Effect of Rooting Media and Growth Regulators on the Callusing, Rooting and Survival of Air Layers of Bougainvillea Spp. Variety–Thimma

THESIS

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MASTER OF SCIENCE IN AGRICULTURE

(Horticulture)

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1989

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C E R T I F I C A T E-I

This is to certify that the thesis entitled, "EFFECT OF ROOTING MEDIA AND GROWTH REGULATORS ON THE CALLUSING, ROOTING AND SURVIVAL OF AIRLAYERS OF BOUNGAIN-VILLEA Spp. VARIETY-THIMMA", submitted in partial fulfilment of the requirement for the degree of MASTER OF SCIENCE IN AGRICULTURE (Horticulture) of the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur is a record of the bonafide research work carried out by Shri Mukesh Kumar Rathore under my guidance and supervision. The subject of the thesis has been approved by the students Advisory Committee and the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma (certificate/awarded etc.) or has been published . All the assistance and helps received during the course of the investigation have been duly acknowledged by him.

T P Singh

CHAIRMAN OF THE ADVISORY COMMITTEE.

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C E R T I F I C A T E -II

This is to certify that the thesis entitled, "EFFECT OF ROOTING MEDIA AND GROWTH REGULATORS ON THE CALLUSING, ROOTING AND SURVIVAL OF AIR LAYERING OF BOUNGAINVILLEA Spp. VARIETY THIMMA", submitted by Shri Mukesh Kumar Rathore to the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur in partial fulfilment of the requirement for the degree of MASTER OF SCIENCE IN AGRICULTURE (Horticulture) in the Department of Horticulture, College of Agriculture, Gwalior (M.P.) has after evaluation, been approved by the external examiner and by the Student's Advisory Committee after an oral examination on the same.

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DEPARTMENT OF HORTICULTURE
COLLEGE OF AGRICULTURE
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"DEDICATED TO MY AFFECTIONATE PARENTS AS A TOKEN OF DEEP DEVOTION AND PROFOUND RESPECT"

MUKESH KUMAR RATHORE
B. Sc. (Ag.)

1989

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

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Dated: (Mukesh Kumar Rathore)

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INTRODUCTION

CHAPTER - I

INTRODUCTION

In India and abroad, under tropical and sub-tropical regions, Bougainvillea has become very popular gardening plant due to profuse flowering almost throughout the year. Numberous bougainvillea varieties with deverse form, shape, size, flower pattern, growth and blooming habit with splendid contrast of colours are available for the beautification of landscape in urban and rural areas. Bougainvillea serves purposes like climber on a wall, bush speciman on a lawn, as a hedge along the handrail, or an arch or porch. Display of splendid and magnificant coloured pattern of bougainvillea bracts creates enormous occasions for the improvement of

landscape. These by heavently behaviour of petaloid bracts from morning to evening cause sensation among sense organs to realise their charming and enchanting scenery like heaven on the earth.

The Genus Bougainvillea belonging to the natural order "Nyctaginaceae" is a native of South America. Numarous species of Bougainvillea are available due to introduction and hybridization. Among these most important are B.buttiana, B.glabra, B. peruviana, B spectabilis. Besides several species and newly evolved hybrids are also grown and it is not possible to enumerate all the new introductions are Bougainvillea here.

Several varieties of Bougainvillea have been evolved like single colour, multicolour, multicolour with variegated leaves, double bracts etc. From these group of variety B.Thimma was picked up for experimentation. This variety possesses whitish yellow patch in the centre of leaves and develops pink and white colour bracts on the same inflorescence. Thus giving decent looking a amidist gardning plant when viewed in conjunction with flowers and foliage of other B. varieties and certain other flowering plants during a session.

In the nursery practices multiplication of

plants by cutting and air layering are the first step in propagation of plants on their own roots. While air layering had been reported to be successful as early as 1974 by Pal and Swaroop. Marcottage is probably the most certain method of propagation of woody plants and feucht, et al. (1961) considered air layering to be the modern version of marcottage, Singh and Teotia (1951), Garg (1954), Cheema, et al. (1954), Singh (1954), Rao and Rao (1956), Hartmann and Kester (1976) have reported that many clone whose cuttings will not root easily can be propagated by air layering, thus enabling the plants to be established on their our roots within a shorter period. Beside some other numerous factors have been reported affecting the success in propagation of ornamental and fruits plants viz. (1) Different plant and their varieties. (2) Stem treatment (3) Age of stock plants (4) Water and nutrients supply (5) Etiolation (6) Rooting media (7) Application of root promoting substances (8) Containers, moisture supply, good aeration and moderate temperature in rooting zone. (9) Growth regulators and their combinations. (10) Environmental conditions (Time of operation, rainfall, range of temperature, moderate sun-shine and wind velocity in the atmosphere) contribute much towards the success in plant propagation. Among these

rooting media and application of root promoting substances are considered more important for rooting and survival of Bougainvillea air layers.

The modern technology of using rooting media and growth regulator in plant propagation has further improved the scope of vegetative propagation in various varieties of Bougainvillea. Several workers have reported successful use of rooting media in stimulating the process of etiolation, callusing and growth of the root primordia in air layers. The rooting media must provide sufficient moisture and oxigen and must be relatively disease free. It is not necessary that the rooting media be a source of nutrients until a rooting system is established. The rooting media may have distinct effect on the percentage of air layers or cuttings rooted and on the type of roots formed various rooting media containing soil, sand, leaf mould, peat and artificial inorganic substances such as vermiculite and perlite have been widely used.

Many workers have used several growth regulators in different woody plants propagated by air layering. Auxin particularly IAA, IBA and NAA have been reported to induce rooting in many of the (hard and semi hard wood) woody plants with varied success.

However, the response of treatment with different substances varied with variety to variety and with changing physiological and environmental conditions. Several workers have reported successful use of plant regulator and rooting media in stimulating growth of root primordia in air layers, Zimmerman, et al.(1933) reported for the first time a chemical that had a specific and marked capacity to cause rootage, Avery, et al. (1947), Thimann and Behnke (1947), Pearse (1948) and Thukey (1954) may be quoted to illustrate the undoubted efficiency of growth promoting substances.

In India and abroad whatever work done in the past is confined to the other plants seems similar in nature with regard, nature of wood and physiological aspects of plants. Looking to the utility of Bougainvillea for the improvement and beautification of landscape during the modern age of materialistic world fast multiplication of plants of Bougainvillea varieties by the best and quicker method of propagation with the aid of growth regulator under present state of affairs seems most desirable and thus the present experiment. "Effect of rooting media and growth regulators on the callusing, rooting and survival of air layers of Bougainvillea species variety Thimma" is proposed to be conducted in the

experimental area of ornamental garden, Department of Horticulture, J.N.K.V.V., Jabalpur Campus College of Agriculture, Gwalior during the period July 1988 to January 1989 under agroclimatic and soil conditions of northern Madhya Pradesh with the following objectives :

1. To find out the suitable rooting media for the multiplication of Bougainvillea, variety Thimma by air layering.

2. To select the suitable growth regulator and their concentration for the good rooting and survival of air layers of Bougainvillea.

3. To determine the effect of interaction between the rooting media and concentrations of growth regulators to obtain better rootage and survival of air layers of B. Thimma.

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REVIEW OF LITERATURE

CHAPTER - II

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REVIEW OF LITERATURE

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In this chapter efforts have been made to review the work done in India and abroad so for on the propagation of Bougainvillea species and other woody plants by air layering. Many workers have tried different concentrations for propagating Horticultural plants on their own roots. The observations and results recorded by them are of great are of great important in context to the present investigation and have been presented under separate appropriate headings.

Review of literature pertaining to the propagation of horticultural plants by air layering :

Burns and Prayag (1920) suggested the use of air layers for successful propagation of mango.

Thakarta and Datta (1941) stated that marcottage is probably the most certain method of propagation of woody plants. Similarly Avery, et al. (1947), Hunter (1950), Singh and Teotia (1951), Garg (1954), Cheema, et al. (1954), Singh (1954) and Rao and Rao (1956) have also reported this methods (air layering) an improved method of propagation.

Adriance and Brison (1955-59) described that air layering is used exclusively in the propagation of Bougainvilleas, hybrid crotons, hybrid-hibiscus, dracaenas and many other kinds of ornamental plants. It is frequently used as a novelty method of propagation for plants that can not easily be propagated by other methods.

Venkataratnam and Satyanarinswami (1956) reported air layers of one year old shoot and current season shoots of sitaphal. Current season shoots gave better percentage of success in comparison to older ones.

Feucht et al. (1961) considered air layering to be the modern version of marcottage.

Hartmann and Kester (1972) mentioned that root formation during layering is stimulated by various stem treatments which cause an interruption in the downword translocation of organic materials carbohydrates, auxin, and other growth factors from the leaves and growing shoot tips. These materials accumulate near the point of treatment, and rooting occurs in this general area even though the stem is still attached to the parent plant.

Review of literature pertaining to the different rooting media :

The rooting media must provide sufficient moisture and oxygen and must be relatively disease free. It is not necessary that the rooting media be source of nutrients until a root system is established. Many research workers have formulated essential and desirable qualities of a good medium.

Hitchcock (1928) from his extensive trials with peat moss, peat moss mixture with sand and sand alone and reported that out of 96 varieties of 46 genera only 5 failed to root best in a mixture of equal praportion of peat moss and sand. He stated that the efficiency of the mixture was mainly due to its high moisture retaining capacity, to the presence of growth

promoting material furnished by peat moss, to efficient aeration and in some cases to its acid reaction.

Eaper and Roof (1931) concluded from his experiment with soft wood cutting of nine species, that slag and peat together formed a very good medium as the proper balance of pH was obtained in such mixture.

Chadwick (1932) found that sand and peat mixture often resulted in better massing of roots at the base of taxces cuttings. He also found that roots produced in peat were more flexible than those produced in sand.

Long (1933) observed that the difference in characteristics of root produced in sand and peat moss might be due to the difference in the moisture content of the media. Determination of the air and moixture content of peat moss and sand when each was at the point of considered optimum for rooting of cuttings showed that on a volume basis, peat moss contained over twice as much air and three times as much moisture as sand. He pointed out further that media had no influence on rooting of easy to root cuttings but it had influenced to a considerable degree on difficult to root cuttings.

Hubert, et al.(1939) experimenting with 10 different media found that mixture of peat and sand and peat alone proved best for number of plant species . They concluded that the beneficial effect of peat media might be due to the stimulating substances in the peat.

Swingle (1940) Quotes and Woycicki and Lerpinaki (1937) showed that the moisture of a sand medium has a marked effect on rooting.

Dobrovitzkaya (1940) worked on lemon cuttings and found that the mixture of peat and sand was better for cuttings. The length and number of rootlets was highest in a mixture of peat and sand or in pure peat.

Grace and Farror (1941) observed that mixtures of peat and sand were superior to sand alone for norway spruce cuttings.

Deboer (1947) found that for acer cuttings a mixtures of 2 parts peat moss :1 part sand gave better results over traditional mixtures of high sand content.

Opitz (1951) found that for troyer citronge cuttings, the mixture of sand and peat was satisfactory.

Dickey (1952) observed that among several rooting media tested those containing peat moss and

sawdust in combination with each other or with vermiculite were the best.

Puccini (1954) compared vermiculite with sand, soil, leaf mould, and sphagnum moss for herbaceouse and semi woody and woody ornamental and observed that vermiculite had a better water absorbing and water holding capacity than any of the other materials except sphagnum moss, but in general was not a good medium.

Ford (1954) reported that among all the media tried soil and sand mixture in the ratio of 3: 1 proved superior in the case of citrus cuttings.

