during different periods

Treatments		A_1	A_2	A_3	Mean
Levels of IBA (ppm) and thickness (cm)					
Control, 0.5-1.49	(B_1)	1.80	2.55	2.60	2.32
Control, 1.5-2.50	(B_2)	0.90	3.55	1.45	1.97
IBA 250, 0.5-1.49	(B_3)	10.90	5.05	4.00	6.95
IBA 250, 1.5-2.50	(B_4)	6.95	3.50	4.55	5.00
IBA 500, 0.5-1.49	(B_5)	10.65	6.05	3.10	6.60
IBA 500, 1.5-2.50	(B_6)	5.90	3.10	3.15	4.05
Mean		6.18	4.12	3.14	

$CD_{(0.05)}$

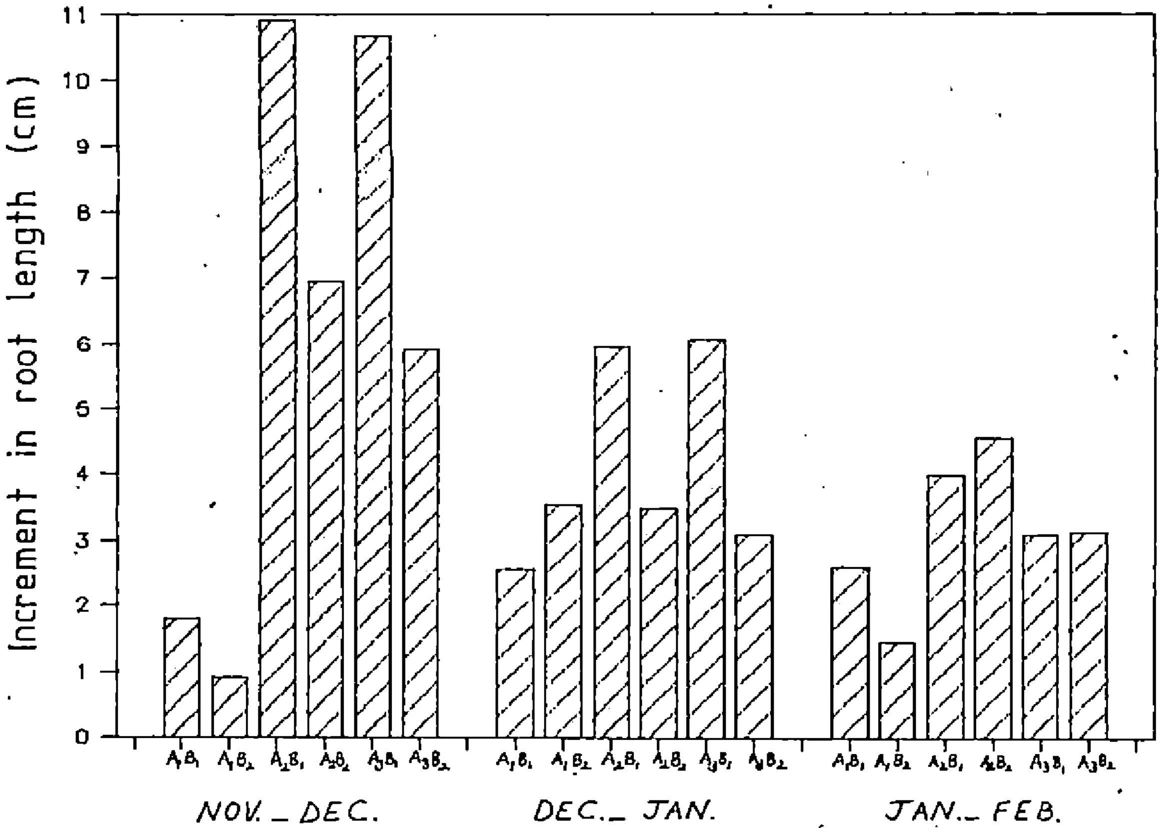
A - 1.395 B - 1.973 AB - 3.41

A_1 - Increment in root length during the period November to December. (Second to third month after planting)

A_2 - Increment in root length during the period December to January. (Third to fourth month after planting)

A_3 - Increment in root length during the period January to February. (Fourth to fifth month after planting)

FIG 3. EFFECT OF IBA AND THICKNESS OF CUTTINGS ON THE INCREMENT IN ROOT LENGTH IN MUSSAENDA _ FIELD CONDITIONS



A_1 - Control

A_2 - IBA 250 ppm

A_3 - IBA 500 ppm

B_1 - Thin cuttings

B_2 - Medium thick cuttings

the first fortnight where IBA at 250 ppm was on par with IBA at 500 ppm, but both were superior to control. (Table 1.7)

Significant difference was noticed among the different levels of thickness on the number of leaves produced. Thin cuttings gave the best results and medium thick cuttings produced less number of leaves. The difference were statistically significant during all periods. (Appendix V)

The interaction effects were also found to be statistically significant. Thin cuttings treated with 250 ppm IBA gave the best results during all the observation periods.

4.1.1.8. Effect of treatments on the height of the plant

Different levels of IBA exerted differential effects on the height of the plant. IBA at 250 ppm recorded the maximum plant height, (18.8 cm) followed by IBA treatment at 500 ppm (15.5 cm) and lastly by control. (14.1 cm) All the differences were statistically significant. (Table 1.8)

There was also significant difference among the levels of thickness on the height of the plant. Thin cuttings were significantly superior to medium thick

Table 1.7. Effect of treatments on the number of leaves produced per cutting.

Treatments	Observations at fortnightly intervals									
	1	2	3	4	5	6	7	8	9	10
Levels of IBA (ppm)										
Control (A_1)	1.48	1.51	1.77	2.09	2.21	2.25	2.5	2.53	2.68	2.88
IBA 250 (A_2)	1.86	3.19	3.35	3.86	3.92	3.85	4.21	4.23	4.47	4.69
IBA 500 (A_3)	1.69	2.66	2.78	3.28	3.32	3.36	3.67	3.7	4.05	4.31
$CD_{(0.05)}$	0.215	0.146	0.113	0.095	0.116	0.202	0.096	0.104	0.079	0.108
Levels of Thickness (cm)										
0.5 - 1.49 (B_1)	1.81	2.76	2.95	3.48	3.57	3.53	3.85	3.87	4.09	4.3
1.5 - 2.5 (B_2)	1.54	2.14	2.32	2.67	2.74	2.78	3.07	3.1	3.38	3.62
$CD_{(0.05)}$	0.175	0.119	0.092	0.077	0.095	0.165	0.078	0.085	0.064	0.088
A x B interaction										
A_1 B_1	1.62	1.7	1.96	2.38	2.49	2.54	2.88	2.88	3.07	3.26
A_1 B_2	1.34	1.31	1.57	1.8	1.93	1.96	2.11	2.17	2.28	2.49
A_2 B_1	2.07	3.63	3.77	4.29	4.37	4.21	4.59	4.61	4.79	5.00
A_2 B_2	1.65	2.76	2.92	3.43	3.47	3.50	3.84	3.86	4.15	4.38
A_3 B_1	1.74	2.96	3.1	3.78	3.83	3.84	4.08	4.11	4.41	4.64
A_3 B_2	1.64	2.35	2.46	2.78	2.81	2.38	3.25	3.28	3.69	3.98
$CD_{(0.05)}$	N S	0.207	0.16	0.135	0.164	N S	N S	N S	N S	N S

Note: Data given are the transformed values.

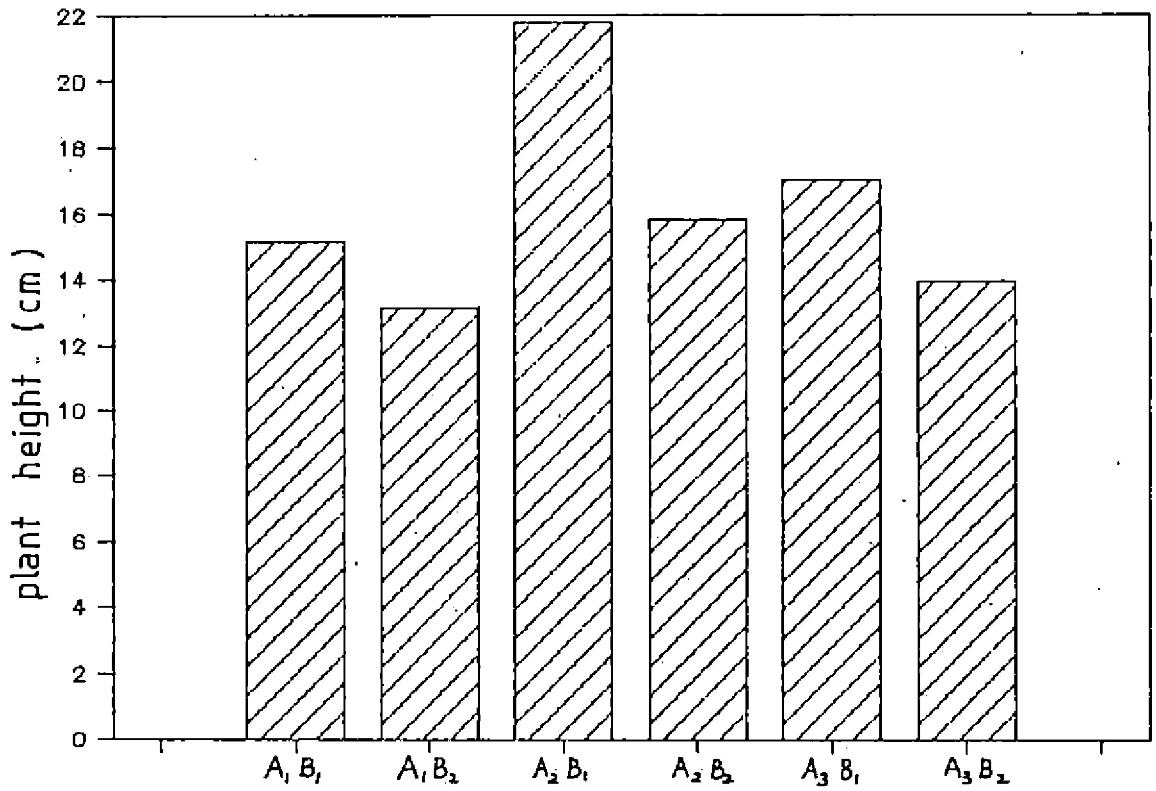
Table 1.8. Effect of treatments on the height of plant

Levels of IBA (ppm)	Levels of thickness (cm)		
	0.5-1.49 (B_1)	1.5-2.5 (B_2)	Mean
Control (A_1)	15.15	13.15	14.15
IBA 250 (A_2)	21.75	15.85	18.80
IBA 500 (A_3)	17.05	13.95	15.50
Mean	17.98	14.32	

C $D_{(0.05)}$

A - 0.872 B - 0.712 AB - 1.23

FIG 4 EFFECT OF IBA AND THICKNESS OF CUTTINGS ON THE PLANT HEIGHT IN MUSSAENDA — FIELD CONDITIONS



A_1 - Control B_1 - Thin cuttings

A_2 - IBA 250 ppm B_2 - Medium thick cuttings

A_3 - IBA 500 ppm

cuttings. (Appendix VII). Figure 4. represents the graph.

Significant difference was observed for the interaction effect. Thin cuttings treated with 250 ppm IBA recorded maximum plant height. (21.75 cm)

4.1.2. Bougainvillea

4.1.2.1. Effect of treatments on the number of days taken for sprouting

The results of analysis showed that there was significant difference among the levels of IBA on the number of days taken for sprouting. Treatment with IBA at 250 ppm took the least number of days for sprouting (8.3). IBA at 500 ppm gave the next best result (8.7) and control cuttings took the maximum number of days for sprouting (11.2). Statistically IBA at 250 ppm was on par with IBA at 500 ppm and both were superior to control. (Table 2.1)

No significant difference was noticed among the levels of thickness on the number of days taken for sprouting. (Appendix II)

The interaction effect was found to be

Table 2.1. Effect of treatments on the number of days taken for sprouting

Levels of thickness (cm)	Levels of IBA (ppm)			Mean
	Control A_1	IBA 250 A_2	IBA 500 A_3	
0.5-1.49 (B_1)	3.43	3.15	2.78	3.12
1.5-2.50 (B_2)	3.25	2.62	3.14	2.99
Mean	3.34	2.88	2.95	

C $D_{(0.05)}$

A - 0.285 B - 0.403 AB - N S

Table 2.2. Effect of treatments on the percentage of sprouting

Levels of thickness (cm)	Levels of IBA (ppm)			Mean
	Control A_1	IBA 250 A_2	IBA 500 A_3	
0.5-1.49 (B_1)	29.87	68.40	60.62	52.96
1.5-2.50 (B_2)	43.54	74.12	67.47	61.71
Mean	36.71	71.26	64.04	

C $D_{(0.05)}$

A - 9.50 B - 7.75 AB - N S

Note : Data given are the transformed values.

significant. Medium thick cuttings treated with 250 ppm IBA recorded minimum number of days for sprouting (6.84).

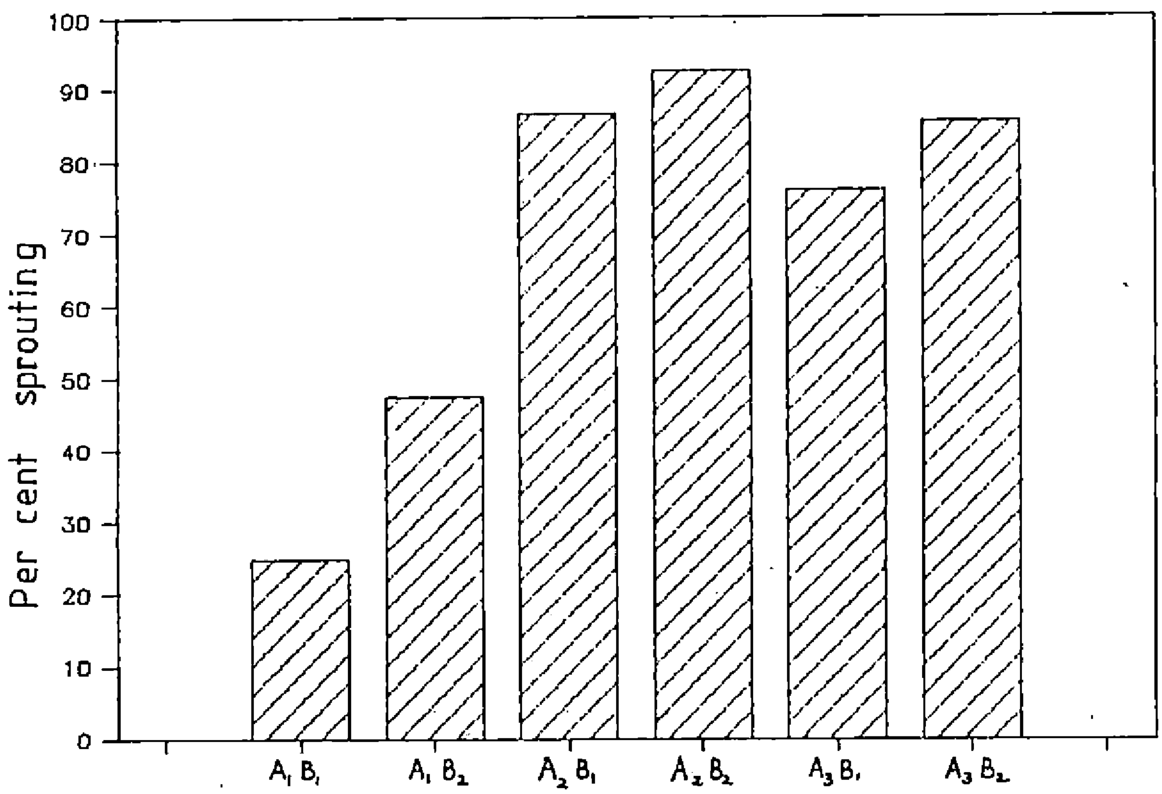
4.1.2.2. Effect of treatments on the percentage of sprouting

The levels of IBA differed significantly on the percentage of sprouting. Treatment with IBA at 250 ppm gave the best results (89.7 %) followed by IBA at 500 ppm (80.85 %) and lastly by control (35.7 %). Treatment with IBA at 250 ppm was on par with IBA at 500 ppm, but both were superior to control. (Table 2.2)

There was also significant difference among the different levels of thickness on the percentage of sprouting. Medium thick cuttings which recorded 77.55 per cent sprouting was statistically superior to thin cuttings (63.7 %). (Appendix II)

No significance was noticed for the interaction effect. Figure 5. shows the graphical representation.

FIG. 5. EFFECT OF IBA AND THICKNESS OF CUTTINGS ON THE PERCENTAGE OF SPROUTING IN BOUGAINVILLEA — FIELD CONDITIONS



A_1 - Control

A_2 - IBA 250 ppm

A_3 - IBA 500 ppm

B_1 - Thin cuttings

B_2 - Medium thick cuttings

4.1.2.3. Effect of treatments on the number of sprouts produced per cutting at monthly intervals

The experimental results showed that there was no significant difference among the different levels of IBA on the number of sprouts produced. (Table 2.3)

The levels of thickness differed significantly on the number of sprouts produced. Medium thick cuttings produced more number of sprouts than thin cuttings on all months except the first month where thin cuttings recorded more number of sprouts than medium thick cuttings. (Appendix III)

The interaction effects were found to be significant during the last three months.

4.1.2.4. Effect of treatments on the number of shoots produced per cutting at monthly intervals

Significant difference was observed among the different levels of IBA with regard to the number of shoots developed per cutting. Treatment with IBA at 250 ppm was found to be the best, followed by IBA at 500 ppm but both were statistically on par. Control was inferior

Table 2.3. Effect of treatments on the number of sprouts produced per cutting taken at monthly intervals

Treatments	1	2	3	4	5
Levels of IBA (ppm)					
Control (A_1)	1.52	1.52	1.39	1.39	1.39
IBA 250 (A_2)	1.47	1.21	1.45	1.45	1.45
IBA 500 (A_3)	1.50	1.18	1.47	1.47	1.47
C $D_{(0.05)}$ A	N S	N S	N S	N S	N S
Thickness (cm)					
0.5-1.49 (B_1)	1.54	1.02	1.38	1.38	1.38
1.5-2.50 (B_2)	1.46	1.40	1.49	1.49	1.49
C $D_{(0.05)}$ B	0.067	0.08	0.094	0.094	0.094
A x B interaction					
A_1 B_1	1.55	1.55	1.24	1.24	1.24
A_1 B_2	1.48	1.49	1.53	1.53	1.53
A_2 B_1	1.53	1.55	1.47	1.47	1.47
A_2 B_2	1.39	1.39	1.43	1.43	1.43
A_3 B_1	1.50	1.50	1.43	1.43	1.43
A_3 B_2	1.48	1.49	1.49	1.49	1.49
C $D_{(0.05)}$ AB	N S	N S	0.163	0.163	0.163

Note : Data given are transformed values.

to both the other treatments. (Table 2.4)

The results of analysis also showed that there was significant difference among the different levels of thickness on the number of shoots developed. Medium thick cuttings was significantly superior to thin cuttings.

During the third, fourth and fifth months the interaction effects were statistically significant. Medium thick cuttings treated with 250 ppm IBA recorded the maximum number of shoots. (Appendix IV)

4.1.2.5. Effect of treatments on the number of roots produced per cutting

There was significant difference among the treatments on the number of roots produced. Maximum number of roots were produced when medium thick cuttings treated with 250 ppm IBA, (11.39) were used. This was on par with medium thick cuttings treated with 500 ppm IBA, but superior to the rest of the cuttings. Medium thick cuttings treated with 500 ppm IBA was on par with thin cuttings treated with 500 ppm IBA, but was superior to the rest. Control thin cutting was the inferior most treatment. Figure 6. represents the graph. (Table 2.5)

The seasonal effect was also significant.

Table 2.4. Effect of treatments on the number of shoots produced per cutting taken at monthly intervals

Treatments	1	2	3	4	5
Levels of IBA (ppm)					
Control (A_1)	1.25	0.95	0.96	0.94	0.94
IBA 250 (A_2)	1.57	1.21	1.25	1.25	1.25
IBA 500 (A_3)	1.50	1.18	1.20	1.20	1.20
C $D_{(0.05)}$ A	0.135	0.13	0.092	0.086	0.086
Thickness (cm)					
0.5-1.49 (B_1)	1.35	1.024	1.04	1.02	1.02
1.5-2.50 (B_2)	1.53	1.20	1.23	1.23	1.23
C $D_{(0.05)}$ B	0.11	0.106	0.075	0.07	0.07
A x B interaction					
A_1 B_1	1.13	0.88	0.88	0.84	0.84
A_1 B_2	1.37	1.01	1.05	1.05	1.05
A_2 B_1	1.44	1.03	1.06	1.06	1.06
A_2 B_2	1.71	1.38	1.44	1.44	1.44
A_3 B_1	1.49	1.15	1.17	1.17	1.17
A_3 B_2	1.50	1.21	1.22	1.22	1.22
C $D_{(0.05)}$ AB	N S	N S	0.13	0.12	0.12

Note : Data given are transformed values.

Table 2.5. Effect of treatments on the increment in root number during different periods

Treatments	A_1	A_2	Mean
Levels of IBA (ppm) and thickness (cm)			
Control, 0.5-1.49 (B_1)	2.00	1.86	1.93
Control, 1.5-2.50 (B_2)	3.07	1.73	2.40
IBA 250, 0.5-1.49 (B_3)	3.16	2.12	2.64
IBA 250, 1.5-2.50 (B_4)	3.60	3.14	3.37
IBA 500, 0.5-1.49 (B_5)	3.67	2.12	2.89
IBA 500, 1.5-2.50 (B_6)	3.60	2.54	3.07
Mean	3.18	2.25	

C $D_{(0.05)}$

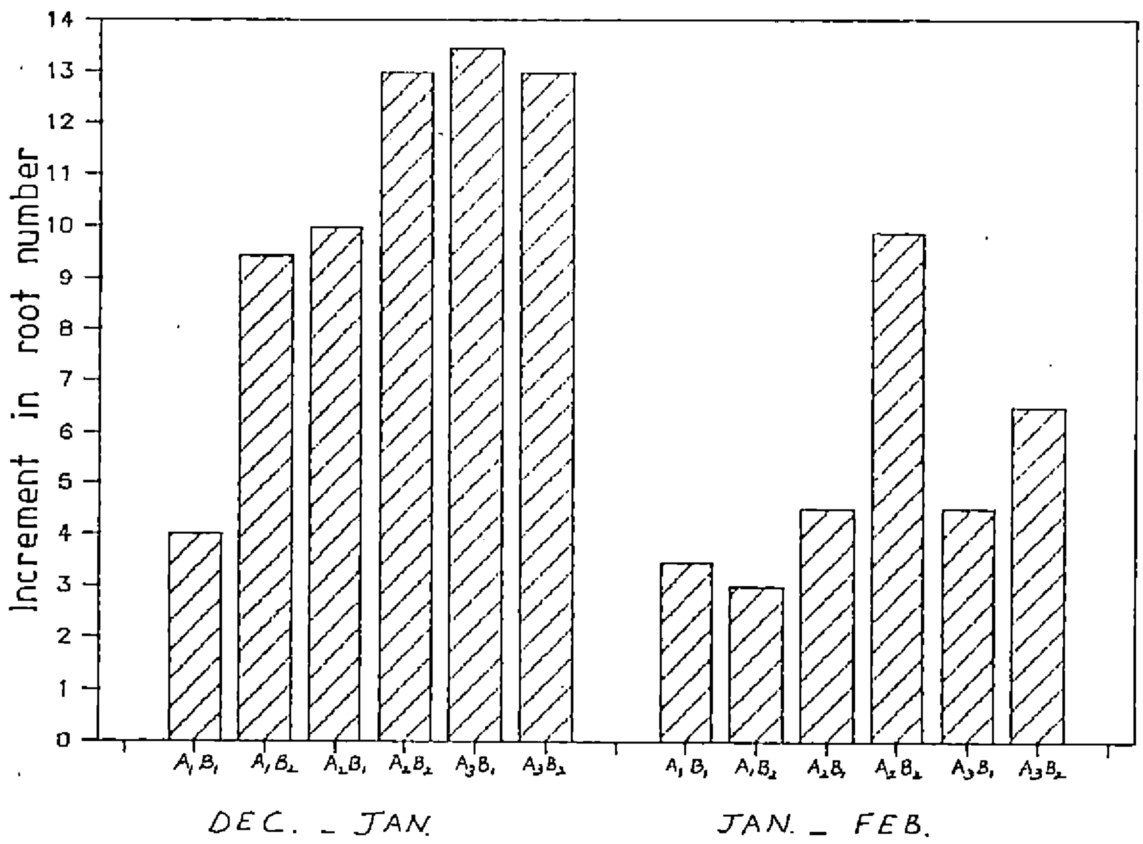
A - 0.197 B - 0.342 AB - 0.484

Data given above are transformed values.

A_1 - Increment in root number during the period December to January. (Third to fourth month after planting)

A_2 - Increment in root number during the period January to February. (Fourth to fifth month after planting)

FIG.6. EFFECT OF IBA AND THICKNESS OF CUTTINGS ON THE INCREMENT IN ROOT NUMBER IN BOUGAINVILLEA — FIELD CONDITIONS



A_1 - Control

A_2 - IBA 250 ppm

A_3 - IBA 500 ppm

B_1 - Thin cuttings

B_2 - Medium thick cuttings

Maximum number of roots were produced during the period from December to January and this was superior to the other period from January to February.

Significant difference was noticed for the interaction effects too. The maximum number of roots were produced during the period from December to January for thin cuttings treated with 500 ppm IBA (13.45). It was also found that for all treatments root production was more active and significant in the period December to January than the other period. (Appendix VI)

4.1.2.6. Effect of treatments on the length of roots produced

The effect of treatments on the length of roots produced was statistically significant. Maximum length of root was recorded for medium thick cuttings treated with 250 ppm IBA (9.35 cm). This treatment was superior to all other treatments. Medium thick cuttings treated with 500 ppm IBA was the next best treatment. Control thin cuttings was the inferior most treatment. (Table 2.6)

It was also noticed that the seasonal

Table 2.6. Effect of treatments on the increment in root length during different periods

Treatments		A_1	A_2	Mean
Levels of IBA (ppm) and thickness (cm)				
Control, 0.5-1.49	(B_1)	2.65	1.55	2.10
Control, 1.5-2.50	(B_2)	5.75	1.90	3.82
IBA 250, 0.5-1.49	(B_3)	6.50	2.75	4.62
IBA 250, 1.5-2.50	(B_4)	12.65	6.05	9.35
IBA 500, 0.5-1.49	(B_5)	7.60	5.20	6.40
IBA 500, 1.5-2.50	(B_6)	8.55	7.20	7.87
Mean		7.28	4.11	