Adriance and Brison (1955) have conducted that any medium used should be loose and easily worked to facilitates up rooting of cuttings with little damage to the roots. It should be fairly retentive of moisture and yet well drined. It should be free from fungi and bacterial, which attack cuttings and it should be freely available at rea so hable cost.

DeBoer (1955) made another study of various rooting media for soft wood cuttings of different species viz. Peat (pH 3.9), river sand (pH 7.2), sand mixture of peat and sand in the proportions 4 :1, 3 : 1, 2 : 1, 1 : 1, 1 : 2, 1 : 3 and 1: 4. She found that

most of the plants had optimum root formation in a mixture with high praportion of peat. Ericaceous and some other plants preferred pure peat. While with Daphne and contomeaster, sand medium was better. She also noted that in sand callus formation was stimulated at the expense of root formation.

Evans (1958) reported that works on the propagation of coffee revealed the facts about suitability of different media for rooting. He recommended vermiculite and river silt 1 : 1 mixture on ideal medium for the purpose. For practical use a 1 : 1 mixture of red soil and river sand was recommended.

Hartman and Kester (1959) reported that cuttings planted in sand had produced long, unbranched, coarse and brittle roots, but in peat moss roots were well branched, slender and more flaxible. The latter type was found to be more desirable than the former type.

Singh (1959) reported that the soft wood cuttings of kagzi lime were quite successful in 50:10 sand and leaf mould mixture.

Singh (1960) observed that of all the media a mixture of sand and leaf mould (1:1) proved quite

satisfactory for nursery cuttings of Citrus karna.

Singh and Singh (1961) working on the rooting of (Citrus karna) cutting obtained from young nursery plants and from mature bearing trees found that those taken from nursery plants gave best results in a mixture of sand and leaf mould but cuttings from bearing trees performed better in sand alone. Soil alone gave the poorest results.

Pennock and Meldonado (1963) did not obtained any appreciable effect of rooting media on rooting of guava, when cutting were planted in various media such as coco-peat, firebark, vermiculite, perlite and maxiferm.

Clay (1964) reported that vermiculite was a more suitable rooting medium then coarse sand for rooting of kale cuttings. Similar results were also obtained for avocado cuttings.

Foster (1965) the pH of the rooting medium had a significant effect upon root initiation and very early root growth of musk melon cutting. Optimum pH was found to be ranging from 6.5 to 7.0 with a sharp increase in time required for root initiation in the more acid media.

Flores and Kester (1966) observed significantly better rooting of almond cuttings with perfite peat moss mixture than peat vermiculite or vermiculite perlite mixture. Cutting in media which included peat moss product longer roots than did those in the vermiculite perlite mixture.

Mukherjee (1967) stated that physical and chemical characteristics of the media are given in Table. It will be seen that total nitrogen and water holding capacity of peat moss in higher then others, but the important aspects is perhaps the pH which is acidic in M_4 and M_5 and this may also account for better success.

Media	pH	Water holding capacity (%)	Sand	Silt	Clay	Total nitrogen
Sand M_1	7.6	21.80	-	-	-	0.03
Sand + Leaf mould M_2	6.6	65.78	50	34	15.91	0.51
Vermiculite M_3 1 : 1	8.8	596.30	-	-	-	0.01
Peat moss M_4	3.5	475.44	-	-	-	1.95
Peat moss + Sand M_5 1 : 1	4.4	212.62	-	-	-	1.10

Mukherjee (1967) reported that medium of peat moss and sand (1:1) was better for rooting then either material alone, vermiculice or soil plus leaf mould.

Rathore (1982) reported that rooting media soil + Sand + Leaf mould (R_3) proved significantly superior to all the other rooting media.

Banerjee, et al. (1983) shoots of cinnamonum camphora (about 45 cm. along and 1 cm. in diamter) had a 1.5 cm. ring of bark removed. The cut was treated with several phenolic compuns, covered with sphagnum and soil (1 : 1) and wrapped with polythen. The layers were detached 60 days later and assessed for rooting treatment with 5% in the control and 10% in shoots treated with tannic acid at 1000 ppm results for other variants are tabulated.

Gurjar (1983) reported that among the five rooting media leaf mould proved significantly better for rooting of kagzi layers.

Tomar (1985) reported that among the six rooting media, sand (R_2) proved significantly better for rooting of kagzi lime air layers.

Review of literature pertaining to the mode of action of growth regulator and physiology of rooting of air layer :

Research workers have tried to under stand the mode of action of plant growth regulators from the time of their discovery in the rooting of plants propagated by air layerings.

Wend (1938) appears to consider that his postulated rhizacline is the effective agent in initiating root formation and that natural of synthetic hormones act indirectly by mobilising the rhizocaline.

Cooper (1940) presumed that the application of growth substances results in accumulation of certain chemical sub-stances at the base of cutting which stimulates the meristem to divide quickly and from roots.

Burstorm (1942, 1950 snf 1952) found that auxin induced acceleration of cell alongation in indicidual root cells. Elongation of cell is caused by stimulation of the first phase cell stretching. The second phase of cell elongation can only be retarded

by auxin. Thus an overall acceleration of elongation can be brought about by addition of auxin only if its concentration is so low that the acceleration of the first phase of growth is not completely marked by retardation of the second phase.

Skoog (1944) reported that when the ratio of auxin to certain other plant constituents especially adenine is low the meristem section tend to form bud and leaf primordia when the ratio is medium callus is formed and when the auxin content is high root primordia developed.

Gardon (1953) almost any living plant tissue cambium, epidermis, pericycle, endodermix, cortical parenchyma pith rays will form roots by the interaction of a suitable gross nutritional level and raised auxin level. The low concentration of auxin required for root initiation are generally above the level required for cell elongation, low concentration like wise induces cell division in root cambium or pericycle which forms lateral roots. Roots produced following treatment with growth regulators, are similar in origin to those produced naturally. Branch, roots, generally arise

from the larger primary root structures. Root initials appear first in the pericycle, where cells divide to form a growing point with a root cap. The secondary roots penetrates through the cortical tissue and epidermis of the root.

Bouillenne and Bouillenne (1955) proposed that "rhizocline" be considered as a complex of three components, (1) a specific factor, translocated from the leaves and characterized chemically as on or tho-dihydroxyphenol and (ii) a non specific factor (auxin) which is translocated and is found in biologically low concentrations and (iii) a specific enzyme located in cells of certain tissues (pericycle, phloem, cambium) which is probably of the polyphenel-oxidase type.

They further proposed that the ortho-dehydroxyphenor reacts with auxin wherever, the enzyme is present, giving rise to the complex, "rhizocaline" Applied auxines in high concentrations, are believed to act as accelerators of respiration and cell mitosis. Rhizocaline may be considered one step ahead in a chain of reactions which ends in the differentiation of tissues and finally in the organization of root structure. Such

indole-phenol complex may react at the base of the cutting with a specific enzyme, initiating cell division and heading to adventitious root formation as follows.

Phenolic

Co-factor + auxin

Frambuds (endogenous of applied)..../auxin ..../phenolcomplex ...../cell division...../ adventitious root initials enzyme.

Samanti and Pattanaik (1956) observed three stages of development of roots in cuttings treated with growth regulators. The first stage was governed by plant regulators which converted the parenchyma tissue into meristems. While the other two stages were the reorganization of meristems in to root-primordia and the development of factors such as Vit.B.

Cautheret (1969), Olimen et al. (1971) and Haising (1972) stated that auxin natural or artificially applied is a requirement for initiation of adventitious roots on stem and indeed it has been shown that the division of first root initial cell is dependent upon either applied or endogenous auxin.

Haising (1971) observed that root initials in stem is apparently dependent upon the native auxin in plant plus auxin synergist together these lead to synthesis of ribonuclic acid (RNA) which is involved in initiation of the root primordia.

Devlin (1974) stated that action of auxin in root is similar to that in stem, but that the concentration of auxin to stem growth are inhibitory to root growth. In other words, roots are much more sensitive to auxin than stem and real stimulation or root alongation may be achieved if low concentrations are used. The application of relatively high concentration of IBA to root not only retards root elongation but a noticease in number of branch roots.

Use of growth regulators on air layers of B.thimma :

Zimmerman et al. (1933) reported for the first time a chemical that has a specific and marked capacity to cause rootage.

Cooper (1935) obtained quicker and more rooting in the cutting of Euraka lemon and several other varieties of citrus by treatment with IBA and IAA compared to control.

Zimmerman (1936) tried several other analogous synthetic chemicals and recorded their beneficial effects of rooting.

Thiamann and Behnke (1947) reported that the chemicals increase the percentage of success by facilitating the root formation in plants which have so far affered difficulty.

Chandro (1956) reported that Rauvolfia canescans L. can be raised by vegetative means i.e. by treating the hard wood cutting with IAA.

Chattopadhya (1959) reported NAA induced high rate of rooting in Ipecac cuttings. Deficiency of minerals resulted in reduced root growth, with hormones better effect was noticeable but not as good as with all the nutrients added together with NAA.

Parihar (1960) stated that persual of the results obtained so far clearly shows that, in general cuttings of plant species and variety which are normally easy to root from cuttings almost in variably respond well to hormone treatment, the time taken to root is shortened a larger percentage of cuttings from roots

and the number of roots produced is usually greatly increased with cutting taken from spedies and varieties which are moderately difficult to root. Hormone treatment is also effective in a large number of cases in accelerating root formation and in causing the production of more roots per cutting.

Audus (1963) summarised that the growth regulators and their use in rooting have helped considerably in plant propagation and particularly IBA, IAA and NAA are more effective in rooting of cuttings.

Shanmugavelue (1971) found that the application of IBA either as spray or in lanoline paste on the seedings of jack fruit increased the root growth.

Randhawa (1971) observed that cuttings of certain species root more readily if taken from young trees than from mature trees. He further reported that the hard wood of most of the trees and shrabs respond less to treatment with growth substances than the soft wood cuttings.

Hartmann and Kester (1972) mentioned that root formation during layering is stimulated by various growth regulators treatments which cause an interuption

in the downward translocation of organic materials, carbohydretes, auxin and other growth factors from the leaves and growing shoot tips. These materials accumulate near the point of treatment and rooting occurs in this general area even though the stem is still attached to the parent plant.

Hartmann and Kester (1976) stated that synthetic root promoting chemicals have been found most reliable in stimulating adventitious root production in cutting. Although there are other which can also be used. IBA is probably the best chemical for general use because it is non-toxic over wide concentration rang and is effective in promoting roots of a lart number of plants.

Kushwaha (1984) used three growth regulators (IAA, NAA, IBA) in his experiment. IBA proved significantly better than IAA and NAA for the percent success in rooting and survival percentage of kagazi lime air layers.

Effect of concentrations of growth regulator on rootage of air layaring :

Marques (1938) got better rooting by using 100 and 50 ppm IAA and NAA long dip in case of sour orange cuttings.

Sen (1939) reported that effect of IBA in stimulating the rooting of cutting of litchi chinensis and Justicea gandarusa. He found that the treatment with IBA was more effective than IAA as indicated by callus growth and in all case 60 ppm when applied for the longest period, produced the best results.

Thakurta and Datta (1941) recorded 80% success in air layers of mango with IAA 1% in lanoline paste.

Parihar (1948) showed that in psidium guajava (Guava) air layering combined with hormone application could be one of the very easy methods of vegetative reproduction. He obtained successful results by using 0.05% of IBA and NAA in lanoline paste.

Singh (195) also got favourable results in Guava with 1% NAA.

Singh and Teotia (1951) treated mango air layer with several plant regulators in different concentrations and found 1% & 2% NAA, 2% IAA and 1% IBA as the most effective.

Singh et al. (1954) studies the effect of the different growth regulators and their treatment on air

layers of golden yellow loquate. The obtained 20% rooting in control. 100% in NAA (3%), 50% in phenyle acetic acid (1%),80% in IAA (2%), 90% in IBA (3%) and 40% in 2, 4-D (1%).