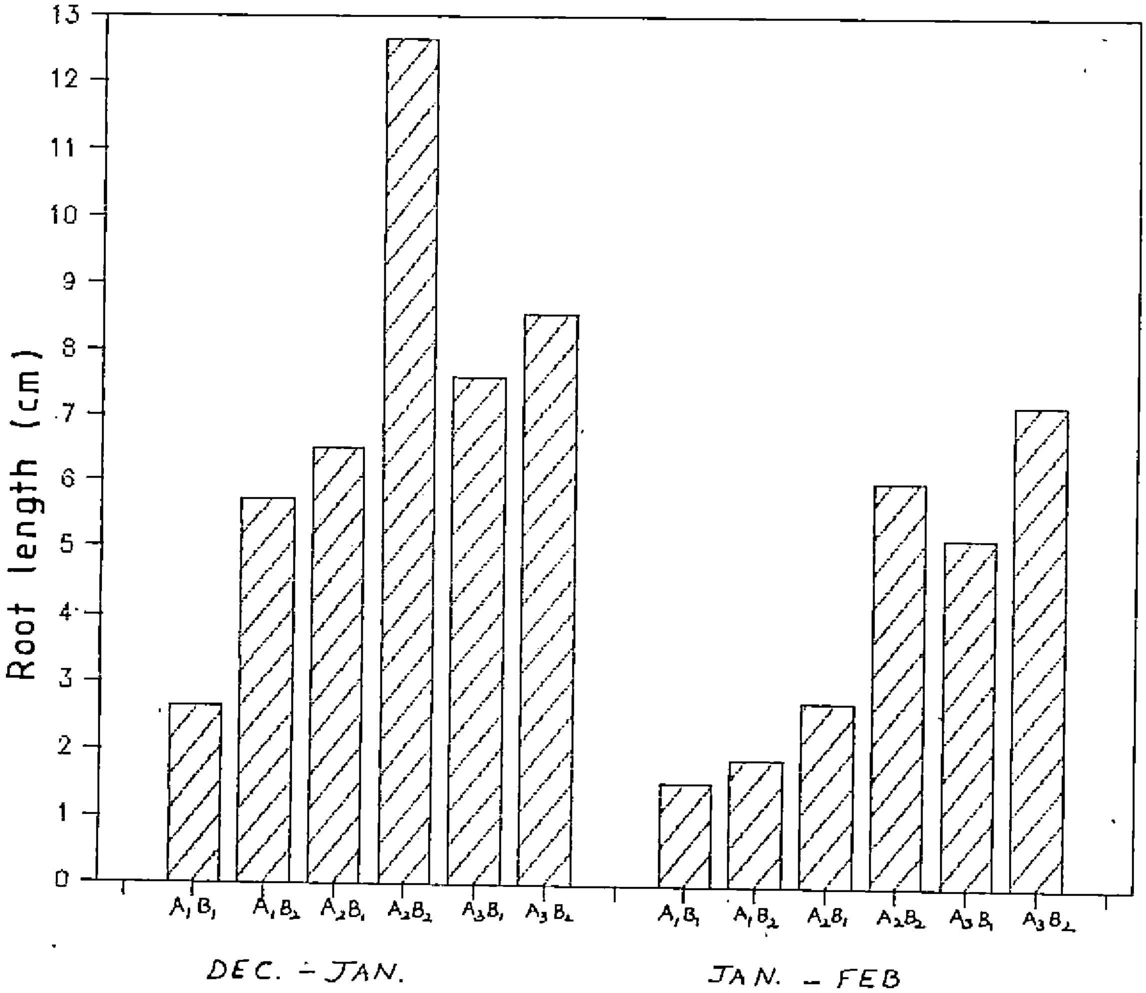
C $D_{(0.05)}$

A - 0.399 B - 0.691 AB - 0.977

A_1 - Increment in root length during the period December to January. (Third to fourth month after planting)

A_2 - Increment in root length during the period January to February. (Fourth to fifth month after planting)

FIG. 7. EFFECT OF IBA AND THICKNESS OF CUTTINGS ON THE INCREMENT IN ROOT LENGTH IN BOUGAINVILLEA — FIELD CONDITIONS



A_1 - Control

A_2 - IBA 250 ppm

A_3 - IBA 500 ppm

B_1 - Thin cuttings

B_2 - Medium thick cuttings

effect was significant. Maximum root length was produced during the period from December to January and this was statistically superior to the period January to February. (Appendix VI)

There was significant difference for the interaction effects. Maximum length (12.65 cm) was produced during the period from December to January for medium thick cuttings treated with 250 ppm IBA. Thus the results evidently proved that the application of IBA at the rate of 250 ppm on medium thick cuttings during the months of December to January was the most suited treatment. Figure 7. shows the graphical representation.

4.1.2.7. Effect of treatments on the number of leaves produced per cutting at fortnightly intervals

The different levels of IBA varied significantly on the number of leaves produced per cutting. IBA at 250 ppm gave the best result followed by IBA at 500 ppm and then by control. All the differences were significant during third, eighth, nineth, tenth and eleventh fortnights. Treatment with IBA at 250 ppm was on par with IBA at 500 ppm and both were superior to control on all other fortnights. (Table 2.7)

Table 2.7. Effect of treatments on the number of leaves produced per cutting.

Treatment	Observations at fortnightly intervals										
	1	2	3	4	5	6	7	8	9	10	11
Levels of IBA (ppm)											
Control (A_1)	1.009	1.212	2.388	3.024	3.5	3.85	4.16	4.39	4.8	5.19	5.39
IBA 250 (A_2)	1.68	2.42	4.31	4.79	4.86	5.38	5.6	5.99	6.52	6.87	7.24
IBA 500 (A_3)	1.45	2.33	4.12	4.7	5.04	5.26	5.48	5.73	6.15	6.51	6.91
$CD_{(0.05)}$	0.119	0.138	0.173	0.149	0.355	0.173	0.124	0.116	0.094	0.089	0.077
Levels of Thickness (cm)											
0.5 - 1.49 (B_1)	1.33	1.82	3.3	3.86	4.14	4.58	4.84	5.05	5.39	5.79	6.11
1.5 - 2.5 (B_2)	1.43	2.15	3.91	4.48	4.79	5.07	5.31	5.69	6.26	6.59	6.92
$CD_{(0.05)}$	0.097	0.112	0.142	0.12	0.29	0.143	0.101	0.095	0.077	0.073	0.063
A x B interaction											
A_1 B_1	1.00	1.13	2.28	2.85	3.39	3.78	4.02	4.22	4.66	5.06	5.24
A_1 B_2	1.02	1.29	2.48	3.19	3.61	3.92	4.3	4.55	4.93	5.33	5.54
A_2 B_1	1.55	2.08	3.64	4.14	4.12	4.8	5.1	5.33	5.57	5.96	6.38
A_2 B_2	1.81	2.77	4.98	5.43	5.6	5.92	6.09	6.65	7.46	7.77	8.1
A_3 B_1	1.44	2.25	3.99	4.59	4.92	5.16	5.42	5.6	5.93	6.36	6.71
A_3 B_2	1.46	2.4	4.25	4.89	5.16	5.37	5.54	5.69	6.38	6.59	7.11
$CD_{(0.05)}$	N S	0.195	0.245	0.211	0.502	0.245	0.175	0.164	0.134	0.127	0.109

Note: Data given are the transformed values.

Significant difference was also noticed among the different levels of thickness on the number of leaves produced. Medium thick cuttings were statistically superior to thin cuttings. (Appendix V)

The interaction effect was also found to be significant and medium thick cuttings treated with 250 ppm IBA was the best treatment.

4.1.2.8. Effect of treatments on the plant height

The experimental results showed that the different levels of IBA varied significantly with regard to the plant height. Treatment with IBA at 250 ppm produced taller plants followed by IBA at 500 ppm and lastly by control. All the differences were statistically significant. (Table 2.8)

The different levels of thickness also varied significantly and medium thick cuttings were better than thin cuttings. (Appendix VII)

There was statistical significance for the interaction effect also. Medium thick cuttings treated with 250 ppm IBA recorded the maximum plant height. (65.6 cm) Figure 8. represents the graph.

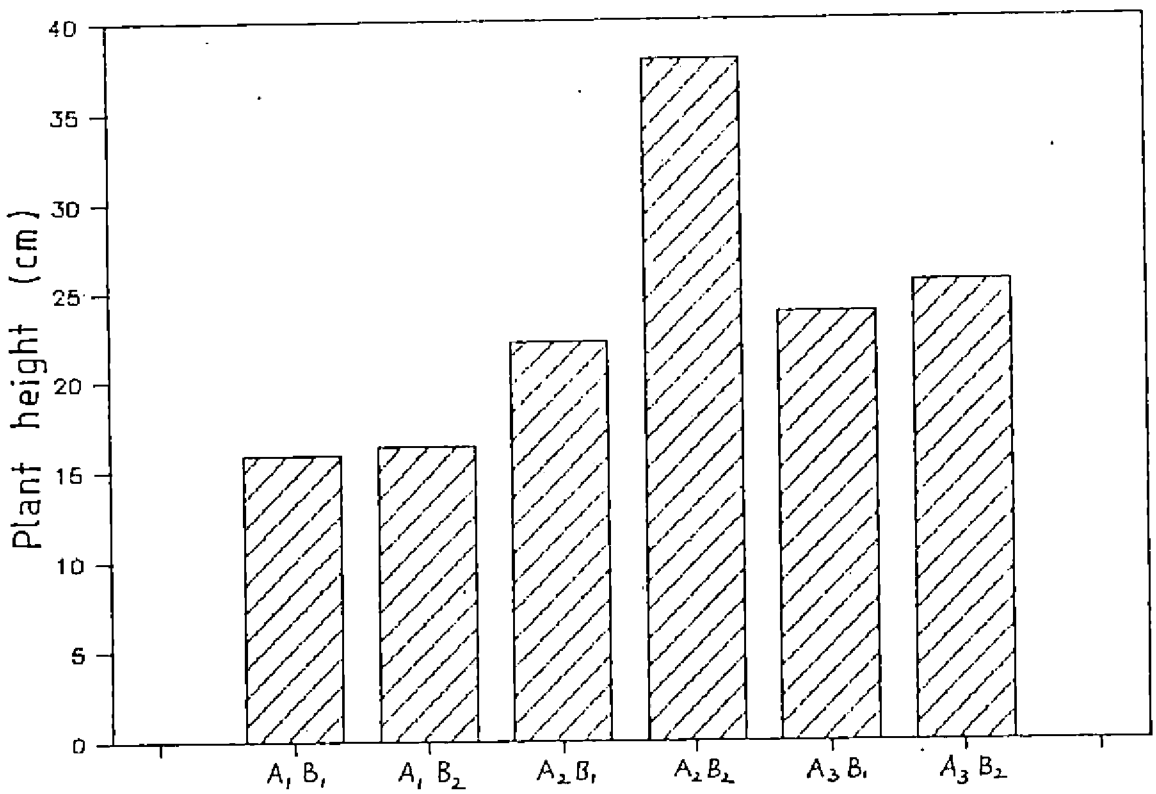
Table 2.8. Effect of treatments on the height of plant

Levels of IBA (ppm)	Levels of thickness (cm)		
	0.5-1.49 (B_1)	1.5-2.5 (B_2)	Mean
Control (A_1)	15.87	16.32	16.10
IBA 250 (A_2)	22.20	37.80	30.00
IBA 500 (A_3)	23.75	25.50	24.62
Mean	20.61	26.54	

C $D_{(0.05)}$

A - 0·407 B - 0.406 AB - 0.704

FIG. 8. EFFECT OF IBA AND THICKNESS OF CUTTINGS ON THE PLANT HEIGHT IN BOUGAINVILLEA — FIELD CONDITIONS



A_1 - Control

A_2 - IBA 250 ppm

A_3 - IBA 500 ppm

B_1 - Thin cuttings

B_2 - Medium thick cuttings

4.1.3. Ficus

The data was insufficient as there was very low percentage of sprouting and hence statistical analysis was not done.

4.2. Rooting of cuttings under glasshouse conditions by providing mist.

Three types of cuttings based on the number of nodes present (three noded, two noded and single noded cuttings) were used in the study. IBA was given along with mist at 0.1, 1, and 10 ppm concentrations. Control cuttings were sprayed with water alone.

4.2.1. Bougainvillea

4.2.1.1. Effect of treatments on the number of days taken for sprouting

The effect of IBA on the number of days taken for sprouting was statistically significant. Application of IBA at 1 ppm recorded the minimum number of days for sprouting (9.48), but was statistically on par with IBA misting at 0.1 ppm and control. Misting IBA at 10 ppm recorded the maximum number of days for sprouting. (Table 1.1)

The interaction effect between the type of cuttings and levels of IBA was not significant. (Appendix VIII)

Table 1.1. Effect of treatments on the number of days taken for sprouting

Type of cuttings	Levels of IBA (ppm)				Mean
	Control B_1	IBA 0.1 B_2	IBA 1 B_3	IBA 10 B_4	
3 noded (A_1)	3.10	3.43	3.15	3.77	3.29
2 noded (A_2)	3.59	3.28	2.74	4.26	3.47
1 noded (A_3)	3.25	3.19	3.34	4.30	3.52
Mean	3.31	3.3	3.08	4.01	

C D (0.05)

A – N S B – 0.439 AB – N S

Table 1.2. Effect of treatments on the percentage of sprouting

Type of cuttings	Levels of IBA (ppm)				Mean
	Control B_1	IBA 0.1 B_2	IBA 1 B_3	IBA 10 B_4	
3 noded (A_1)	71.53	90	90	90	85.38
2 noded (A_2)	90	90	90	90	90
1 noded (A_3)	63.4	71.53	90	60.09	71.25
Mean	74.98	83.84	90	80.02	

C D(0.05)

A - 1.477 B - 1.705 AB - 2.95

Note : Data given are the transformed values.

4.2.1.2. Effect of treatments on the percentage of sprouting

The experimental results showed that there was significant difference among the different types of cuttings with regard to the percentage of sprouting. Two noded cuttings recorded cent per cent sprouting, followed by three noded cuttings which recorded an average sprouting of 99.25 per cent. The lowest percentage of sprouting was recorded by single noded cuttings (89.7 %). All the treatments were statistically different to each other. (Table 1.2)

The effect of different levels of IBA with regard to percentage sprouting were also found to be significant. Treatment with IBA at 1 ppm misting recorded cent per cent sprouting, and was significantly superior to IBA at 0.1 ppm which gave an average sprouting of 98.85 per cent. Treatment with IBA at 10 ppm recorded 97 per cent sprouting and was significantly superior to control. (Appendix VIII)

The interaction effects were also found to be significant. Two noded cuttings at all levels of IBA recorded cent per cent sprouting. Similarly IBA misting at 1 ppm recorded cent per cent sprouting in three noded, two noded and single noded cuttings.

4.2.1.3. Effect of treatments on the number of sprouts produced per cutting at monthly intervals

The effect of type of cuttings on the number of sprouts produced was statistically significant. Three noded cuttings recorded maximum number of sprouts during the first and second months (1.798 and 1.868 respectively). Two noded cuttings were found to be the next, and single noded cuttings produced the least number of sprouts. All the differences were significant during the second month, the first month three noded cuttings varied significantly to two noded and single noded cuttings which were on par. (Table 1.3)

There was also significant difference between the levels of IBA with respect to number of sprouts produced. Treatment with IBA at 0.1 ppm recorded the maximum number of sprouts during the first and second months (1.382 and 1.565 respectively). During the first month, IBA misting at 0.1 ppm was found to be on par with IBA misting at 1 ppm, but was significantly superior to IBA misting at 10 ppm and control. During the second month IBA misting at 0.1 ppm was significantly superior to all other treatments which were on par with each other. (Appendix IX)

Table 1.3. Effect of treatments on the number of sprouts produced per cutting

Levels of IBA (ppm)	Type of cuttings 3 noded A_1	2 noded A_2	1 noded A_3	Mean
One month after planting				
Control (B_1)	1.74(1.32)	1.0(1.0)	1.0(1.0)	1.22(1.11)
IBA 0.1 (B_2)	2.0(1.414)	1.24(1.12)	1.0(1.0)	1.38(1.18)
IBA 1 (B_3)	1.84(1.36)	1.15(1.07)	1.0(1.0)	1.31(1.14)
IBA 10 (B_4)	1.6(1.26)	1.0(1.0)	1.0(1.0)	1.13(1.09)
Mean	1.79(1.34)	1.09(1.05)	1.0(1.0)	
$CD_{(0.05)}$				
A - 0.058	B - 0.067	AB - N S		
Two months after planting				
Control (B_1)	1.74(1.32)	1.0(1.0)	1.0(1.0)	1.22(1.11)
IBA 0.1 (B_2)	2.0(1.414)	1.79(1.34)	1.0(1.0)	1.57(1.25)
IBA 1 (B_3)	1.84(1.36)	1.23(1.11)	1.0(1.0)	1.34(1.16)
IBA 10 (B_4)	1.89(1.38)	1.23(1.11)	1.0(1.0)	1.35(1.16)
Mean	1.87(1.37)	1.3(1.14)	1.0(1.0)	
$CD_{(0.05)}$				
A - 0.093	B - 0.107	AB - N S		

Note : The figures in parenthesis denote the transformed values.

4.2.1.4. Effect of treatments on the number of shoots produced at monthly intervals

The results showed that there was statistical significance among the types of cuttings on the number of shoots developed. Three noded cuttings recorded the maximum number of shoots both during the first and second months (1.142 and 1.437 respectively). Two noded cuttings were found to be the next best, and single noded cuttings developed the least number of shoots. All the differences were significant during the first month, but during the second month, three noded cuttings varied significantly to two noded and single noded cuttings which were on par with each other. (Table 1.4)

Significant difference was also noticed between the levels of IBA with respect to number of shoots produced per cutting. During the first month, IBA misting at 1 ppm recorded maximum number of shoots per cutting. (0.992). This was significantly superior to all other treatments which were statistically on par with each other. During the second month, IBA misting at 0.1 ppm, was on par with IBA misting at 1 ppm, but superior to IBA misting at 10 ppm and control. (Appendix IX)

Table 1.4. Effect of treatments on the number of shoots produced per cutting

Levels of IBA (ppm)	Type of cuttings			Mean
	3 noded A_1	2 noded A_2	1 noded A_3	
One month after planting				
Control (B_1)	1.05(1.02)	0.55(0.74)	0.44(0.66)	0.65(0.81)
IBA 0.1 (B_2)	1.0(1.0)	0.60(0.77)	0.60(0.77)	0.72(0.85)
IBA 1 (B_3)	1.4(1.18)	1.0(1.0)	0.65(0.81)	0.99(0.99)
IBA 10 (B_4)	1.15(1.07)	0.45(0.67)	0.41(0.64)	0.63(0.80)
Mean	1.14(1.07)	0.63(0.8)	0.52(0.72)	
C $D_{(0.05)}$				
A - 0.0608	B - 0.0702	AB - N S		
Two months after planting				
Control (B_1)	1.09(1.05)	0.65(0.81)	0.81(0.90)	0.84(0.92)
IBA 0.1 (B_2)	1.25(1.12)	0.89(0.95)	1.0(1.0)	1.04(1.02)
IBA 1 (B_3)	1.83(1.35)	1.05(1.02)	1.0(1.0)	1.27(1.13)
IBA 10 (B_4)	1.63(1.28)	0.49(0.70)	0.53(0.73)	0.82(0.90)
Mean	1.44(1.20)	0.76(0.87)	0.82(0.91)	
C $D_{(0.05)}$				
A - 0.098	B - 0.114	AB - N S		

Note : The figures given in parenthesis denote the transformed values.

4.2.1.5. Effect of treatments on the number of roots produced per cutting

The different types of cuttings varied significantly with regard to the number of roots produced. Three noded cuttings produced the maximum number of roots (9.388) followed by two noded cuttings and single noded cuttings. All the differences were statistically significant. (Table 1.5)

The results also showed that the levels of IBA differed significantly. The maximum number of roots were obtained with IBA misting at 0.1 ppm (10.549). This was on par with IBA misting at 1 ppm, but was superior to IBA misting at 10 ppm and to control. (Appendix XI) Figure 9. shows the bar diagram.

4.2.1.6. Effect of treatments on the length of roots

The different types of cuttings exhibited significant differences with regard to the length of roots. Three noded cuttings recorded maximum root length (3.16 cm) followed by two noded cuttings (2.74 cm) and single noded cuttings (2.006 cm). All the differences were statistically significant. (Table 1.6)

Table 1.5 . Effect of treatments on the number of roots produced per cutting

Levels of IBA (ppm)	Type of cuttings			Mean
	3 noded A_1	2 noded A_2	1 noded A_3	
Control (B_1)	11.45(3.38)	7.0(2.64)	5.95(2.44)	7.97(2.82)
IBA 0.1 (B_2)	15.49(3.94)	9.44(3.07)	7.49(2.74)	10.5(3.25)
IBA 1 (B_3)	9.44(3.07)	9.49(3.08)	6.96(2.64)	8.59(2.93)
IBA 10 (B_4)	3.48(1.87)	3.93(1.98)	2.91(1.7)	3.43(1.85)
Mean	9.39(3.06)	7.26(2.7)	5.67(2.38)	

C $D_{(0.05)}$

A - 0.292 B - 0.337 AB - N S

Table 1.6. Effect of treatments on the length of roots produced

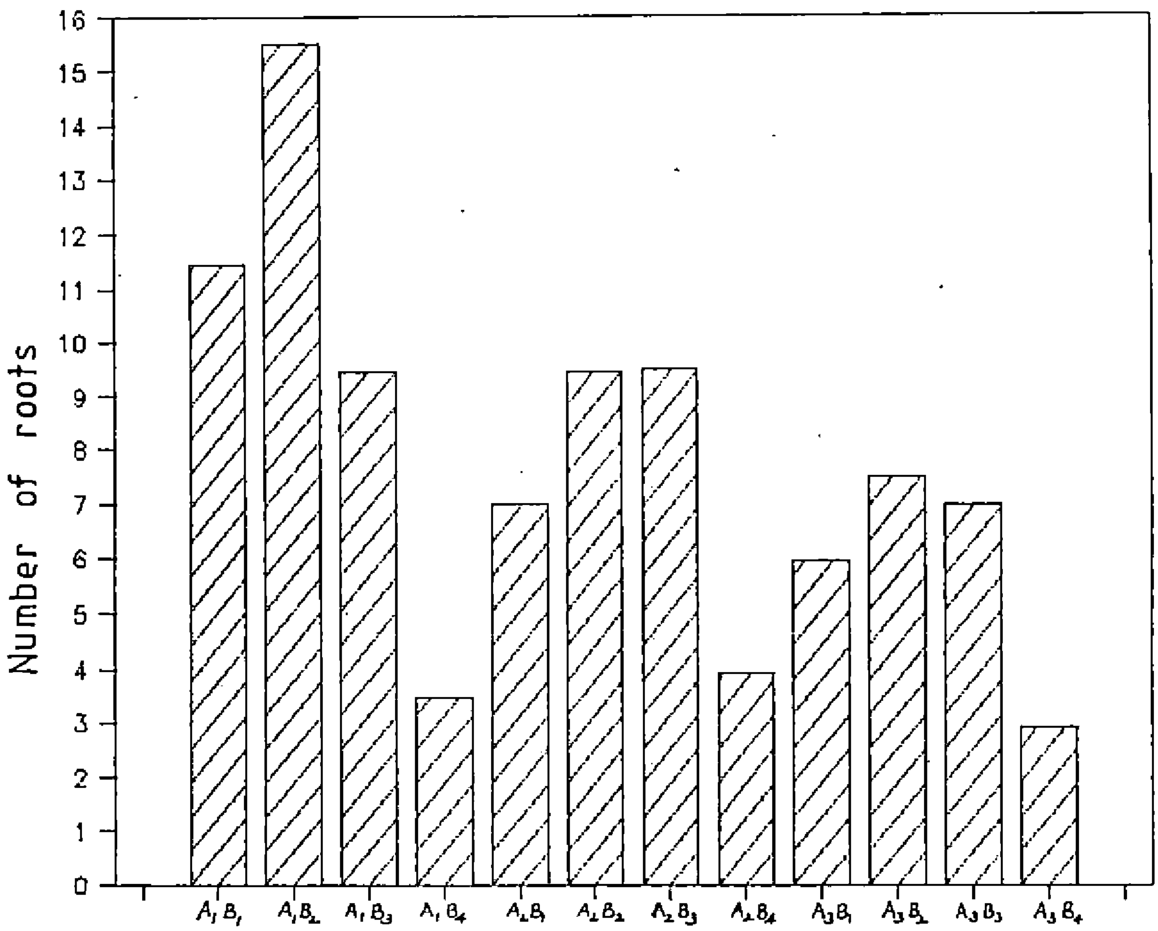
Type of	Levels of IBA (ppm)				Mean
	Control B_1	IBA 0.1 B_2	IBA 1 B_3	IBA 10 B_4	
3 noded (A_1)	3.3	4.05	3.24	2.05	3.16
2 noded (A_2)	2.77	3.32	2.77	2.11	2.74
1 noded (A_3)	2.00	2.02	2.50	1.50	2.006
Mean	2.69	3.13	2.83	1.88	

C $D_{(0.05)}$

A - 0.281 B - 0.325 AB - 0.563

Note : The figures given in the parenthesis denote the transformed values.

FIG 9 EFFECT OF TYPE OF CUTTINGS AND IBA ALONG WITH MIST ON THE NUMBER OF ROOTS IN BOUGAINVILLEA



A_1 - 3 noded cuttings

A_2 - 2 noded cuttings

A_3 - 1 noded cuttings

B_1 - Control

B_2 - IBA 0.1 ppm

B_3 - IBA 1 ppm

B_4 - IBA 10 ppm

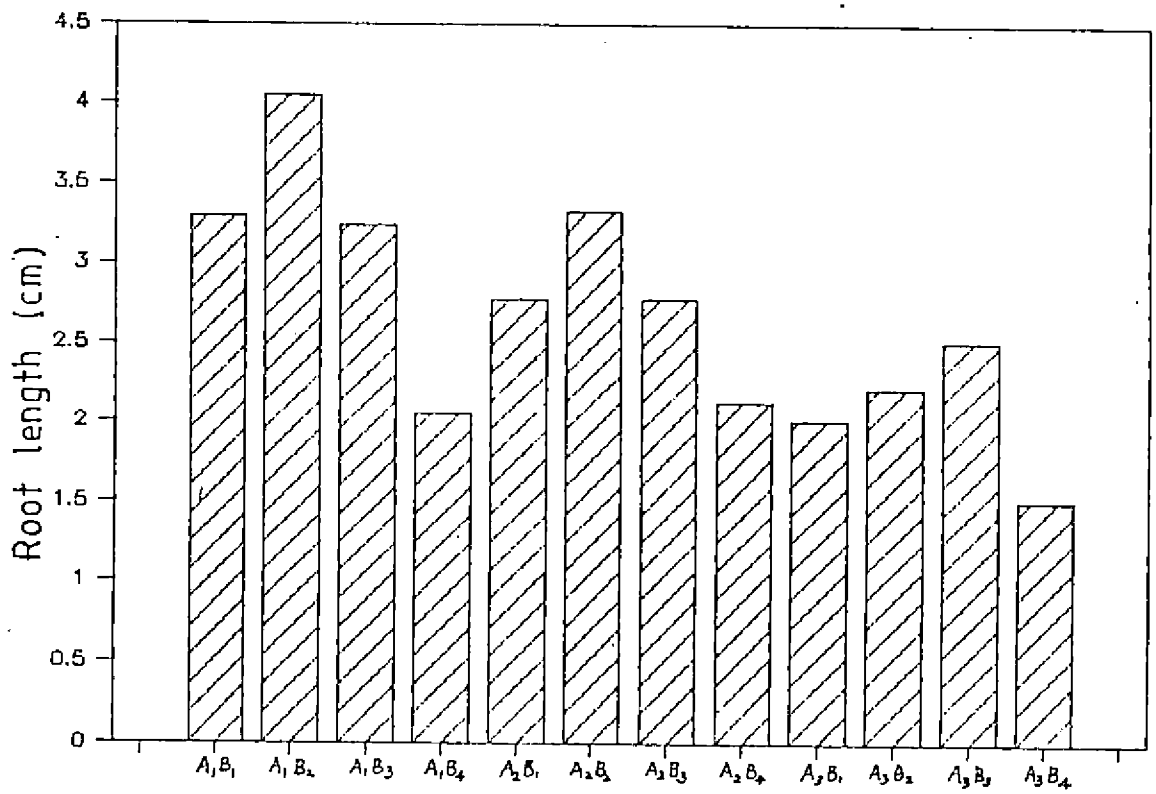
There was also significant difference among the levels of IBA. IBA misting at 0.1 ppm recorded maximum root length (3.133 cm) which was on par with IBA misting at 1 ppm, but superio to IBA misting at 10 ppm and to control. (Appendix XI)

The interaction effects were also found to be significant. Three noded cuttings treated with 0.1 ppm IBA misting recorded the maximum root length (4.05 cm), and was superior to all other treatments. Figure 10. represents the graph.