Singh and Sharma (1954) reported percent[illegible] rooting with 3% NAA in the cutting from Eriobotrys joponica Lind. Var. Goldern yellow.

Singh (1955) compared different plant regulators at different concentrations for jack fruits and obtained 100% success with 1% IBA.

Singh (1955) investigated the effect of a number of growth regulators on the rooting of citrus air layers. He obtained good results with hormone mixture of IAA (1%) and IBA (1%) in kegazi lime.

Singh and Bhatnagar (1955) reported the propagation of Jasminum grandiflorum by stem cutting with the aid of auxins in different concentrations. In hard wood cuttings 500 ppm NAA give best results by giving 90% rooting as compared to 30% in the control.

Jauhari and Nigam (1958) reported that 10,000 and 20,000 ppm concentrations of IBA and IAA can successfully be utilized for propagation of karonda by air layering Alpha NAA and control failed to produce roots.

Kempounds and Chandrasekhariah (1959) used several compounds for inducing rooting in cuttings of Gliricidia maculate H.B. and K. The cutting were dipped for 24 hours in different concentrations and combinations of IAA, IBA, NAA, IPA and also in pregnant cow's urine collected in the previous evening. Treatment were also made with hormonal powders in talcum. They found that IBA and NAA at 1,000 ppm were superior to others in producing roots about 28 to 32 days after treatment.

Sen and Bose (1959) observed great success in air layers of jack fruit with the use of 5,000 ppm and 10,000 ppm NAA.

Bhattacharjee and Bhandari (1960) obtained better rootings by treating apical shoot and soft wood cuttings of Rauvolfia serpentina Benth with 5,000 and 1,000 ppm IBA. The hard wood cuttings and untreated ones gave poor rooting.

Jauhari (1960) found that the shoot cuttings of phalsa gava 60% rooting when treated with 100 ppm IBA solution for 24 hours whereas the controls did not root.

Jauhari (1960) has reported IBA to be useful for inducing rooting in karonda. He used 2,500; 5,000; 7,500 and 10,000 ppm concentrations of IBA and got maximum rotting percentage, number of roots formed and length of roots in 7,500 ppm IBA treatment.

Jauhari and Jit (1960) recorded the effectiveness of plant growth regulators on the rooting of air layers in loquate with hormones NAA (10,000 to 30,000), IBA (20,000 to 30,000 ppm) and IAA(10,000 to 20,000 ppm). They have found NAA to be the best.

Jauhari (1960) reported vegatative propagation of Zizyphus mauritiana Lamk. From goottee and cutting with the 12-15 years old trees were treated each with 10,000 pp, mixture. Goottee were covered with wet sphagnum moss and firmly field with plastic rubber. Air layers examined two weeks after treatment demonstration profuse root development with an average of 8 to 6 roots/ goottee and the largest root measured 4 to 8 cm. The control had no roots.

Singh (1960) conducted a trial with Karna Khatta, Sweet lime and Kagzi lime cutting by treating with IBA by the concentrated dip method. It was found that the early rooting of cuttings of young nursery plants of Karna Khatta and Soft wood cuttings of Kagzi lime had not

responded to any concentration of IBA except the semi-hard wood cuttings of Karna Khatta which require only 500 ppm for effective rootings. Hard wood cuttings did not show any improvement by IBA treatment and In all the cases the rooting was very poor.

Shanmugavelu (1960) showed that the soak method with 20 to 200 ppm of IBA was the most promising for the rooting and average number and length of roots for the cuttings of Hibiscus rosasinensis L. and Allamanda catherxica L. He also recorded 60% rooting with 20 ppm IAA and 75% with 1,000 ppm of NAA in the case of the soft wood cutting. While untreated ones showed only about 10% In hard wood and semi hard wood cuttings encoureging results were also recorded.

Lingaraj and Chandarasekhariah (1961) applied IAA, ABA and NAA individually and in combination for inducing rooting in cuttings of Antirrhimum majus L. The cuttings were dipped in theharmone powder at concentrations varying from 2,000 to 4,000 ppm and planted in seed pans containing sand and red earth in equal portions. Combinations induce better rooting than individual regulators and IBA showed the best results. Amongest them lower concentration proved to

be generally unfavourable except in combination of IAA and IBA. Rooting was found to commence from 2nd week after the treatment. The response appears to be intimately connected with the penetration of the regulator through out the apidermis and cortex upto the pericycle region, requiring high concentration.

Shanmugavela (1961) treated 12.5 cm. thick hard wood cuttings of one year old Hibiscus rosasinensis L. with IAA, IBA and NAA by sock quick dip and dust method and obtained 85 to 95% rooting after soak treatment with NAA for 24 hours.

Singh et al. (1961) obtained the best rooting response (92.5%) with IBA 2,500 ppm. In golden yellow loquate air layers whereas, NAA 250 ppm was found less effective than IBA. The mixture of NAA and IBA gave the same results as those of IBA alone.

Jolieour (1962) obtained maximum of 44% rooting in guava with 0.8% IBA under mist.

Singh (1963) noted a marked improvement in rooting as well as sprouting of sweet lime cuttings (Citrus limetta iodes Tan.) by quick dip application of 2000 ppm IBA.

Rao, et al. (1963) have reported the optimum production of rooted cutting with the use of mixture of IBA, IAA, IPA and NAA at 0.25 or 0.50% in lanoline pastes. The cuttings were then covered with saw dust and wrapped in violet coloured Alkethene sheets.

Sen and Hore (1963) studied the effect of growth regulators on the vegetative propagation of several ornamental plants. Air layering with IBA, NAA and Seradex in lanoline at concentrations of 1,000 to 10,000 ppm gave 90 to 100 percent rooting in Amherstia nobilis Wall, 50 to 100 percent in Brownea ariza Benth, 60 to 100 percent in Sterculia diversifolia Don 60 to 80 percent in Mesua ferrea Linn. and 30 to 50 in Cinnamomum camphora as against poor rooting not exceding 50 percent in the control sets.

Rathore (1964) worked on guave layers and found 2% concentration of different hormones to be most effective.

Chinnappa (1966) recorded the effect of plant growth regulators on the rooting of air layers in litchi with 10,000 and 15,000 ppm of IBA and NAA respectively. The results showed that the higher concentrations were more successful.

Murkherjee (1967) tried to propegate litchi and guava by air layering with the help of IBA 5,000 ppm and found that this concentration gave 100% rooting in both the fruit crops.

Murkherjee et al. (1967 b) reported that the mango cutting may be made to induce roots proved . IBA at 5,000 ppm in lanoline past was applied at the base of cutting after ringing while may were still attached to the mother trees. The rooting of cuttings of different age groups was improved from 20 to 52.5% from 10 years old tree to one month seedling.

Sulladnath and Kologi (1969) treated chiku air layers with IBA, NAA, IAA and IBA + NAA to concentrations between 5,000 to 20,000 ppm. The highest rooting i.e. 90% was recorded with the treatment of 10,000 ppm of IBA + NAA.

Mishra and Jouhari (1970) conducted an experiment to evaluate the potentiality of certain growth substances on rooting of Morus alba and Zizgphis mauritiana Stem. In case of Morus alba. IBA and NAA mixture at 7,500 ppm level with boron proved to be best for the rooting in air layers followed by IBA and NAA mixture of 7,500 ppm without boron. In case of

Zizyphis mauritiana a mixture of IBA and NAA with boron at concentration of 7,500 ppm proved to be the best followed by the mixture with boron at concentration of 5,000 ppm control layers did not produce any root.

Lal et al. (1971) conducted a trial in which Bougainvillea cuttings were treated with 100, 500 and 1,000 ppm of IAA, NAA and IBA. All soft wood cuttings died but the treatment improved the sprouting and rooting of hard wood cuttings. The best results were obtained with IAA at 500 ppm. The treated cutting had a survival rate of 18.3 from 20 cuttings compared with only 20 in untreated cuttings.

Verma et al. (1971) recorded a strong synere-gistic of IBA at the level of 7,500 ppm on all characters of mango, guava and citrus marçots. The high rooting success of 100% in citrus 60% in Guava and 80% in mango was obtained by 7,500 ppm IBA.

Chhonkar and Singh (1972) found IBA at 5,000 ppm to be more effective in propagation of mango by air layering.

Saraswat (1973) observed that (2.5%) IBA in the form of lanoline paste increased the rooting in air

layers of jack fruit but survival rate was very low.

Quadeer (1974) found that 2% IBA in form of lanoline paste gave very good results in propagation of jack fruit by air layering however, the survival percentage was very low.

Vijay kumar and Chouhan (1974) recorded that the rooting of Guava cuttings from girdled and etiolated shoots may be improved by IBA treatment. They found the highest rooting in seeding cuttings viz. 98.5% with 8,000 ppm. IBA treatment followed by Allahabad safeda 82.22% and pink flushed 63.96%. The average number of roots and length of primary roots also recorded the highest in seedless cutting followed by other cultivars compared to control cuttings.

Nanda, K.K. (1975) reported the cutting of molus prunifolia treated with IBA 1250 and 2500 ppmm gave 90% rooting. Even IBA 625 ppm gave 70% success.

Rathore, Singh and Chhabra (1975) reported that soft wood cuttings of Guava taken at the end of July were given a quick dip in IBA, IAA or NAA each at 0 to 20,000 ppm before planting in pots under polythene cover in a lath house and the effects were assessed on plant survival,

rooting and sprouting over a 10 weeks period. The best results were obtained with IAA followed by IBA, each at 2,500 ppm.

Maiti (1977) obtained minimum success of 32% in the treatment air layers of Ixora singaporensis against 22% in control. IBA and NAA (1,000, 2,000 and 3,000 ppm) gave better results than IAA. In NAA success diminished with the size in concentration whereas the case was nearly reverse in IBA. By 1,000 ppm NAA cent percent layers produced roots.

Khaskalam (1978) has reported that growth regulators help in intiation of rooting. He observed the maximum number of roots and their fresh weight with the application of IBA 5,000 ppm and also noted the significant effect of various concentrations of IBA on various root characters, like number of roots, length, diameter and fresh weight of roots. He also noted the cent percent survival of IBA treated air layers after detachment. However, effect of IBA on number of secondary roots was found to be not significant. Control failed to give any root.

Tomar (1979) have also obtained the maximum length of primary roots number and length of secondary

roots in karonda air layers with IBA 10,000 ppm.

Sharma (1981) concluded that NAA 10,000 ppm had significantly effected the various root characters followed by NAA 7,500 ppm and IBA 10,000 ppm in karonda air layers.

Tomar (1981) reported that among the four concentration of IBA 5,000 ppm proved significantly better for rooting of kagzi lime air layers.

Rathore (1982) reported that among four concentration of IBA 15,000 ppm proved significantly better for rooting of guava air layers.

Gurjer (1983) reported that among the three concentration of IBA 10,000 ppm was found significantly better for the callusing and rooting success and survival of air layers of kagzi lime.

Bhadoria (1985) concluded that IBA at all the levels helped in better root initiation, survival and growth at highest concentration of IBA (10,000 ppm) proved to be the most effective concentration. IAA at all concentration have shown datroriation in characters as compared to control and do not found suitable for use.

Gurjar (1986) Growth regulator NAA 10,000 ppm showed a great important in callusing, rooting and survival of air layers of Bungainvillea Thimma.

Review of literature pertaining to the effect of interation between different footing media and concentration of growth regulators on the rooting of air layerings :

Kale (1972) reported that when the hard wood cutting of B. variety Mary Palmer were dipped in solution of IBA, IAA and NAA at 1,000, 1,500; 2,000 and 2,500 ppm before planting. IBA treatment proved the most successful. The 1,500 ppm treatment of IBA resulted in 75% rooting as compared to 15% in untreated cutting.