4.2.1.7. Effect of treatments on the number of leaves produced per cutting at fortnightly intervals

The results of analysis showed that there was significant difference among the different types of cuttings with regard to the production of leaves. Three noded cuttings recorded maximum number of leaves during all the days of observation. Two noded cuttings were the next best and single noded cuttings recorded the least number of leaves. All the differences were significant during the first and fourth fortnights. During the second and third fortnights, three noded cuttings were significantly superior to both two noded and single noded cuttings which were

FIG. 10. EFFECT OF TYPE OF CUTTINGS AND IBA ALONG WITH MIST ON ROOT LENGTH IN BOUGAINVILLEA



A_1 - 3 noded cuttings

A_2 - 2 noded cuttings

A_3 - 1 noded cuttings

B_1 - Control

B_2 - IBA 0.1 ppm

B_3 - IBA 1 ppm

B_4 - IBA 10 ppm

on par with each other. (Table 1.7)

Significant difference was also noticed between the levels of IBA. Misting IBA at 1 ppm recorded maximum production of leaves on all days of observation. During the first fortnight, IBA misting at 1 ppm was on par with IBA misting at 0.1 ppm, but was superior to the other treatments. During the second, third and fourth fortnights, IBA misting at 1 ppm was significantly superior to all other treatments, and IBA misting at 10 ppm gave the poor results. (Appendix X)

The interaction effect was significant during the second and fourth fortnights. Three noded cuttings given IBA at 1 ppm recorded maximum production of leaves (10.69 and 18.33 respectively).

4.2.1.8. Effect of treatments on the height of the plant

Significant difference was noticed between the levels of IBA, but there was no significance among the type of cuttings. Maximum height was obtained when IBA was used along with mist at 1 ppm (16.25 cm). This was on par with IBA misting at 0.1 ppm but superior to the other treatments. IBA misting at 10 ppm recorded the lowest plant height of 7.32 cm. (Table 1.8)

Table 1.7. Effect of treatments on the number of leaves produced per cutting at fortnightly intervals

Treatments	1	2	3	4
Type of cuttings				
3 noded (A_1)	2.50	3.08	3.35	3.84
2 noded (A_2)	1.99	2.20	2.50	3.44
1 noded (A_3)	1.49	2.02	2.47	2.96
C $D_{(0.05)}$ A	0.168	0.281	0.267	0.35
Levels of IBA (ppm)				
Control (B_1)	1.95	2.43	2.67	3.35
IBA 0.1 (B_2)	2.17	2.51	2.81	3.39
IBA 1 (B_3)	2.24	2.89	3.16	4.02
IBA 10 (B_4)	1.61	1.89	2.45	2.92
C $D_{(0.05)}$ B	0.194	0.324	0.308	0.404
A x B interaction				
A_1 B_1	2.54	2.99	3.24	3.90
A_1 B_2	2.66	2.89	3.16	3.36
A_1 B_3	2.60	3.27	3.54	4.28
A_1 B_4	2.21	3.15	3.45	3.80
A_2 B_1	1.88	2.18	2.44	3.59
A_2 B_2	2.10	2.39	2.71	3.64
A_2 B_3	2.34	2.85	3.08	3.91
A_2 B_4	1.64	1.37	1.75	2.62
A_3 B_1	1.41	2.18	2.33	2.56
A_3 B_2	1.75	2.24	2.54	3.17
A_3 B_3	1.79	2.57	2.85	3.87
A_3 B_4	1.00	1.15	2.15	2.23
C $D_{(0.05)}$ AB	N S	0.562	N S	0.701

Note : Data given are transformed values.

Table 1.8. Effect of treatments on the height of plant

Levels of IBA (ppm)	Type of cuttings			Mean
	3 noded A_1	2 noded A_2	1 noded A_3	
Control (B_1)	8.20	10.00	6.02	8.07
IBA 0.1 (B_2)	15.03	13.45	13.75	14.07
IBA 1 (B_3)	17.33	14.92	16.50	16.25
IBA 10 (B_4)	10.25	6.50	5.23	7.32
Mean	12.70	11.21	10.37	

$CD_{(0.05)}$

A - N S B - 2.39 AB - N S

No significance was noticed for the interaction effects. (Appendix XII).

4.2.2. Mussaenda

4.2.2.1. Effect of treatments on the number of days taken for sprouting

The effect of type of cuttings varied significantly on the number of days taken for sprouting. Three noded cuttings recorded the minimum number of days for sprouting (7.68), and this was on par with two noded cuttings (7.86), but both were statistically superior to single noded cuttings. (10.69). (Table 2.1)

There was also significant difference among the different levels of IBA. Misting IBA at 0.1 ppm recorded early sprouting, but was statistically on par with IBA misting at 1 ppm and control. Misting IBA at 10 ppm was the inferior most treatment. (Appendix VIII)

4.2.2.2. Effect of treatments on the percentage of sprouting

The results of analysis showed that there was significant difference among the different types of

Table 2.1. Effect of treatments on the number of days taken for sprouting

Type of cuttings	Levels of IBA (ppm)				Mean
	Control B_1	IBA 0.1 B_2	IBA 1 B_3	IBA 10 B_4	
3 noded (A_1)	2.78	2.7	2.7	2.9	2.77
2 noded (A_2)	2.9	2.72	2.73	2.87	2.8
1 noded (A_3)	3.01	2.83	3.37	3.91	3.27
Mean	2.9	2.75	2.93	3.23	

$CD_{(0.05)}$

A - 0.258 B - 0.298 AB - N S

Table 2.2. Effect of treatments on the percentage of sprouting

Type of cuttings	Levels of IBA (ppm)				Mean
	Control B_1	IBA 0.1 B_2	IBA 1 B_3	IBA 10 B_4	
3 noded (A_1)	90	90	90	90	90
2 noded (A_2)	80.7	80.7	90	90	85.38
1 noded (A_3)	29.8	41.9	33.19	32.8	34.48
Mean	66.8	70.9	71.06	70.96	

$CD_{(0.05)}$

A - 7.685 B - N S AB - N S

Note : Data given are the transformed values.

cuttings on the percentage of sprouting. Three noded cuttings recorded cent per cent sprouting, followed by two noded cuttings with an average of 99.35 per cent sprouting. Single noded cuttings recorded a sprouting of 32.05 per cent and was inferior to both two noded and three noded cuttings. (Table 2.2)

No significance was noticed either for the different levels of IBA or for the interaction effects. (Appendix VIII)

4.2.2.3. Effect of treatments on the number of sprouts produced per cutting at monthly intervals

The experimental results showed that there was significant difference among the different types of cuttings used. Three noded cuttings gave the best result both during the first and second months (1.833 and 1.857 respectively), followed by two noded cuttings and single noded cuttings. All the differences were statistically significant. (Table 2.3)

Significant difference was also noticed among the different levels of IBA. IBA misting at 0.1 ppm recorded the maximum number of sprouts. This was on par with IBA misting at 1 ppm and control. IBA misting at

Table 2.3. Effect of treatments on the number of sprouts produced per cutting

Levels of IBA (ppm)	Type of cuttings: 3 noded A_1	2 noded A_2	1 noded A_3	Mean
One month after planting				
Control (B_1)	1.85(1.36)	1.85(1.36)	1.39(1.18)	1.69(1.3)
IBA 0.1 (B_2)	1.65(1.28)	1.90(1.38)	1.79(1.34)	1.78(1.33)
IBA 1 (B_3)	1.85(1.36)	1.65(1.28)	1.55(1.24)	1.66(1.29)
IBA 10 (B_4)	2.0(1.414)	1.20(1.09)	1.12(1.06)	1.41(1.19)
Mean	1.83(1.35)	1.63(1.28)	1.45(1.21)	
$CD_{(0.05)}$				
A - 0.0697	B - 0.0804	AB - 0.139		
Two months after planting				
Control (B_1)	1.85(1.36)	1.85(1.36)	1.40(1.18)	1.69(1.3)
IBA 0.1 (B_2)	1.74(1.32)	1.90(1.38)	1.79(1.34)	1.81(1.34)
IBA 1 (B_3)	1.85(1.36)	1.85(1.36)	1.55(1.24)	1.74(1.32)
IBA 10 (B_4)	2.0(1.414)	1.0(1.0)	1.0(1.0)	1.3(1.14)
Mean	1.86(1.36)	1.62(1.27)	1.42(1.19)	
$CD_{(0.05)}$				
A - 0.0611	B - 0.0706	AB - 0.1223		

Note : The figures given in parenthesis denote the transformed values.

10 ppm was significantly inferior to all other treatments. (Appendix IX)

The interaction effects were also found to be statistically significant. Three noded cuttings treated with IBA at 1 ppm and control recorded maximum number of sprouts per cutting (1.846).

4.2.2.4. Effect of treatments on the number of shoots produced per cutting at monthly intervals

The different types of cuttings varied significantly with regard to number of shoots developed. Three noded cuttings recorded maximum number of shoots during the first and second months (0.132 and 0.857 respectively), and was significantly superior to two noded and single noded cuttings which were on par with each other. (Table 2.4)

There was also significant differences among the different levels of IBA. Misting IBA at 0.1 ppm recorded maximum number of shoots during the first and second months (0.108 and 0.784 respectively). During the first month, IBA misting at 0.1 ppm varied significantly from IBA misting at 1 ppm which was on par with IBA misting at 10 ppm. No shoots were developed for control. But during

Table 2.4. Effect of treatments on the number of shoots produced per cutting

Level of IBA (ppm)	Type of cuttings: 3 noded A_1	2 noded A_2	1 noded A_3	Mean
One month after planting				
Control (B_1)	0 (1)	0 (1)	0 (1)	0 (1)
IBA 0.1 (B_2)	0.35(1.16)	0 (1)	0 (1)	0.11(1.05)
IBA 1 (B_3)	0.15(1.07)	0 (1)	0 (1)	0.05(1.02)
IBA 10 (B_4)	0.04(1.02)	0 (1)	0 (1)	0.016(1.008)
Mean	0.13(1.06)	0 (1)	0 (1)	
C $D_{(0.05)}$				
A - 0178	B - 0.0205	AB - N S		
Two months after planting				
Control (B_1)	0.65(1.28)	0.36(1.17)	0.16(1.08)	0.38(1.17)
IBA 0.1 (B_2)	1.25(1.50)	0.55(1.24)	0.6(1.264)	0.78(1.34)
IBA 1 (B_3)	1.15(1.47)	0.25(1.12)	0.41(1.19)	0.56(1.26)
IBA 10 (B_4)	1.45(1.21)	0.10(1.05)	0.12(1.06)	0.22(1.11)
Mean	0.86(1.36)	0.31(1.44)	0.32(1.15)	
C $D_{(0.05)}$				
A - 0.058	B - 0.067	AB - N S		

Note : The figures given in parenthesis denote the transformed values.

the second month, IBA misting at 1 ppm was the second best followed by control and IBA misting at 10 ppm. All the differences were statistically significant. (Appendix IX)

The interaction effects were found to be significant during the first month, but during the second month it was not significant. Three noded cuttings treated with IBA at 0.1 ppm recorded the maximum number of shoots (0.349).

4.2.2.5. Effect of treatments on the number of roots produced per cutting

The type of cuttings varied significantly with regard to the number of roots produced. Three noded cuttings recorded maximum number of roots during the first and second months (8.32 and 15.02 respectively), and was on par with two noded cuttings. Single noded cuttings were significantly inferior to the other two treatments. (Table 2.5)

Significant difference was also noticed among the different levels of IBA. Misting IBA at 0.1 ppm recorded best results during the first and second months (8.327 and 23.726 respectively) and was statistically superior to other treatments. IBA misting at 10 ppm

Table 2.5. Effect of treatments on the number of roots produced per cutting

Levels of IBA (ppm)	Type of cuttings 3 noded A_1	2 noded A_2	1 noded A_3	Mean
One month after planting				
Control (B_1)	5.96(2.64)	6.0(2.64)	0 (1)	3.38(2.09)
IBA 0.1 (B_2)	17.46(4.30)	13.93(3.86)	0(1)	8.33(3.05)
IBA 1 (B_3)	8.97(3.16)	6.87(2.8)	0 (1)	4.38(2.32)
IBA 10 (B_4)	3.48(2.11)	5.49(2.55)	0 (1)	2.56(1.88)
Mean	8.32(3.05)	7.79(2.96)	0(1)	
C $D_{(0.05)}$				
A - 0.247	B - 0.285	AB - 0.494		
Two months after planting				
Control (B_1)	12.45(3.53)	10.35(3.22)	7.42(2.72)	9.97(3.16)
IBA 0.1 (B_2)	30.96(5.56)	31.34(5.6)	11.92(3.45)	23.73(4.9)
IBA 1 (B_3)	14.39(3.79)	12.45(3.53)	11.5(3.39)	12.75(3.57)
IBA 10 (B_4)	6.85(2.62)	6.96(2.64)	4.49(2.12)	6.04(2.46)
Mean	15.02(3.88)	14.02(3.75)	8.55(2.92)	
C $D_{(0.05)}$				
A - 0.423	B - 0.488	AB - N S		

Note : The figures given in parenthesis denote the transformed values.

recorded the least number of roots; during the first month it was on par with control, but during the second month it was significantly inferior to the rest of the treatments. (Appendix XI)

The interaction effects were found to be significant during the first month. Three noded cuttings treated with IBA at 0.1 ppm recorded maximum number of roots per cutting. Figure 11. represents the bar diagram.