Pal and Vishnuswarup (1974) have reported that the latest varieties of B. are propagated by air layers or cutting with the help of growth regulators.

Gandotra et al. (1975) in a trial with IBA, NAA and IAA at 6,000 to 10,000 ppm observed that the best result with four node hard wood cuttings of B. variety Mary Palmar were obtained with IBA at 6,000 ppm as compared to other hormones.

Singh (1977) tried IBA at 1,000 ppm on cuttings viz. hard wood (25 cm long), semihard wood

(25 cm long) and soft wood (10 cm) cutting of Bougainvillea. Variety Mary Palmer and Thimma planted either in the open sunlight or under partially shaded polythene tents. All the soft wood cutting rooted,but they had the lowest survival rate (48%) as compared with 83%) rooting and 54% survival for hard wood cuttings. The performance of semi-hard wood cuttings was intermediate. None of the cuttings rooted when planted in open sunlight and 91% rooting was obtained in those planted under shaded polythene.

Jain (1980) found that the treated G_3 (10,000 ppm of IBA) in combination with V_4 (B. Alok) gave significantly better results than all other treatments with regards to number and length of primary roots and mean length of secondary roots but the same treatment G_3 (10,000 ppm IBA) gave better results with V_2 (H.C. Back) with regard to fresh weight of primary roots. The combination of the treatment G_1V_3(0 ppm IBA on B.Thimma) have the minimum rooting response. As regards the diameter of primary roots, maximum diameter was recorded under the treatment combination G_3V_4 (10,000 ppm IBA on Alok). But response was statistically not significant.

Yadav (1981) concluded that growth regulators in combination with varieties could not show any significant effects. Though they effected the per cent rooting number of primary roots, number of secondary roots, length and diameter of secondary roots, weight of primary and secondary roots, survival percentage height of plant and number of branches marginally.

Gurjar (1986) reported that treatment combination between rooting media and growth regulators M_4G_7 (Soil + FYM and NAA 10,000 ppm) was found a better combination for maximum callusing, rooting and survival percent of air layers of B. Thimma.

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METHODS AND MATERIALS

C H A P T E R - III

MATERIALS AND METHODS

The present investigation " Effect of rooting media and growth regulators on the callusing, Rooting and survival of air layers of Bougainvillea species variety Thimma " was carried out in the experimental areas of Department of Horticulture, College of Agriculture, Gwalior (J.N. Krishi Vishwa Vidyalaya, Jabalpur) during rainy season of the year, 1988-89 under agro-climatic and soil conditions of northern Madhya Pradesh. The details of Materials, Methods and Techniques followed in the experiment are given below :

1. EXPERIMENTAL SITE :

The experiment was conducted on the Bougainvillea variety Thimma planted on either sides of the approach road as a bush specimen on the lown of college ornamental garden in the year 1978-79 for the beautification of the college landscape. The plants were well grown, healthy and proper in display.

2. CLIMATE AND SEASON :

The experiment was conducted during rainy season because propogation by air layering is always undertaken during the rainy season when suitable temperature range and high humidity about 80-82% are available. Gwalior is having a typical sub-tropical climate with high temperature and very high humidity during rainy months and low temperature with occasional frost occurance during winter months. The average maximum temperature goes upto 43.8°C in the month of May and June and minimum temperature as low as 6.0°C in the month of December - January. Average annual rainfall is 26" - 28" mostly distributed during July to mid September. Occasional winter rains are also received.

Gwalior is situated in the northern parts of Madhya Pradesh at an elevation of 192.2 meters above the mean sea level with latitude and longitude 26^{o}, 13 and 78^{o}, 15' east respectively. This place enjoys sub-tropical climate with hot summer, cool winter and occasional showers in winter. The details regarding the season and climate of Gwalior are as under .

3. COLLECTION OF METEOROLOGICAL DATA:

The meteorological data or the mean monthly value for experimental duration or kharif season regarding temperature (minimum and maximum), relative humidity and total rainfall as recorded at the Meteorological Observatory of Agricultural Research Farm, J.N.K.V.V., Jabalpur, Campus : College of Agriculture, Gwalior-2 during the year 1988-89 and are given in Table-1 and depicted graphically in Fig.1.

TABLE-1 : Mean monthly temperature(Minimum and maximum), relative humidity and total rainfall during experimental period or for kharif season 1988-89.

S. No.	Month & Year	Mean Temperature: Mini-mum (^{o}C)	Maxi-mum (^{o}C)	Relative humidity (%)	Rainfall (mm)
1.	July 1988	23.45	33.79	81.83	213.9
2.	August 1988	23.08	32.00	82.16	248.7
3.	Sept. 1988	23.62	35.48	71.26	247.2
4.	Oct. 1988	18.6	33.58	59.70	43.00
5.	Nov. 1988	10.4	29.86	61.73	-
6.	Dec. 1988	9.2	25.29	72.11	-
7.	Jan. 1989	5.9	22.3	82.2	17.5

It is obvious from the above table that this year the rainfall was good during the rainy season as shown in the above table.

4. DETAILS OF EXPERIMENT :

The experiment was laidout in Randomized Block Design with 3 replications.

Treatments and their symbols :

M- Stand for rooting media.

G- Stand for concentrations of growth regulators.

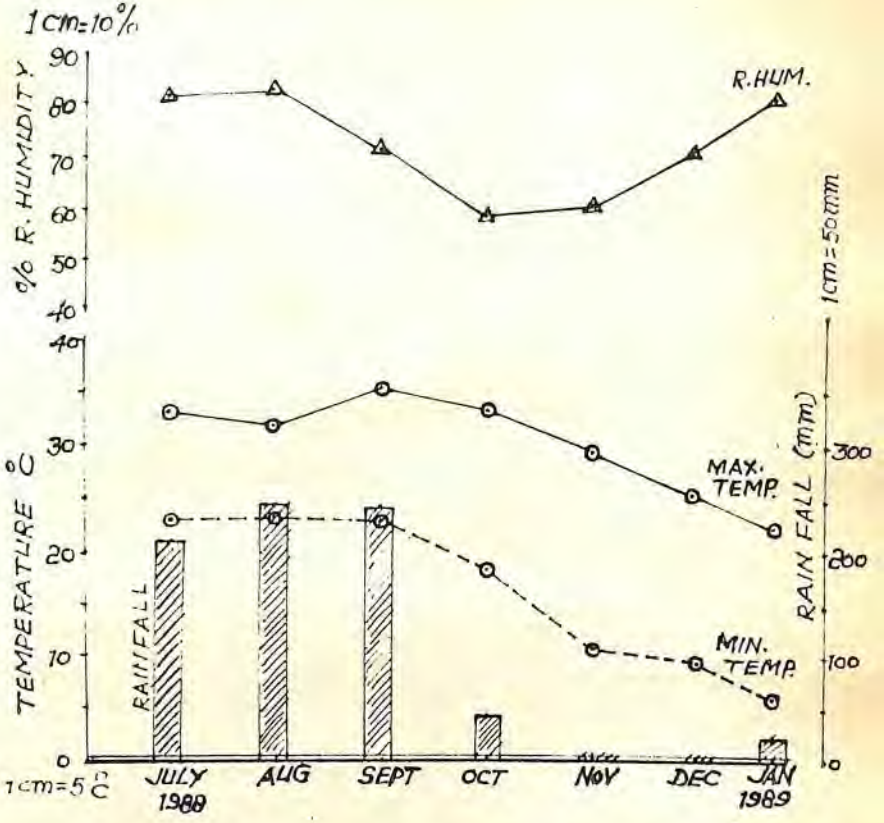

FIG-1 METEOROLOGICAL DATA DURING THE CROP SEASON

For the present study two factors viz.

(A) Rooting media - (at three levels):

		Symbol
(1)	Soil	M_1
(2)	Soil + Leaf mould	M_2
(3)	Soil + FYM	M_3

(B) Growth regulator - (at five levels):

(1)	Without growth regulator or control	G_o
(2)	IBA - 7,500 ppm	G_1
(3)	IBA - 10,000 ppm	G_2
(4)	NAA - 7,500 ppm	G_3
(5)	NAA - 10,000 ppm	G_4

(C) Treatment combinations-

(1)	G_oM_1	(6)	G_oM_2	(11)	G_oM_3
(2)	G_1M_1	(7)	G_1M_2	(12)	G_1M_3
(3)	G_2M_1	(8)	G_2M_2	(13)	G_2M_3
(4)	G_3M_1	(9)	G_3M_2	(14)	G_3M_3
(5)	G_4M_1	(10)	G_4M_2	(15)	G_4M_3

TABLE-2: Details of treatments and their combinations :

S.No.	Name of treatments	Rooting medias	With and without growth regulators (Details of ingredients).
1.	M_1G_o	Soil	oo ppm control.
2.	M_1G_1	Soil	7,500 ppm IBA
3.	M_1G_2	Soil	10,000 ppm IBA
4.	M_1G_3	Soil	7,500 ppm NAA
5.	M_1G_4	Soil	10,000 ppm NAA
6.	M_2G_o	Soil + Leaf mould	00 ppm without growth regulator or control.
7.	M_2G_1	Soil + Leaf mould	7,500 ppm IBA
8.	M_2G_2	Soil + Leaf mould	10,000 ppm IBA
9.	M_2G_3	Soil + Leaf mould	7,500 ppm NAA
10.	M_2G_4	Soil + Leaf mould	10,000 ppm NAA
11.	M_3G_o	Soil + FYM	00 ppm control
12.	M_3G_1	Soil+ FYM	7,500 ppm IBA
13.	M_3G_2	Soil+ FYM	10,000 ppm IBA
14.	M_3G_3	Soil+ FYM	7,500 ppm NAA
15.	M_3G_4	Soil+ FYM	10,000 ppm NAA

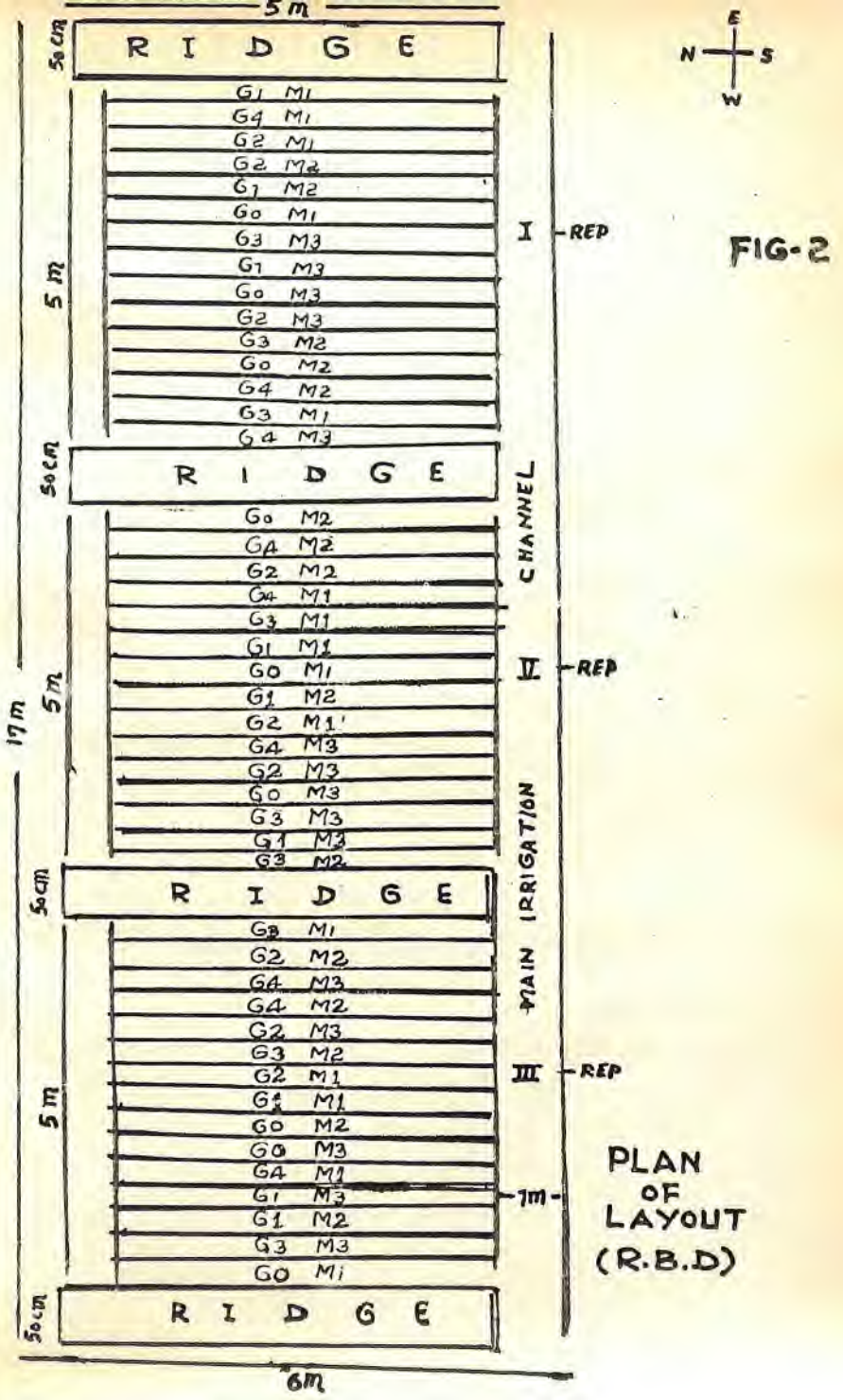

FIG-2

PLAN OF LAYOUT (R.B.D)

Design	: Randomized Block Design (R.B.D.)
No.of replications	: 3
Total No.of treatments	: 15
Number of layers/ treatment	: 20
Total No.of air layers/Replication	: 300
Total Number of layers in the experiment for all the treatments	: 900
Date of layering	: 15 July to 17 July 88
Date of preparing rooting media	: 10.7.1988
Name of plants	: Bougainvillea Thimma
Age of plants	: 9 years
Number of plants in each replication	: 3
Total number of Bougainvillea plants	: 9

5. SELECTION OF PLANTS AND THEIR BRANCHES:

For trial nine bougainvillea plants (three plants in each replication) of uniform size and vigour were selected on these plants well matured and healthy branches of pencils thickness were selected. The average length of the branches was 45 cm and diameter 1 cm. approximately. 300 selected branches were layered

on every three bougainvillea plants in each replication. Thus total number of branches layered 900 in all the three replications and all treatments.

6. PREPARATION OF ROOTING MEDIA :

i) Soil :

Soil taken for rooting media was sandy loam in nature. It was taken from the garden area. Water was added to change it into mud. All the pieces of gross roots and bricks etc. were removed. This soil was then seived and moisture was added to convert it into mud form.

ii) Soil + Leaf mould :

Soil and leaf mould were sieved and mixed together in the ratio of (1 : 1). Before using they were made in mud form ready to use for covering the girdled portion.

iii) Soil + FYM :

Soil and farm yard manure were sieved separately and then both were taken in the ratio of (1:1) and mixed together thoroughly. After mixing water was added to make it into mud form for using it for covering the wounded part of shoots.

7. PREPARATION OF GROWTH REGULATOR MIXTURE IN LANOLINE PASTE

TABLE-3 Ingredients of growth regulator mixture

Growth regulator	Quantity of growth regulator in (gm)	Quantity of alcohol in (ml)	Quantity lf lanoline paste (gm)	Total quantity of mixture (gm)	Strength of growth regulator in (ppm)
IBA	0.750	20	99.250	100	7,500
IBA	1.000	20	99.000	100	10,000
NAA	0.750	20	99.250	100	7,500
NAA	1.000	20	99.000	100	10,000

Lanoline paste was taken as a media for growth regulators for applying it in air layers. In the present experiment concentrations of IBA and NAA was used. The quantity of growth regulator and lanoline paste was shown in above table No.3 growth regulators was weighted separately with the help of electric balance.

The growth regulators were taken in different glass beakers and dissolved in 20 ml. of 95% Ethyl alcohol. When regulators was dissolved, indicated quantity of lanoline paste was added in each beaker and shaked so that whole materials will be uniformly mixed.

8. METHOD OF TREATMENT :

After selection of branch, 1 cm. wide circular patch of bark was removed. Thin course sand was rubbed over girdled portion to remove cambium layer. There after small quantity of prepared growth regulator in Lanoline paste was taken with the help of cemel hair brush and applied at upper part of girdled shoot. The cut, thus treated was covered with rooting media and then wrapped with polythene film and tied with the help of sutli.

9. DETACHMENT OF AIR LAYERS :

After 50 days from the date of operation, air layers were detached from mother plants. When roots were visible cut was made just below the lowest cut end of the ringed surface with the help of secateur. After detachment the air layers were brought under the shade of trees and their polythene covers were removed gently. The care was taken that the roots may not be injured while removing the polythene cover. After doing this, the successfull goottees (air layers), after removal of plastic cover were planted in a well prepared nursery bed laid out statistically. given in lay out plan fig. No.2.

10. PREVIOUS HISTORY OF THE EXPERIMENTAL AREA OF NURSERY :

The area for planting the air layers of B.Thimma after detachment were selected in the nursery near the pot yard and irrigation facility. The details regarding previous history of the experimental area is presented in Table -4.

TABLE-4 Previous history of the experimental field.

S.No.	Year	Kharif	Rabi	Summer
1.	1984-85	Fallow	Winter season nursery	Cut flower beds
2.	1985-86	Air layers of Kagji lime	Continued	Continued.
3.	1986-87	Fallow	Winter season nursery	Cut flower beds
4.	1987-88	Fallow	Winter season nursery	Cut flower beds
5.	1988-89	Present experiment	Continued	-

11. PREPARATORY TILLAGE AND CULTURAL OPERATION :

Before transplanting of rooted air layers in the nursery. The field was ploughed cross-wise with the mould board plough and cultivator followed by planker. After ploughing the plot measuring was marked and laid out as per plan Fig.2.

12. SOIL OF THE EXPERIMENTAL NURSERY :

The soil of experimental nursery plot and area was sandy loam having good drainage. Before transplanting, the soil samples of the experimental plot up to depth of 0 - 15 cm. were taken randomly from different sections of the plot and analysed for mechanical and chemical composition in the department of soil chemistry. Results of the analysis given by soil chemist are as under in Table -5(a) and 5(b).

TABLE-5(a): Mechanical composition of soil of the experimental area.

S.No.	Constituents	Percentage over dry basis	Method of determination of constituents
1.	Sand	57.41	By hydrometric method (Piper, 1950)
2.	Silt	15.29	
3.	Clay	25.20	
4.	Calcium carbonate	2.10	Rapid titration method

TABLE-5(b): Chemical composition of soil of the experimental plot.

S.No.	Constituents	Value over dry basis	Method of determination of constituents
1.	Available nitrogen	79.63 kg/ha	Available nitrogen estimation was done Alkaline permagnate method.
2.	Available phosphorus	30.18 kg/ha	Available phosphorus was estimated by Oleson's method
3.	Available potash	424.40 kg/ha	Available potasium estimation was done by Flame photometer.
4.	Organic carbon	0.45 kg/ha	Organic carbon was estimated by Black and Wakley method.
5.	Electric conductivity	0.15 m.mhos/ cm.	Conductivity was measured by L.B.H. type conductivity meter.
6.	pH of soil	7.7	The pH was tested by Backmen pH meter model H-2.

13. OBSERVATIONS TO BE RECORDED :

Three air layers were selected randomly per plot and the following observations were recorded at 10 days intervals in each treatment and replications.

(A) ROOTING STUDIES :

1. Callus formation (cm.)
2. Number of rootingprimordias are initiation of rooting (No.)
3. Total number of primary roots (No.)
4. Average length of primary roots (cm.)
5. Diameter of primary roots (mm.)
6. Total number of secondary roots (No.)
7. Average length of secondary roots (cm.)
8. Diameter of secondary roots (mm.)
9. Fresh weight of roots (gm.)
10. Percent success in rooting (%).

(B) GROWTH STUDIES :

1. Height of plants (cm.)
2. Number of branches (No.)
3. Length of branches (cm.)
4. Average number of leaves (No.)
5. Percentage survival after transplanting (%)

SAMPLING TECHNIQUE FOR VARIOUS OBSERVATIONS :

For observations three air layers of Bougainvillea Thimma were taken from each treatment at 10 days interval for observation. After detachment all the air layers were transplanted in already laid out plot where air layers were selected further growth studies. In the nursery

observations for the record of survival of air layers carried out on the air layers which were planted in the same spot in which layers were already planted in well laid out plot of the nursery area.

IRRIGATION :

Irrigation to plants was given at an interval of 10 days starting from the day of transplanting.

WEEDING AND HOEING :

In all weedings and hoeings were done at 15 days interval after transplanting of air layers keeping care not to cause any injury to the root system.

PLANT PROTECTION :

Aldrin powder was mixed in the soil as a preventive measure for protection from the attack of termite .

STATISTICAL ANALYSIS :

Data on rootage and growth as collected at the time of detachment (45 days after operation) and final observation (105 days after operation) were analysed statistically as per method given by Fisher, (1950).

The skeleton of analysis of variance table is given below .

TABLE-6: Skeleton of analysis of variance.

S.No.	Source of variance	D.F.	S.S.	M.S.S.	'F' value Calcu- lated	'F' value Table
1.	Replication(R)	2				
2.	Growth regulator(G)	4				
3.	Media (M)	2				
4.	Interaction(GxM)	8				
5.	Error (E)	28				
	Total	44				

The 'F' test was used to judge the significance of treatment effects. The significant difference between different means was judged by using critical difference calculated at 5% level of significance. The C.D. was calculated as follows :

S.E.(m) to compare the mean of rooting media.

$$= \sqrt{\frac{EMSS}{15}}$$

C.D. = S.E.(m) x $\sqrt{2}$ x 't' Table value at 5% level of significance for error d.f.(28).

S.E.(m) to compare the mean of growth regulator.

$$= \sqrt{\frac{E\ MSS}{9}}$$

C.D. for Growth regulator

= S.E.(m) x $\sqrt{2}$ x't' Table value at 5% level of significance for error d.f.(28).

S.E.(m) for interaction between rooting media x growth regulator

$$= \sqrt{\frac{E\ MSS}{3}}$$

C.D. = S.E.(m) x $\sqrt{2}$ x't' Table value at 5% level of significance for error d.f. (28).