4.2.2.6. Effect of treatments on the length of roots produced per cutting

The effect of type of cuttings on the length of roots was statistically significant. Three noded cuttings recorded maximum root length during the second month (3.85 cm) and two noded cuttings gave maximum root length during the first month (1.991 cm). Single noded cuttings were found to be statistically inferior to two noded and three noded cuttings which were on par. (Table 2.6)

There was also significant difference among the different levels of IBA. IBA misting at 0.1 ppm recorded maximum root length during the first and second

Table 2.6. Effect of treatments on the length of roots produced

Type of cuttings	Levels of IBA (ppm)				
	Control B_1	IBA 0.1 B_2	IBA 1 B_3	IBA 10 B_4	Mean
One month after planting					
3 noded (A_1)	1.04	3.49	1.80	1.27	1.9
2 noded (A_2)	1.60	3.17	1.91	1.27	1.99
1 noded (A_3)	0	0	0	0	0
Mean	0.88	2.22	1.23	0.85	

C $D_{(0.05)}$

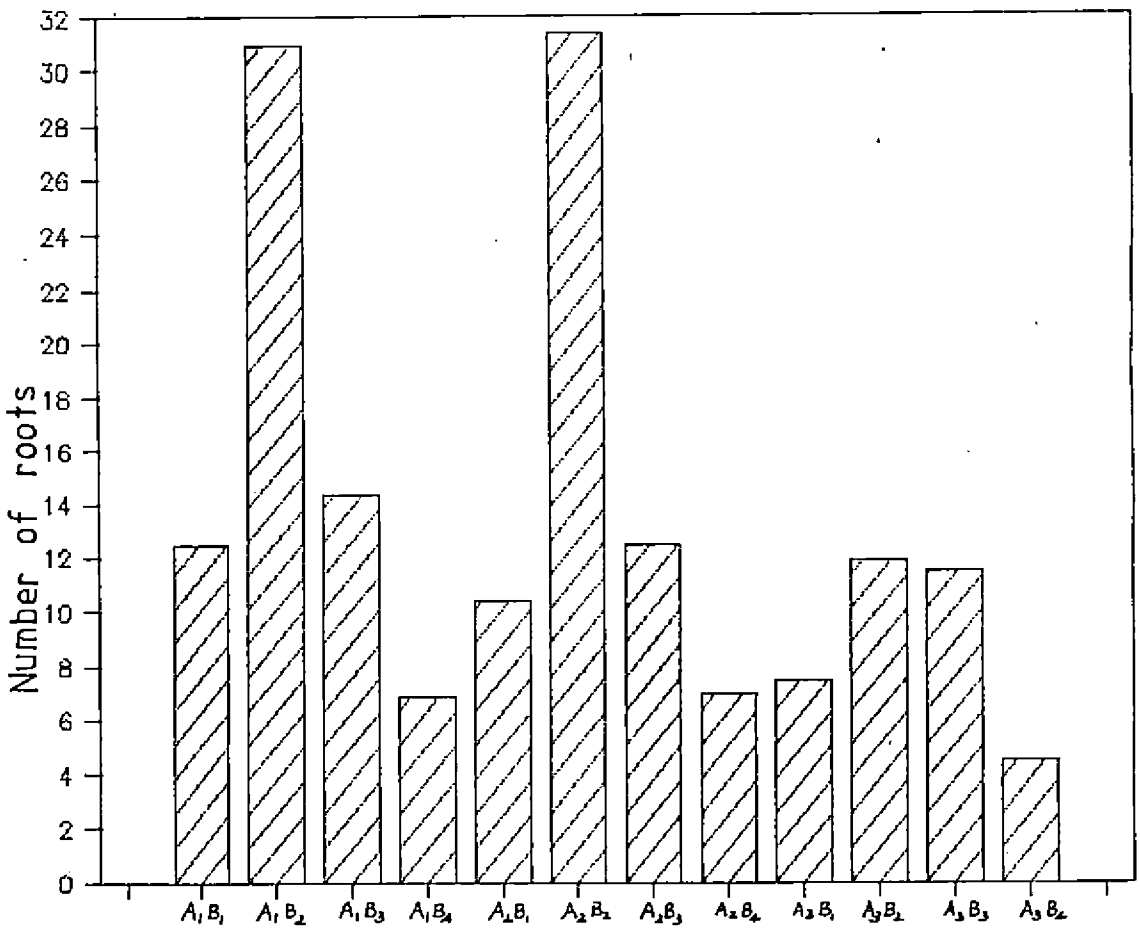
A - 0.309 B - 0.359 AB - 0.619

Type of cuttings	Control B_1	IBA 0.1 B_2	IBA 1 B_3	IBA 10 B_4	Mean
Two months after planting					
3 noded (A_1)	3.55	5.63	3.52	2.70	3.85
2 noded (A_2)	3.07	5.35	2.95	2.10	3.36
1 noded (A_3)	2.30	3.60	2.35	1.45	2.42
Mean	2.97	4.86	2.94	2.08	

C $D_{(0.05)}$

A - 0.525 B - 0.607 AB - N S

FIG 11 EFFECT OF TYPE OF CUTTINGS AND IBA ALONG WITH MIST ON THE NUMBER OF ROOTS IN MUSSAENDA



A_1 - 3 noded cuttings

A_2 - 2 noded cuttings

A_3 - 1 noded cuttings

B_1 - Control

B_2 - IBA 0.1 ppm

B_3 - IBA 1 ppm

B_4 - IBA 10 ppm

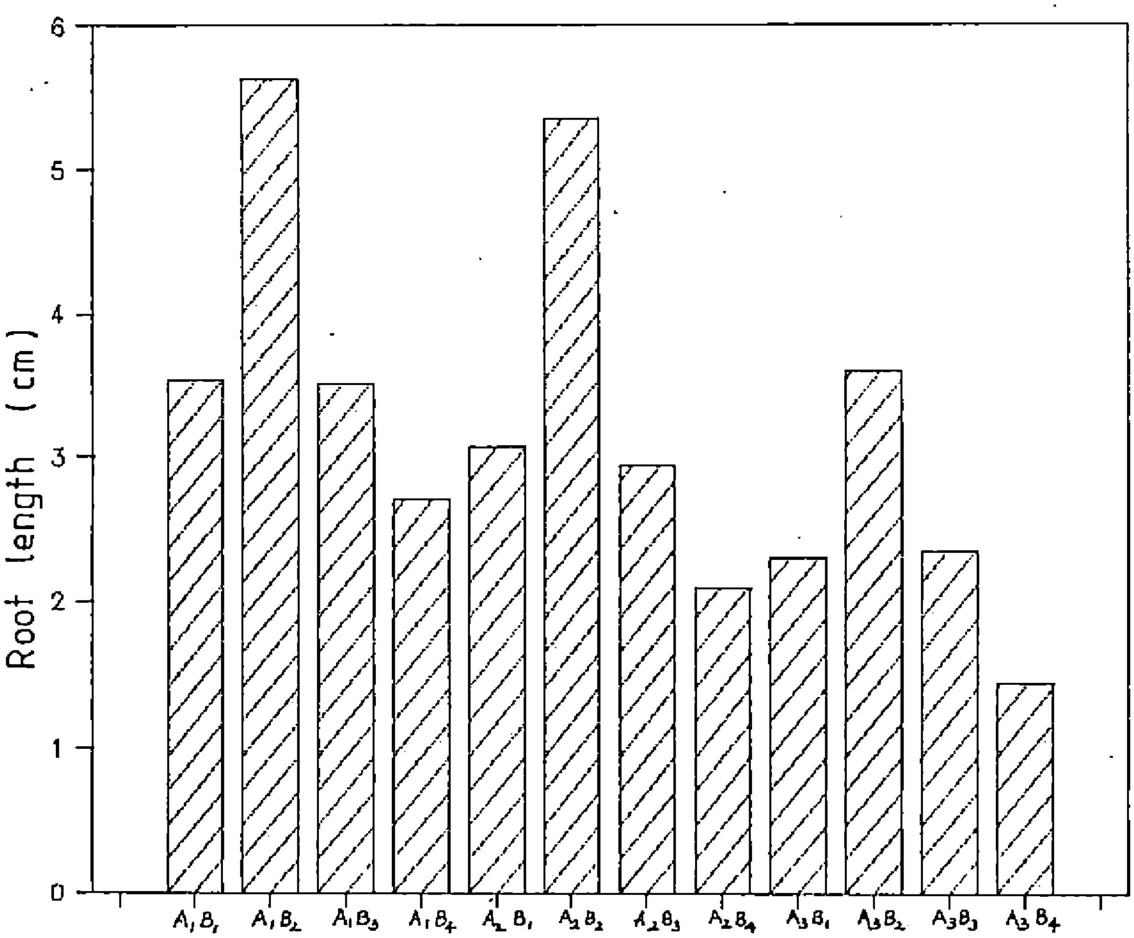
months (2.221 cm and 4.86 cm respectively). During the first month IBA misting at 1 ppm was significantly different from IBA misting at 10 ppm and control. During the second month, IBA misting at 1 ppm was on par with control, but both were superior to IBA misting at 10 ppm. Figure 12. shows the graphical representation.

The interaction effects were found to be significant during the first month. Three noded cuttings treated with IBA at 0.1 ppm was the best treatment. (Appendix XI)

4.2.2.7. Effect of treatments on the number of leaves produced per cutting at fortnightly intervals

The results showed that there was significant difference among the different types of cuttings used with regard to number of leaves produced. Three noded cuttings produced maximum number of leaves at all days of observation (5.466, 6.917 and 9.715 on second, third and fourth fortnights respectively). Two noded cuttings recorded the next best result, and single noded cuttings recorded the least number of leaves. All the differences were significant during the third fortnight. During the second and fourth fortnights three noded cuttings were on par with

FIG. 12. EFFECT OF TYPE OF CUTTINGS AND IBA ALONG WITH MIST ON ROOT LENGTH IN MUSSAENDA



A_1 - 3 noded cuttings
A_2 - 2 noded cuttings
A_3 - 1 noded cuttings

B_1 - Control
B_2 - IBA 0.1 ppm
B_3 - IBA 1 ppm
B_4 - IBA 10 ppm

two noded cuttings and these were superior to single noded cuttings. (Table 2.7)

A significant difference was also noticed among the different levels of IBA. Misting IBA at 0.1 ppm recorded maximum number of leaves on all days of observation. IBA misting at 1 ppm was the next best. Control was better than IBA misting at 10 ppm which recorded the least number of leaves. All the differences were significant during the fourth fortnight. During the second and third fortnights IBA misting at 0.1 ppm was superior to all other treatments, and IBA misting at 1 ppm was on par with control. IBA misting at 10 ppm recorded the least number of leaves. (Appendix X)

The interaction effects were found to be significant during the fourth fortnight. Three noded cuttings treated with 0.1 ppm IBA gave the maximum number of leaves (12.499).

4.2.2.8. Effect of treatments on the height of the plant

The effect of type of cuttings on the height of the plant was statistically significant. Three noded cuttings recorded maximum height (9.87 cm), followed by two noded cuttings and by single noded cuttings. All

Table 2.7. Effect of treatments on the number of leaves produced per cutting at fortnightly intervals

Treatments	2	3	4
Type of cuttings			
3 noded (A_1)	2.34	2.63	3.12
2 noded (A_2)	2.14	2.48	3.01
1 noded (A_3)	1.72	2.04	2.49
C $D_{(0.05)}$ A	0.212	0.125	0.117
Levels of IBA (ppm)			
Control (B_1)	1.95	2.33	2.61
IBA 0.1 (B_2)	2.38	2.68	3.28
IBA 1 (B_3)	2.12	2.41	3.04
IBA 10 (B_4)	1.81	2.10	2.57
C $D_{(0.05)}$ B	0.244	0.144	0.135
A x B interaction			
A_1 B_1	2.02	2.32	2.54
A_1 B_2	2.72	2.97	3.53
A_1 B_3	2.44	2.74	3.27
A_1 B_4	2.12	2.48	3.12
A_2 B_1	2.18	2.60	2.99
A_2 B_2	2.44	2.74	3.36
A_2 B_3	2.19	2.50	3.20
A_2 B_4	1.76	2.08	2.50
A_3 B_1	1.65	2.07	2.32
A_3 B_2	1.98	2.74	2.94
A_3 B_3	1.73	2.00	2.63
A_3 B_4	1.49	1.73	2.09
C $D_{(0.05)}$ AB	N S	N S	0.234

Note : Data given are the transformed values. The data obtained in the first fortnight were not statistically analysed, as it contained a large number of zeros.

the differences were statistically significant. (Table 2.8)

There was also significant difference among the different levels of IBA. Misting IBA at 0.1 ppm recorded maximum height (10 cm), and was significantly superior to IBA misting at 1 ppm, which in turn was superior to IBA misting at 10 ppm and control which were on par. (Appendix XII)

The interaction effects were also significant. Three noded cuttings treated with IBA at 0.1 ppm recorded the maximum plant height and was statistically superior to all other treatments. (13.85 cm).

4.2.3. Ficus

4.2.3.1. Effect of treatments on the number of days taken for sprouting

The results of analysis showed that the effect of type of cuttings on the number of days taken for sprouting was statistically not significant. (Table 3.1)

Significant difference was noticed among the different levels of IBA. Misting IBA at 0.1 ppm recorded early sprouting (13.29) and was on par with

Table 2.8. Effect of treatments on the height of plant

Levels of IBA (ppm)	Type of cuttings			Mean
	3 noded A_1	2 noded A_2	1 noded A_3	
Control (B_1)	7.20	7.45	3.12	5.92
IBA 0.1 (B_2)	13.85	10.60	5.55	10.00
IBA 1 (B_3)	10.85	8.70	4.20	7.92
IBA 10 (B_4)	7.60	5.95	3.05	5.53
Mean	9.87	8.17	3.98	

$CD_{(0.05)}$

A - 0.444 B - 0.512 AB - 0.889

Table 3.1. Effect of treatments on the number of days taken for sprouting

Type of cuttings	Levels of IBA (ppm)				Mean
	Control B_1	IBA 0.1 B_2	IBA 1 B_3	IBA 10 B_4	
3 noded (A_1)	3.50	3.66	3.73	4.15	3.76
2 noded (A_2)	3.80	3.69	3.83	4.39	3.93
1 noded (A_3)	4.01	3.58	3.96	4.15	3.93
Mean	3.78	3.64	3.84	4.23	

$CD_{(0.05)}$

A - N S B - 0.287 AB - N S

Table 3.2. Effect of treatments on the percentage of sprouting

Type of cuttings	Levels of IBA (ppm)				Mean
	Control B_1	IBA 0.1 B_2	IBA 1 B_3	IBA 10 B_4	
3 noded (A_1)	33.19	47.86	42.09	32.88	39.01
2 noded (A_2)	22.49	42.09	29.87	22.49	29.24
1 noded (A_3)	32.88	44.98	39.08	22.49	34.86
Mean	29.52	44.98	37.02	25.95	

$CD_{(0.05)}$

A - 6.79 B - 7.85 AB - N S

Note : Data given are the transformed values.