TABLE 7 : DETAILS OF OPERATIONS PERFORMED IN THE EXPERIMENT

S.No. (1)	Name of operations (2)	Date (3)
1.	Selection of bougainvillea Plants for air layering.	13.7.88
2.	Preparation of harmones mixture	14.7.88
3.	Operation of air layers :	
	Replication I	15.7.88
	Replication II	16.7.88
	Replication III	17.7.88
5.	Preparation of field for transplanting of air layers of B.Thimma	25.8.88
6.	Application of Aldrin dust for termite Control in the nursery	26.8.88
7.	Separation of air layers :	
	Replication I	4.9.88
	Replication II	4.9.88
	Replication III	5.9.88
8.	Pruning of air layers	6.9.88
9.	Rooted percentage	7.9.88
10.	Transplanting of air layers	8.9.88
11.	Irrigation : 9-10, 29-10, 14-11, 29-11, 6-12-88.	
12.	Weeding : 3-30,-10-88, 25-11-88.	
13.	Spraying of Insecticides malathian @ 1 ml/1 Lit of water + Blitox @ 2 g/lit	20.10.88

1.	2.	3.
14.	Date of first observation.	3.8.88
15.	Date of final observation for survival of air layers (Rootage and with growth details)	14,15-12-88

EXPERIMENTAL FINDINGS

CHAPTER - IV

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EXPERIMENTAL FINDINGS

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This chapter deals with the findings of the present experiment, "Effect of rooting media and growth regulator on callusing, rooting and survival of air - layers of bougainvillea spp. variety-Thimma" carried-out during rainy season of the year, 1988-89 in the experimental area of the ornamental garden and Nursery of the College of Agriculture, Gwalior-2, under agro-climatic and soil conditions of Northern Madhya Pradesh. The results obtained during the course of present investigation have been presented under suitable heads.

Observation on callus formation, rooting and survival of air layers B.Thimma at interval of ten (10) days interval. Data of the subsequent observations have been exhibited graphically by figures 3 to 18. Data of the final observations of various characters were subjected to statistical analysis and the analysis of variance is presented in Appendix-I. The mean values of the different characters are presented in Appendix-II and also presented in Table 8 to 23.

ROOTING STUDIES OF AIR LAYERS :

Observations on callus formation, root initiation, number, length and diameter of primary and secondary roots were recorded 10 days after operation with 10days interval. The rate of callusing and rooting have been represented Fig. 3 to 12 and the data of final observations were analysis of variance is given in the Appendix-I.

CALLUS FORMATION :

This is the important step of the root formation process. Rooting media very important role in the development of callus cells and altimately roots. In the present experiment observation were recorded with the help of varnier callipers on the callus formation in

randomely selected three layers under each treatment at an interval of 10 days. The data of the subsequent observations were illustrated by graph figure-3. The data of the final observations were analysed statistically and the analysis of variance is given in Appendix-I. The mean extent of callus cells as affected by different treatments is presented in Table-8.

Table 8 : Mean diameter of callusing as affected by different rooting media, growth regulators, and their combinations.

Treatment	M_1	M_2	M_3	Mean
G_0	.78	.79	.81	.79
G_1	.81	.82	.84	.82
G_2	.83	.85	.89	.85
G_3	.81	.84	.87	.84
G_4	.85	.89	.94	.89
Mean	.81	.83	.87	

	S.E.(m) ±	C.D. at 5%
For Rooting media (M)	0.009	0.026
For growth Regulator (G)	0.011	0.034
For Interaction (MxG)	0.020	N.S.

Perusal of the analysis of variance (Appendix-I) indicates that different rooting media and growth

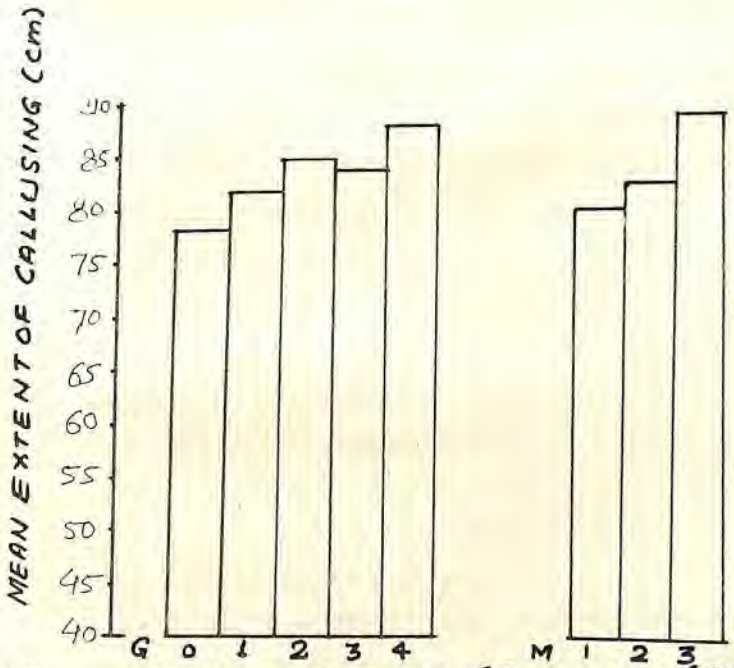


FIG. 3. MEAN EXTENT OF CALLUSING (cm) AS AFFECTED BY DIFFERENT ROOTING MEDIA AND GROWTH REGULATORS.

regulators had affected statistically the extent of callusing of air layers of bougainvillea spp. Thimma. While interaction between rooting media and growth regulator be failed to affect it statistically.

It is clearly shown from table 8 that the treatment rooting media M_3 produced maximum callusing statistically better than treatment M_2 and M_1. Treatment M_2 was ranked at second order but found statistically similar to M_1.

Extent of callusing was significantly affected due to different growth regulator and the highest callusing was noted under treatment G_4 which was found significantly superior to rest of the treatment. Treatment G_2 was ranked at second order but proved statistically similar to G_3 and G_1. While found significantly superior to G_0 (Control). Treatment G_3 was obseved at 3rd position but exhibited statistical similarities with G_1 but proved significantly superior to G_0.

Treatment combinations between rooting media and concentration of growth regulators did not show any significant effect with respect extent of callus of air layers of B. Thimma. However, highest callusing was noted in the combination G_4 M_3 and lowest in M_1 G_0.

Mean number of root primordias per air layers :

Initiation of root primordias and their number are the important characters on which the success or failure of propagation by layerings depends. In the present trial, the initiation of root primordias and their number formed were recorded at 10 days interval and have been depicted in Fig.4.

Data of final observation recorded after 50 days of operation of Bougainvillea air layerings were statistically analysed and given in the Appendix-I. Mean number of root primordias per air-layers of Bougainvillea species as affected by rooting media and growth regulator in Fig.4 and table 9.

Table-9 : Mean number of root primordias as affected by rooting media and growth regulator and their combinations.

Treatment	M_1	M_2	M_3	Mean
G_0	15.75	17.15	19.25	17.38
G_1	18.40	20.25	22.50	20.38
G_2	21.40	22.95	23.50	22.61
G_3	19.10	20.80	23.10	21.00
G_4	20.00	23.65	24.75	22.80
Mean	18.93	20.96	22.62	

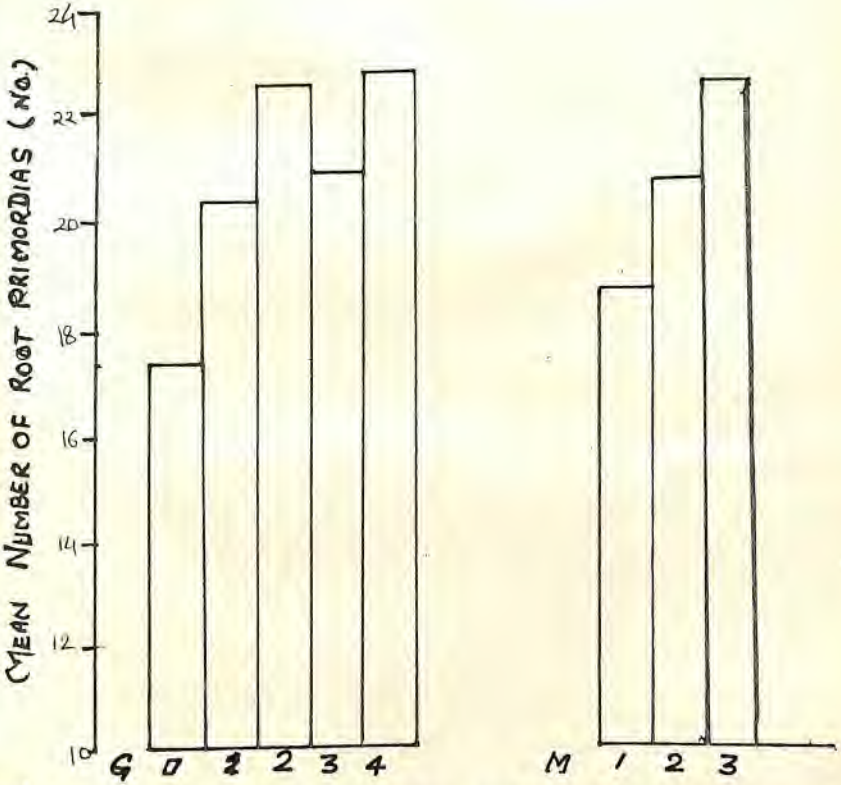
	S.E.(m) ±	C.D. at 5%
For Rootimg media (M)	0.170	0.494
For growth regulator (G)	0.220	0.638
For Interaction (MxG)	0.382	1.106

Analysis of variance presented in Appendix-I exhibits that different rooting media growth regulator & their interaction (MxG) had influenced statistically number of root primordia of air layers of B. Thimma.

Different rooting media differed statistically each other. Largest number of root primordia was noted in the treatment M_3 significantly superior to M_2 and M_1. Treatment M_2 was found at second order and also proved significantly better than M_1.

All the growth regulator treatment were found statistically better than G_0 (Control). Growth regulator treatment G_4 produced highest number of root primordia statistically similar to G_2 but both these treatments were found statistically better than G_3, G_1 and G_0(Control). Treatment G_3 was placed at second order proved statistically similar to G_1.

Among treatment combinations between different rooting media and growth regulator, treatment combinations



6.4 MEAN NUMBER OF ROOT PRIMORDIAS AS AFFECTED BY DIFFERENT ROOTING MEDIA, GROWTH REGULATORS ...

M_3 G_4 gave highest number of root primordia significantly better than rest of the combinations except M_2 G_4. Treatment M_2 G_4 stood at second order but observed statistically similar to M_3 G_2, M_3 G_3, M_2 G_2. While it was proved significantly superior to rest of the combination. Lowest number of root primordia was recorded in combination M_1 G_0.

Mean number of primary roots/air layer :

Initiation of primary roots and their number are important characters on which the success or failure of prepagation by air layering depends. In the present experiment initiation of primary roots and their number formed were recorded. Recording of primary root was started from 50 days after operation with an interval of 10 days. The data of subsequent observations have been depicted by graph figure 5.

The data recorded at 45 days i.e. at the time of detachment were statistically analysis and the analysis of variance is given in the Appendix-I. Mean number of primary roots as affected by different treatment is presented in Table 10.

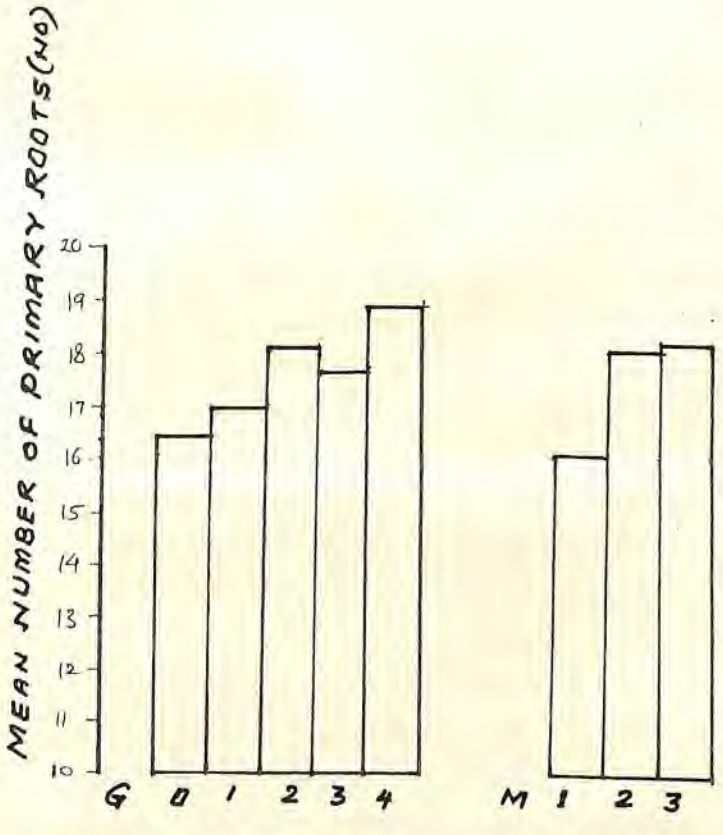
Table 10 : Mean number of primary roots (No.) as affected by rooting media, growth regulators and their combinations:

Treatment	M_1	M_2	M_3	Mean
G_0	15.01	17.00	17.11	16.37
G_1	15.83	17.28	17.44	16.85
G_2	16.92	18.55	18.71	18.06
G_3	16.47	18.23	18.28	17.66
G_4	17.01	19.92	19.73	18.88
Mean	16.24	18.19	18.25	

	S.E.(m) ±	C.D. at 5%
For Rootimg media (M)	0.074	0.215
For growth regulators(G)	0.095	0.277
For Interaction (MxG)	0.166	0.481

From the analysis of variance given in the Appendix-I it is evident that different rooting media, growth regulators and their interaction had exercised significantly effect on the number of primary roots of air layers of B.Thimma.

An examination of table indicates that different rooting media differed each other with respect to number of primary roots and the highest number of



.5 MEAN NUMBER OF PRIMARY ROOTS (NO) AS AFFECTED BY DIFFERENT ROOTING MEDIA, GROWTH REGULATORS.

primary roots and the highest number of primary root was counted in the treatment M_3 which was also proved statistically at par with M_2 and both these treatment were found significantly superior to M_1.

Number of primary roots of B. Thimma air layers was significantly affected due to different concentrations of both the growth regulator and largest number was recorded in the treatment G_4 statistically better than rest of the treatments and control (G_0) treatment G_2 stood at second position and was found significantly superior to G_3, G_1 and G_0 (Control). Treatment G_3 was placed at 3rd position and observed significantly superior to G_1 and G_0. Lowest number of primary roots was noted in G_0.

Among treatment combinations between rooting media and growth regulator combination M_2 G_4 gave maximum number of primary roots statistically better than remaining combinations. Combination M_3 G_4 ranked at second place and obtained significantly superior to rest of the treatment combinations. Combination M_3 G_2 was placed at 3rd order and proved statistically equal to M_2 G_3, M_3 G_3 and M_2 G_3 which all these for combinations were obtained statistically better than

than rest of the combinations. Lowest primary roots was counted in the combinations M_1G_0.

Mean length of primary roots per air layers (cm).

The length of primary roots is important from growth point of view and therefore, it was recorded at every 10 days interval and have been depicted in Fig.6. Date of final observation collected after 50 days of operation of Bougainvillea air layer were statistically analysed and given in the Appendix-I. The mean length of primary roots as affected by different treatments is presented in Table-11 and Fig.6.

TABLE-11

Mean length of primary roots (cm.) as affected by rooting media, growth regulators and their combinations.

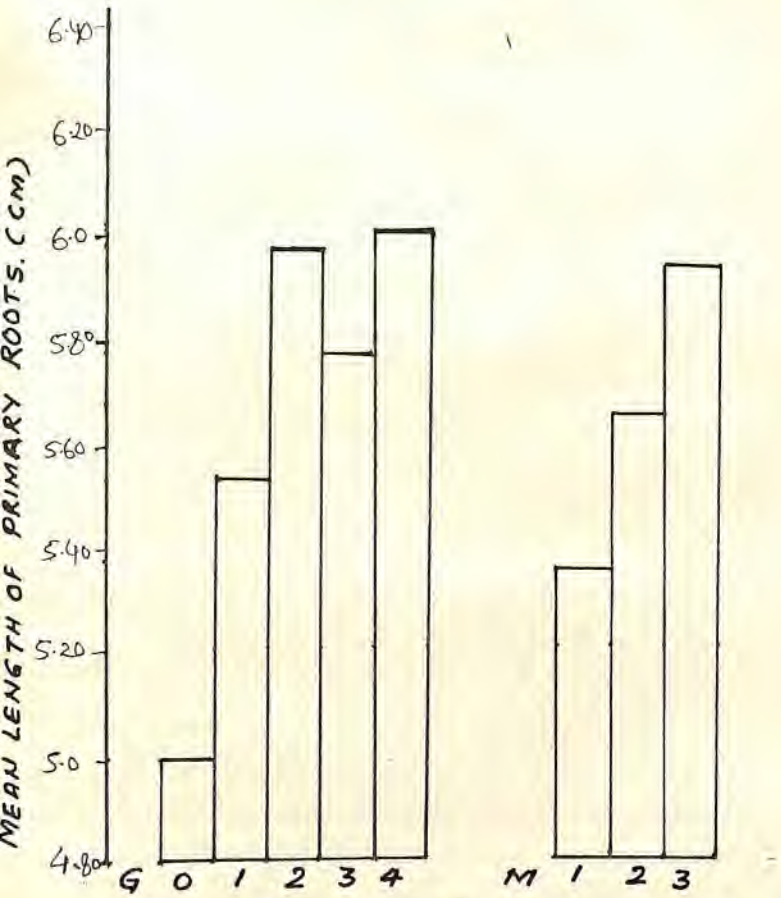
Treatment	M_1	M_2	M_3	Mean
G_0	4.85	5.00	5.20	5.01
G_1	5.22	5.62	5.80	5.54
G_2	5.65	5.95	6.34	5.98
G_3	5.50	5.73	6.12	5.78
G_4	5.70	6.10	6.33	6.04
Mean	5.38	5.68	5.95	

	S.E.(m) ±	C.D. at 5%
For Rooting media(M)	0.017	0.049
For growth regulators (G)	0.022	0.064
For Interaction (MxG)	0.038	0.111

Analysis of variance given in the appendix-I clearly indicates that rooting media, growth regulator and their interaction between (MxG) had influanced statistically the length of primary roots of air layers of B.Thimma.

All the rooting media treatments differed statistically each other and the longest length of primary roots is recorded in the treatment M_3 statistically better than M_2 and M_1. Treatment M_2 occupied second position and proved significantly better than M_1.

All the concentrations of both the growth regulators had influanced length of primary roots significantly superior to G_o (control). Longest primary roots was recorded in the treatment G_4 statistically better than remaining treatment except G_2. Treatment G_2 was observed at second place and found significantly superior to treatment $G_3$and G_1 treatment G_3 Ranked at 3rd position but also found better than G_1.



MEAN LENGTH OF PRIMARY ROOTS (cm) AS AFFECTED BY DIFFERENT ROOTING MEDIA AND GROWTH REGULATORS.

Treatment combinations between different rooting media and growth regulators had shown significant increase the length of primary roots and the combination M_3G_2 developed longest primary roots statistically similar to M_3G_4 and proved significantly superior to remaining combination treatment combination M_3G_3 was ranked at 3rd position and observed statistically similar to M_2G_4 while both these were found significantly superior lowest length of primary roots to were recorded in the combination M_1G_0 and rest of the combinations were intermediate in nature.

Mean diameter of primary roots per air layers.

Diameter of primary root is also an important factors for successful propagation by airlayering besides it's length and number. Hence observations were recorded on the usual observation days and are depicted by diagram-7. The data recorded during final observation had been analysed statistically and mean diameter of primary roots per airlayer as affected by different treatment is shown in the table-12.

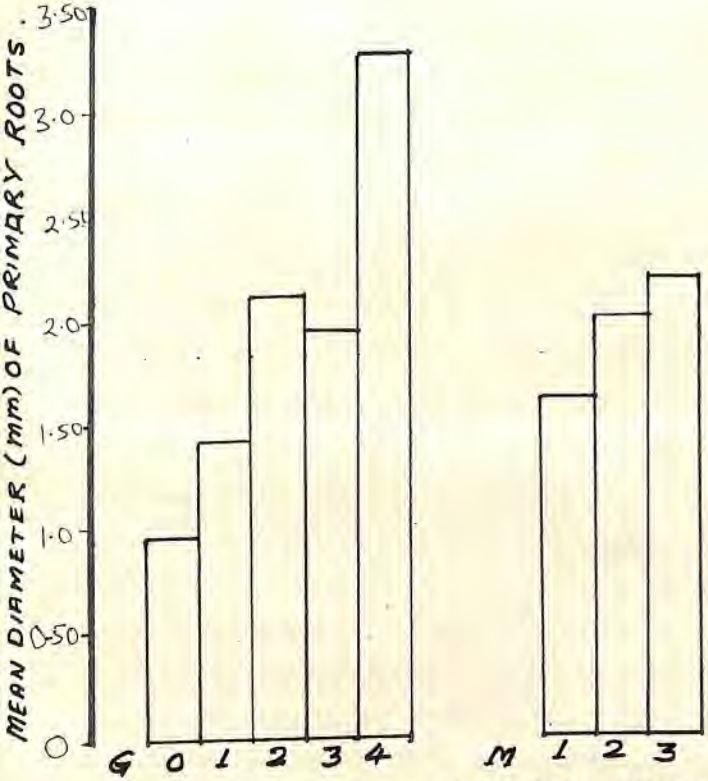
TABLE-12 Mean diameter (mm) of primary roots per airlayer as affected by different rooting media, growth regulators and their combination.

Treatment	M_1	M_2	M_3	Mean
G_o	0.79	0.99	1.03	0.93
G_1	1.16	1.39	1.79	1.44
G_2	1.74	2.24	2.38	2.12
G_3	1.80	1.98	2.18	1.98
G_4	2.71	3.45	3.67	3.28
Mean	1.64	2.01	2.21	

	S.E.(m) ±	C.D. at 5%
For Rooting media(M)	0.012	0.037
For Growth regulators(G)	0.016	0.047
For Interaction (MxG)	0.028	0.082

Perusal of analysis of variance (Appendix-I) clearly shows that different rooting media concentrations of growth regulators and their combinations had produced significant effect on the diameter of primary roots of air layers B.Thimma.

It is observed from Table-12 that all the three rooting media differed significantly and treatment M_3 gave thickest primary roots per air layer statistically higher than other rooting media, while rooting media M_2



MEAN DIAMITER (mm) OF PRIMARY ROOTS AS AFFECTED BY DIFFERENT ROOTING MEDIA AND GROWTH REGULATORS.

was ranked at second place, also proved significantly superior to M_1.

All the concentrations of growth regulator significantly differed each other. Treatment G_4 produced thickest diameter of primary roots significantly superior to rest of the treatments. Treatment G_2 was reduced at second position and also proved statistically superior to G_3, G_1 and G_o. Treatment G_o(control) was found significantly inferior to all the concentration as tried in the experiment.

When different rooting media and concentration of growth regulator were combined a significant effect was noted among treatment combinations between M x G. Treatment combination M_3G_4 gave maximum diameter of primary roots. Significantly better than rest of treatment combinations. Treatment combination M_2G_4 stood at second order and was found statistically superior to rest of the combinations. Lowest diameter of primary roots recorded in the combination M_1G_o. While rest of the combination occupied intermediate position.

Mean number of secondary roots per air layers.

The formation of secondary roots is also an important factor for successful establishment of a plant it was recorded at 10 days interval and data of the subsequent observations are represented by graph in Fig.8, whilethe data of last observations were statistically analysed and represented in Appendix-I. Mean number of secondary roots as affected by different rooting media, growth regulators and their combinations is presented in the Table-13.

TABLE-13 Mean number of secondary roots (No.) as affected by different rooting media, and growth regulators and their combinations.