IBA misting at 1 ppm and control, but all the treatments were statistically superior to IBA misting at 10 ppm which recorded the maximum number of days for sprouting; (17.88). (Appendix VIII).

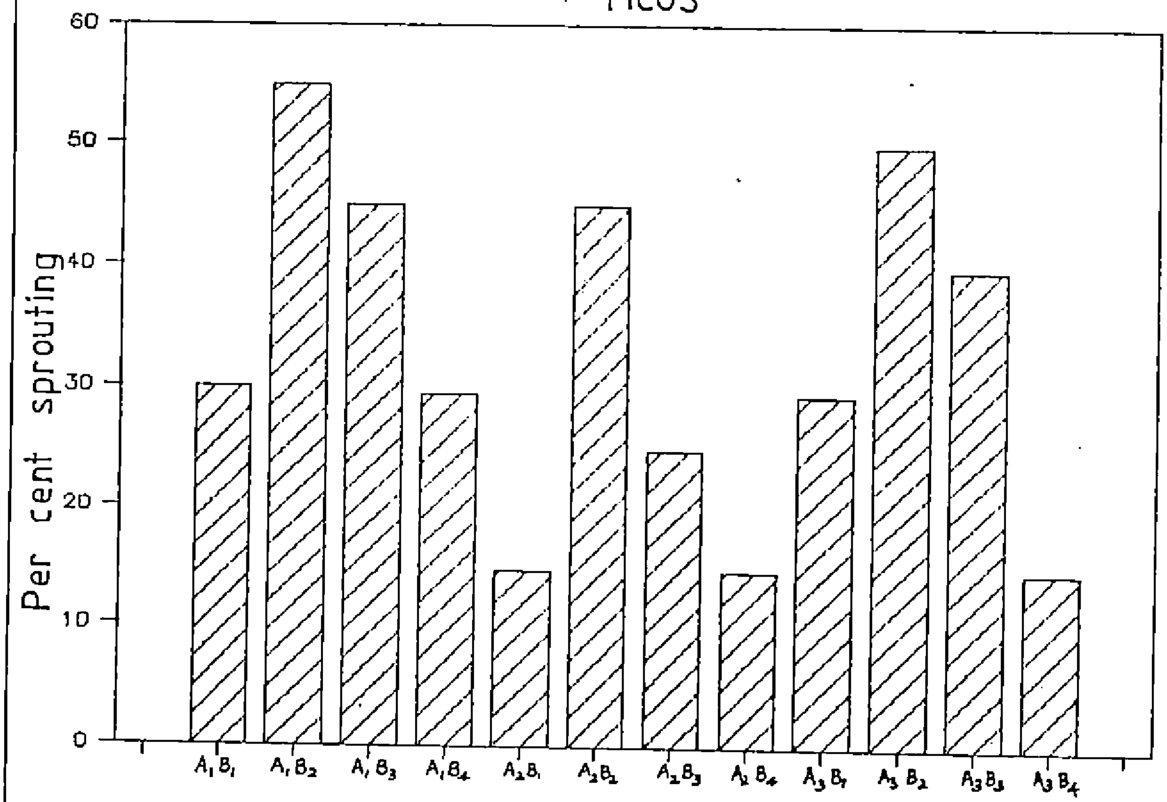
4.2.3.2. Effect of treatments on the percentage of sprouting

The effect of type of cuttings on the percentage of sprouting was statistically significant. Three noded cuttings recorded the maximum percentage of sprouting (39.4 %). Single noded cuttings were the next best, followed by two noded cuttings which recorded the lowest percentage of 24.5. Three noded cuttings were statistically on par with single noded cuttings, and single noded cuttings were on par with two noded cuttings. (Table 3.2)

There was also significant differences among the different levels of IBA. Misting IBA at 0.1 ppm recorded 50 per cent sprouting and was statistically superior to all other treatments. IBA misting at 1 ppm was the next best treatment, but it was on par with control. The percentage of sprouting was lowest when IBA was used for misting at 10 ppm. (Appendix VIII).

Figure 13. shows the graphical representation.

FIG 13. EFFECT OF TYPE OF CUTTINGS AND IBA ALONG WITH MIST ON THE PERCENTAGE OF SPROUTING IN FICUS



A_1 - 3 noded cuttings

A_2 - 2 noded cuttings

A_3 - 1 noded cuttings

B_1 - Control

B_2 - IBA 0.1 ppm

B_3 - IBA 1 ppm

B_4 - IBA 10 ppm

4.2.3.3. Effect of treatments on the number of sprouts produced per cutting at monthly intervals

The statistical analysis of this data was not done as the data contained many similar readings.

4.2.3.4. Effect of treatments on the number of shoots produced per cutting at monthly intervals

The results showed that there was no significant difference among the type of cuttings on the number of shoots developed. (Table 3.3)

A significant difference was noticed among the different levels of IBA with regard to the number of shoots developed. IBA misting at 0.1 ppm recorded maximum number of shoots, (0.692) followed by IBA misting at 1 ppm, control and lastly by IBA misting at 10 ppm. Misting IBA at 0.1 ppm was on par with IBA misting at 1 ppm , and control was on par with IBA misting at 10 ppm. (Appendix IX).

4.2.3.5. Effect of treatments on the number of roots produced per cutting

The effect of type of cuttings on the number of roots produced was statistically significant.

Table 3.3. Effect of treatments on the number of shoots produced per cutting

Type of cuttings	Levels of IBA (ppm)				Mean
	Control B_1	IBA 0.1 B_2	IBA 1 B_3	IBA 10 B_4	
3 noded A_1	1.15	1.30	1.24	1.22	1.23
2 noded A_2	1.11	1.29	1.25	1.11	1.19
1 noded A_3	1.22	1.31	1.21	1.00	1.18
Mean	1.16	1.30	1.23	1.11	

C D (0.05)

A - N S B - 0.0925 AB - N S

Table 3.4. Effect of treatments on the number of roots produced per cutting

Type of cuttings	Levels of IBA (ppm)				Mean
	Control B_1	IBA 0.1 B_2	IBA 1 B_3	IBA 10 B_4	
3 noded (A_1)	3.67	4.58	3.60	2.90	3.69
2 noded (A_2)	3.31	3.81	3.53	2.53	2.29
1 noded (A_3)	2.34	3.24	2.44	2.32	2.58
Mean	3.10	3.87	3.19	2.58	

C D (0.05)

A - 0.289 B - 0.334 AB - N S

Note : Data given are the transformed values.

Three noded cuttings recorded the maximum number of roots (13.608), followed by single noded cuttings (6.687), and two noded cuttings (5.272). All the differences were statistically significant. (Table 3.4)

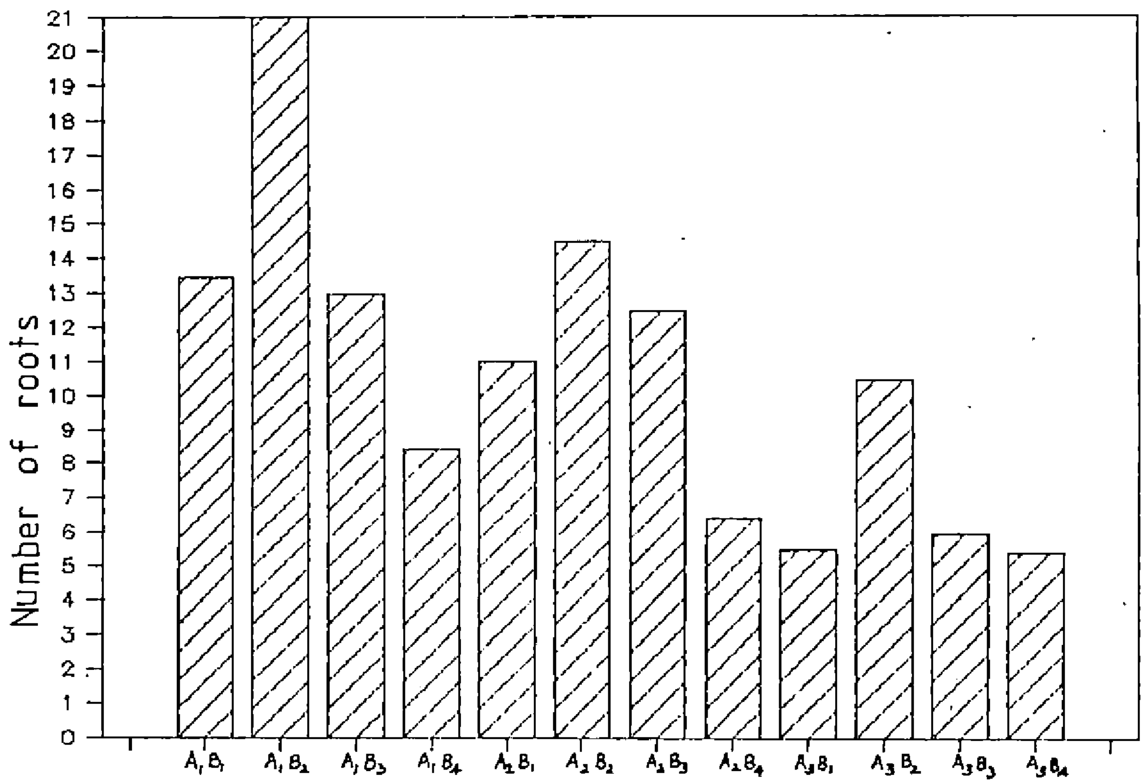
There was also significant difference among the different levels of IBA. Misting IBA at 0.1 ppm recorded maximum number of roots (15.023), and was significantly superior to all other treatments. IBA misting at 1 ppm was on par with control. Misting IBA at 10 ppm recorded the lowest number of roots. (Appendix XI) Figure 14. represents the bar diagram.

4.2.3.6. Effect of treatments on the length of roots produced per cutting

The experimental results showed that there was significant difference among the type of cuttings with regard to the length of roots. Single noded cuttings recorded maximum root length (6.353 cm), and was statistically superior to three noded and two noded cuttings which were on par with each other. (Table 3.5)

There was also significant difference among the different levels of IBA. Maximum root length was obtained when IBA misting was done at 0.1 ppm concentration.

FIG 14. EFFECT OF TYPE OF CUTTINGS AND IBA ALONG WITH MIST ON THE NUMBER OF ROOTS IN FICUS



A_1 - 3 noded cuttings

A_2 - 2 noded cuttings

A_3 - 1 noded cuttings

B_1 - Control

B_2 - IBA 0.1 ppm

B_3 - IBA 1 ppm

B_4 - IBA 10 ppm

Table 3.5. Effect of treatments on the length of roots produced

Levels of IBA (ppm)	Type of cuttings			Mean
	3 noded A_1	2 noded A_2	1 noded A_3	
Control (B_1)	5.11	5.58	6.75	5.82
IBA 0.1 (B_2)	7.15	6.15	7.16	6.82
IBA 1 (B_3)	4.53	5.45	6.15	5.38
IBA 10 (B_4)	4.21	3.95	5.35	4.50
Mean	5.25	5.28	6.35	

C $D_{(0.05)}$

A - 0.534 B - 0.617 AB - N S

This was superior to all other treatments. Misting IBA at 1 ppm was on par with control. IBA misting at 10 ppm recorded minimum root length. (Appendix XI)
Figure 15. represents the bar diagram.

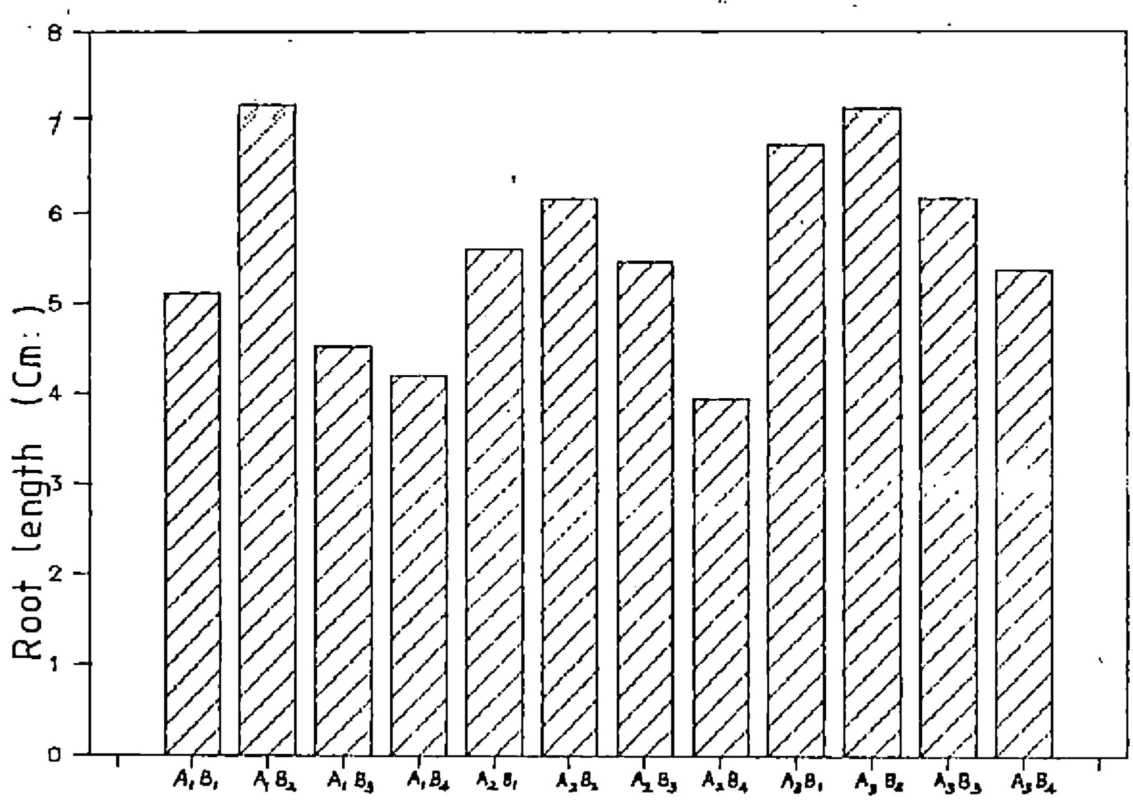
4.2.3.7. Effect of treatments on the number of leaves produced per cutting at fortnightly intervals

Significant difference was noticed only among the different levels of IBA. Application of IBA at 0.1 ppm recorded maximum production of leaves, both during the third and fourth fortnights. During the third fortnight IBA misting at 0.1 ppm was on par with IBA misting at 1 ppm; but during the fourth fortnight, misting IBA at 0.1 ppm was significantly superior to application of IBA at 1 ppm. Control was the next best treatment, but it was on par with IBA misting at 10 ppm. (Table 3.6, Appendix X)

4.2.3.8. Effect of treatments on the height of the plant

The different types of cuttings varied significantly on the height of the plant. Three noded cuttings produced maximum plant height (13.646 cm), followed by two noded cuttings and by single noded cuttings. All the differences were statistically significant. (Table 3.7)

FIG 15. EFFECT OF TYPE OF CUTTINGS AND IBA ALONG WITH MIST ON ROOT LENGTH IN FICUS



A_1 - 3 noded cuttings

A_2 - 2 noded cuttings

A_3 - 1 noded cuttings

B_1 - Control

B_2 - IBA 0.1 ppm

B_3 - IBA 1 ppm

B_4 - IBA 10 ppm

Table 3.6. Effect of treatments on the number of leaves produced per cutting at fortnightly intervals

Levels of IBA (ppm)	Type of cuttings			Mean
	3 noded A_1	2 noded A_2	1 noded A_3	
Third fortnight after planting				
Control (B_1)	1.07	1.00	1.06	1.04
IBA 0.1 (B_2)	1.20	1.34	1.13	1.23
IBA 1 (B_3)	1.20	1.22	1.17	1.19
IBA 10 (B_4)	1.06	1.00	1.00	1.02
Mean	1.13	1.13	1.09	
C $D_{(0.05)}$				
A - N S	B - 0.0745		AB - N S	
Fourth fortnight after planting				
Control (B_1)	1.29	1.11	1.32	1.24
IBA 0.1 (B_2)	1.48	1.41	1.42	1.44
IBA 1 (B_3)	1.28	1.34	1.26	1.29
IBA 10 (B_4)	1.22	1.11	1.11	1.15
Mean	1.32	1.24	1.28	
C $D_{(0.05)}$				
A - N S	B - 0.132		AB - N S	

Note : Data given are the transformed values. The data obtained for the first and second fortnights contained a large number of zeros and hence not statistically analysed.

Table 3.7. Effect of treatments on the height of plant

Levels of IBA (ppm)	Type of cuttings			Mean
	3 noded A_1	2 noded A_2	1 noded A_3	
Control (B_1)	12.05	9.15	6.87	9.36
IBA 0.1 (B_2)	20.78	15.65	13.10	16.51
IBA 1 (B_3)	11.45	10.90	8.30	10.22
IBA 10 (B_4)	10.30	7.75	4.35	7.46
Mean	13.64	10.36	3.15	

C $D_{(0.05)}$

A - 1.65 B - 1.9 AB - N S

Significant difference was also noticed among the different levels of IBA. Application of IBA at 0.1 ppm recorded maximum height (16.511 cm), and was significantly superior to all other treatments. IBA misting at 1 ppm was the next best treatment, and this was on par with control. IBA misting at 10 ppm was the inferior most treatment. (Appendix XII).

The interaction effects were found to be statistically not significant.

DISCUSSION

5. DISCUSSION

The present investigation was carried out as an attempt to find out the beneficial effects of mist along with the growth regulator, Indole-3-butyric acid (IBA) on the rooting behaviour and growth of ornamental plants which are difficult to root under normal conditions. Three popular ornamental shrubs namely *Ficus elastica* (Roxb.), *Mussaenda erythrophylla* (Schum.) and *Bougainvillea spectabilis* (Willd.) var Mahara were used for the study. The research was done in two different conditions and hence the result obtained are discussed under the following titles:

5.1. Effect of treatments under field conditions on the rooting of cuttings

The hormone Indole-3-butyric acid was used with prolonged dip method for twelve hours at 250 and 500 ppm. Two types of cuttings based on thickness (Thin - 0.5 - 1.49 cm thick, and Medium thick - 1.5-2.5 cm cm thick) were also used for the study to find the optimum thickness for each of the plants.

5.1.1. Mussaenda

The study indicated that the maximum percentage of sprouting in Mussaenda cuttings was obtained when 250 ppm IBA was used (52.5 %). Among the types of cuttings, thin cuttings recorded better sprouting than medium thick cuttings. Control cuttings with 1.5-2.5 cm thickness recorded the least sprouting. Thimann and Koepfli (1935) had demonstrated that synthetic auxin was highly active in promoting root initiation. This should be the reason why the cuttings treated with IBA exhibited a higher percentage of sprouting than control.

The maximum number of shoots were produced when 250 ppm IBA was used. However no significant difference was observed for the thickness of cuttings used in the study. Dipping the cuttings in IBA at 250 ppm was found to be the best treatment in producing maximum number of leaves and enhancement in plant height. Thin cuttings were found to be better than medium thick cuttings.

The studies of El-Hakim et al. (1962) reported that lower concentrations (100-200 ppm) of IBA had resulted in better rooting of Ficus cuttings. Still lower concentrations of IBA (25-50 ppm) was found effective in

Phyllanthus cuttings. It could be seen from the results that lower concentrations are effective in rooting of cuttings as evidenced by results obtained and studies of El-Hakim et al. (1962). In the present study also higher concentration (500 ppm) had produced lesser percentage of sprouting (36.8 %) compared to lower concentration. This may be possibly due to the inhibition effect of auxin at higher concentrations. In fact it has been proved that phenoxyacetic acids are effective as herbicides in relatively high, but actually very low concentrations (Zimmerman et al., 1942, 1944).

Better sprouting and growth obtained in thin cuttings may be possibly due to the juvenility factor as evidenced by the studies of Bose et al. (1975), where terminal cuttings of Mussaenda which are considered physiologically young, gave higher percentage of sprouting. This is in full agreement with the results obtained.

The root characters studied had showed that maximum root length was produced for for thin cuttings treated with 250 ppm IBA. The beneficial effects of IBA in inducing root production, increasing percentage of rooting, the number and quality of roots produced and the uniformity in rooting has been reported by many workers like Went (1934);

Thimmann and Went (1934) ; Cooper (1935); Hitchcock and Zimmerman (1936); and Pearse (1938).

5.1.2. Bougainvillea

Medium thick cuttings of Bougainvillea treated with 250 ppm IBA took lesser number of days for sprouting. The number of shoots, number of leaves and height of the plant recorded were also maximum in the same treatment. Medium thick cuttings produced maximum number of sprouts, however no significance was noticed among the different levels of IBA with respect to number of sprouts produced. The percentage of sprouting was maximum when 250 ppm IBA was used and the cuttings were medium thick.

In Bougainvillea, better results were obtained with medium thick cuttings. This may be possibly due to the inadequate amounts of carbohydrate (reserve food material) for regeneration in the thin cuttings. It was reported by Maura et al. (1974) that hardwood cuttings of bougainvillea when treated with 400 ppm IAA or NAA for twelve hours showed high rooting percentage whereas the untreated ones failed to root.

However, a contradictory result has been reported by Singh and Motial (1979) where softwood cuttings of Bougainvillea had given better rooting with higher concentration of IBA (3000 ppm) as quick dip method. The subsequent plant survival was also reported to be satisfactory.

Medium thick cuttings treated with 250 ppm IBA also produced maximum number of roots and root length. The ability of hardwood cuttings of Bougainvillea var Mahara to give maximum rooting, with IBA treatment has been reported by Philip and Gopalakrishnan (1982). Further Bose et al. (1975) obtained cent per cent rooting with woody cuttings of Bougainvillea treated with IBA. It is possible that the rich accumulation of carbohydrates in the woody cuttings of Bougainvillea contribute sufficient substrates for the better root development.

5.1.3. Ficus

Ficus recorded poor results and hence the data was not statistically analysed.

5.2. Effect of treatments under mist conditions on the rooting of cuttings

In the present study the leafy cuttings

of different lengths (three noded, two noded and single noded cuttings) were given a treatment of intermittent mist along with IBA at very low concentrations (0.1 ppm, 1 ppm and 10 ppm). The control plants were sprayed with water alone.

5.2.1. Bougainvillea

The results of the study revealed that the cuttings of Bougainvillea with three or two nodes were found to perform well compared to single noded cuttings in respect of rooting under mist. The percentage of sprouting was cent per cent when two noded cuttings were given 1 ppm IBA spray. Early sprouting was noticed when the cuttings were given 1 ppm IBA spray, however no significant difference was noticed among the type of cuttings used. The number of sprouts and shoots produced were maximum when three noded cuttings were treated with 0.1 ppm IBA. Misting IBA at 0.1 ppm also recorded maximum production of leaves when two noded and three noded cuttings were used. Maximum plant height was also obtained when IBA was sprayed at 0.1 ppm, but no significance was noticed among the type of cuttings used.

It is well known that an increase in the relative humidity prevents desiccation of cuttings and provides more favourable environmental conditions for root formation. Beneficial effect of mist on rooting in a wide variety of difficult to root plants has been reported by Erickson and Bitters (1953); Hartmann and Whisler (1956). Bose and Mondal (1972) reported that sixty species of trees, shrubs and climbers which proved difficult to root from cuttings under polyethylene cover by treatment with root promoting chemicals showed moderate to high percentage of rooting under intermittent mist.

The number of roots and root length were maximum when three noded cuttings were used. Among the different levels of IBA, 0.1 ppm and 1 ppm spray were found to be the best treatment in increasing root length and root number. According to Bose and Mondal (1973) treatment with IBA and NAA not only caused higher percentage of rooting but also developed larger number of roots on the treated cuttings, when kept under intermittent mist.

However experiments are scanty where hormones are used along with mist. In most of the experiments IBA treatment was given in the quick dip method where a high concentration of the hormone is required, and consequently kept under intermittent mist conditions.

5.2.2. Mussaenda

The results obtained with Mussaenda were also identical to that obtained for Bougainvillea. The minimum number of days taken for sprouting was recorded for two noded and three noded cuttings. Among the different levels of IBA spraying with 0.1 ppm or 1 ppm IBA or water alone were the same and all reduced the time taken for sprouting.

There was no significant difference among the different levels of IBA with regard to the percentage of sprouting. However three noded and two noded cuttings proved better than single noded cuttings. The maximum number of sprouts were produced when three noded cuttings were given either 0.1 ppm or 1 ppm IBA or mere water spray. The maximum leaf production was observed for three noded as well as two noded cuttings given 0.1 ppm IBA spray. The maximum number of shoots and maximum plant height were recorded by three noded cuttings treated with 0.1 ppm IBA spray. Thus it could be seen that lower concentrations of IBA spray or even control were better than high concentrations of IBA. In many cases two noded cuttings were equally good as three noded cuttings. So two noded cuttings can be used efficiently for the propagation of Mussaenda.

Kumar and Vijayakumar (1984) observed that in *Mussaenda phillipica*, quick dip at 2000 ppm IBA was the best under intermittent mist conditions and that the percentage of sprouting, number of roots and root length decreased with increase in the concentration of IBA.

The maximum number of roots and root length were also recorded for both two noded and three noded cuttings, and when IBA was applied along with mist at 0.1 ppm.

According to Mukhopadhyay and Bose (1979) leafy cuttings in general produced larger number of rooted cuttings and initiated greater number of roots per cutting, while leafless cuttings failed to produce any root even with the application of IBA. He also observed that rooting in *Mussaenda phillipica* increased appreciably with larger number of leaves in both treated and untreated cuttings. This is in agreement with the present study, where leafy cuttings given IBA along with mist was similar to control cuttings in inducing early sprouting and number of sprouts.

5.2.3. Ficus

The experiment conducted at the field recorded low percentage of sprouting. But when the cuttings were given intermittent mist conditions, the results obtained were satisfactory. It was found that early sprouting could be obtained when IBA spray was given at 0.1 or 1 ppm concentration. There was no significant difference among the type of cuttings used. The maximum percentage of sprouting was recorded when either three noded or single noded cuttings were used, and 0.1 ppm IBA was applied along with mist.

Spraying IBA at 0.1 ppm recorded maximum number of shoots and leaves, but no significant difference was noticed among the type of cuttings. The plant height was maximum when three noded cuttings were used, and 0.1 ppm IBA was applied along with mist. Singh (1979) obtained highest rooting percentage (95) for Jasminum sambac cv Motia, when treated with IBA at 4000 ppm and kept under intermittent mist. Kumar et al. (1984) reported that single leaf, two node semihardwood cuttings of Ficus elastica treated with IBA at 4000 ppm gave the best rooting and survival after transplanting under intermittent mist. The above studies can be compared with the present study where IBA and intermittent mist improved rooting in Ficus.

The number of roots were maximum when three noded cuttings were used with 0.1 ppm IBA spray.