Treatment	M_1	M_2	M_3	Mean
G_o	8.13	11.80	14.18	11.37
G_1	14.13	20.13	21.39	18.55
G_2	16.80	23.81	19.60	20.07
G_3	20.46	23.53	25.43	23.14
G_4	18.13	25.83	26.54	23.50
Mean	15.53	21.02	21.43	

	S.E. (m) ±	C.D. at 5%
For rooting media (M)	0.142	0.411
For growth regulators (G)	0.183	0.530
For Interaction (M x G)	0.317	0.919

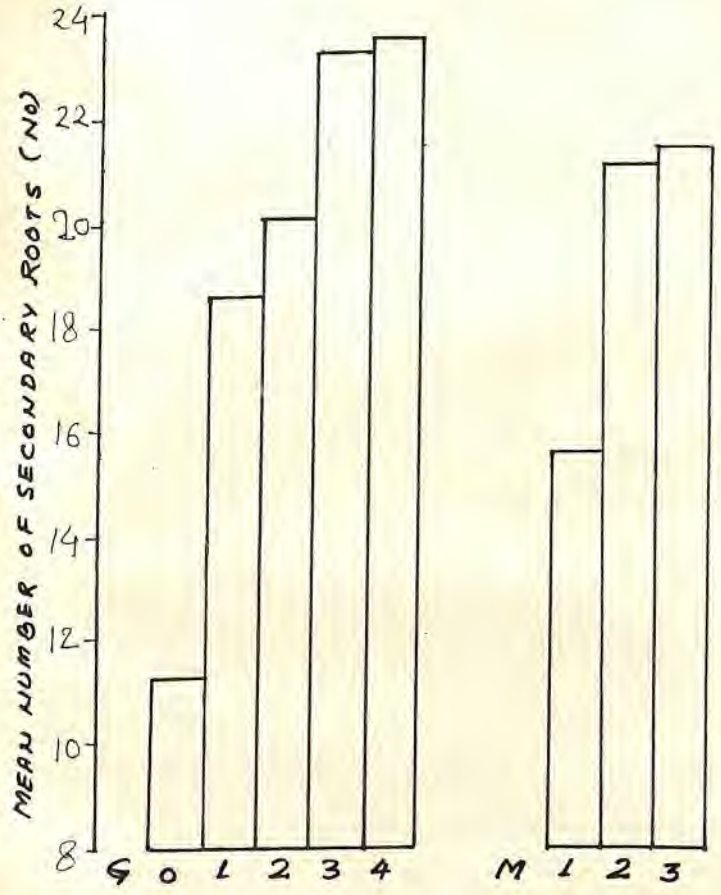


FIG.8. MEAN NUMBER OF SECONDARY ROOTS (NO) AS AFFECTED BY DIFFERENT ROOTING MEDIA AND GROWTH REGULATORS.

A close examination of appendix-I exhibits that different rooting media, concentrations of growth regulators and their interation between M x G had exercised significant effect on the No. of secondary roots.

It is clear from above table-13 that treatment M_3 produced highest No. of secondary roots followed by statistically similar treatment M_2 where as both the treatment proved statistically better than M_1.

All the concentrations of growth regulators were found significantly superior over control. Treatment G_4 produced higher No. of secondary roots statistically similar to G_3, while both these treatments (G_4 and G_3) were proved significantly superior to G_2, G_1 and G_o. Treatment G_2 was observed to occupie IIIrd position and found statistically better than G_1 and G_o.

Combination M_3G_4 produced largest number of secondary roots which was also found statistically equal to M_2G_4 but proved significantly superior to rest of the combinations. Combination M_2G_4 and M_3G_3 occupied 2nd and 3rd position and were observed significantly superior to remaining treatments combinations. Lowest number of secondary root was noted in combination M_1G_o while rest of combination stood in intermediate range.

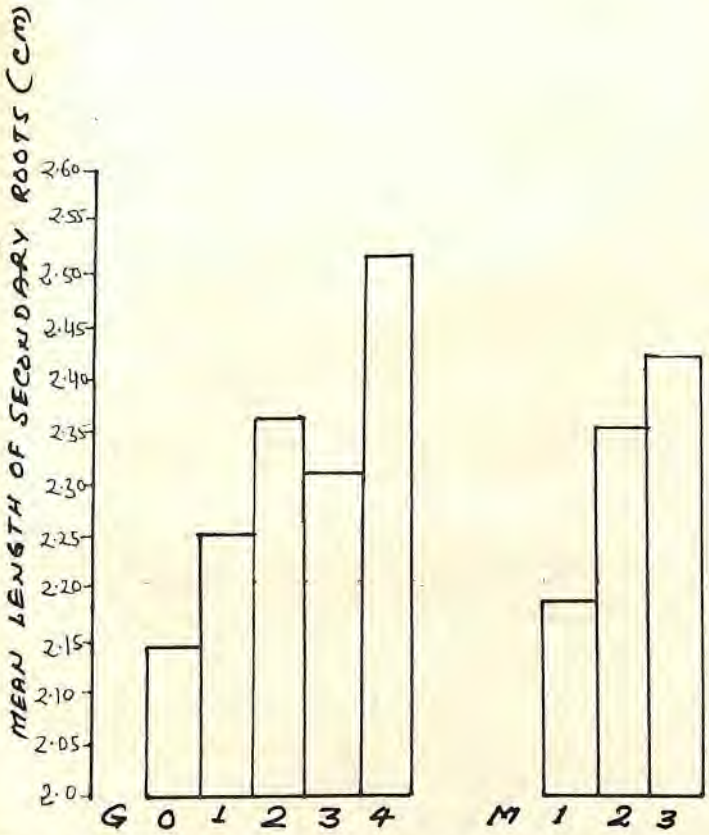


FIG. 9 MEAN LENGTH OF SECONDARY ROOTS (CM) AS AFFECTED BY DIFFERENT ROOTING MEDIA AND GROWTH REGULATORS.

Mean length of secondary roots per air layers (cm).

Evarage length of secondary roots is also an important factor, therefore data regarding it, were recorded subsequently at an interval of 10 days, which are dipicted in figure.9. Final data recorded at the time of detachment of airlayer were analysed statistically as shown in appendix-I. Mean length of secondary roots as affected by different treatments is presented in Table-14.

TABLE-14 Mean length of secondary roots (cm) as affected by different rooting media, growth regulators and their combinations.

Treatment	M_1	M_2	M_3	Mean
G_o	2.00	2.20	2.22	2.14
G_1	2.11	2.28	2.36	2.25
G_2	2.28	2.35	2.45	2.36
G_3	2.21	2.32	2.37	2.30
G_4	2.30	2.61	2.61	2.51
Mean	2.18	2.35	2.41	

	S.E.(m) ±	C.D. at 5%
For rooting media (M)	0.033	0.097
For growth regulator (G)	0.043	0.126
For interaction (M x G)	0.075	N.S.

Examine of the analysis of the variance given in the appendix-I clearly indicated the rooting media and growth regulator had significantly influanced length of secondary roots, while interaction of rooting media and growth regulator (M x G) was not found significantly on length of secondary roots.

Rooting media M_3 produced maximum length of secondary roots. But rooting media M_2 was observed statistically similar to M_3 both the rooting media found were statistically better than M_1 (control) and gave minimum length of secondary roots.

Treatment growth regulators G_4 produced largest length of secondary roots was found significantly superior to rest of the treatments,growth regulator G_2 ranked at second place and is observed statistically similar to G_3 and G_1. Growth regulator G_o produced minimum length of secondary roots and inferior to rest of the treatment.

Interaction of rooting media and growth regulator had not affected significantly length of secondary roots. However, longest length was recorded in combination M_4G_3 and minimum length in M_1G_o. Rest of the combinations are in intermediate in nature.

Mean diameter of secondary roots per air layers (mm).

Besides the number of and length of secondary roots, the girth of secondary roots is also of great importance, therefore, the data on this aspect were recorded at 10 days interval and presented graphically in Fig.10. The data of the last observations i.e.after 140 days after planting of Bougainvillea Thimma air-layers were statistically analysed and given in Appendix-I. The mean diameter of secondary roots as affected by different treatments is presented in the Table-15.

TABLE-15 Mean diameter of secondary roots as affected by different rooting media and growth regulators and their combination.

Treatment	M_1	M_2	M_3	Mean
G_o	0.34	0.49	0.52	0.45
G_1	0.71	0.78	0.73	0.74
G_2	1.45	1.61	1.74	1.60
G_3	0.50	0.89	1.28	0.89
G_4	1.40	1.88	1.93	1.73
Mean	.88	1.13	1.24	

	SE (m) ±	C.D.at 5%
For rooting media (M)	0.015	0.043
For growth regulator (G)	0.019	0.056
For interaction (M x G)	0.033	0.098

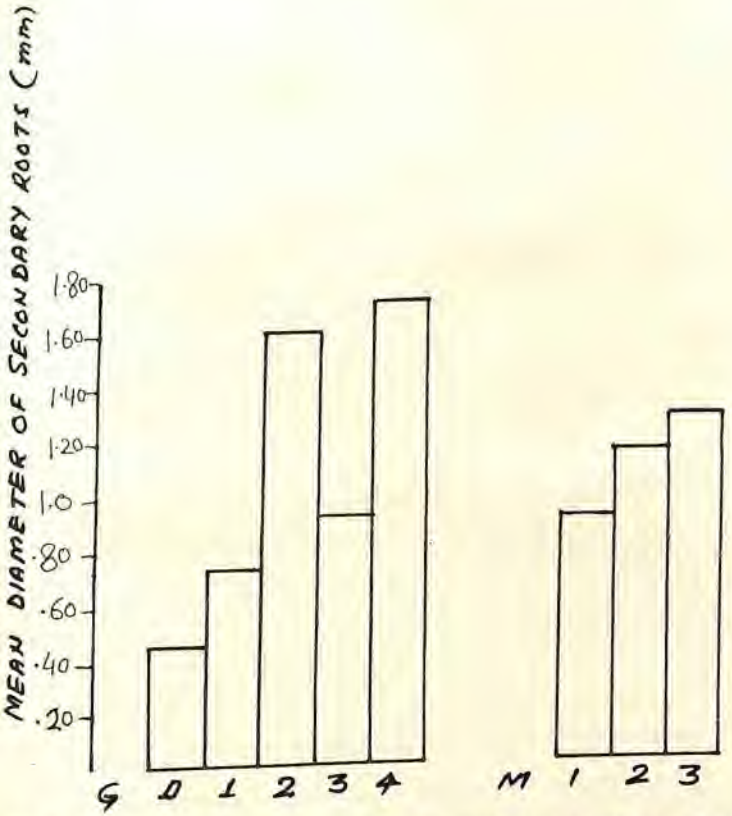


FIG.10 MEAN DIAMETER OF SECONDARY ROOTS (mm) AS AFFECTED BY DIFFERENT ROOTING MEDIA AND GROWTH REGULATORS.

Study of the analysis of variance (Appendix-I) indicate that different rooting media, concentration of growth regulator and interaction M x G had influanced statistically the diameter of secondary roots.

All the rooting media differed significantly each other and the highest diameter of secondary roots was measured in the treatment M_3 significantly better than M_2 and M_1. Treatment M_2 was also observed similarly better than M_1.

All the concentrations of both the growth regulators were proved statistically superior to treatment G_o (control). Treatment G_4 gave maximum diameter significantly superior to G_2, G_3 and G_1 treatment G_2 was observed at second order and proved significantly superior G_3 and G_1.

It is evident from the table-15 that treatment combination between rooting media and growth regulators (M x G) had produced significant effect with respect to diamter of secondary roots and the interaction M_3G_4 gave largest diameter of secondary roots statistically similar to M_2G_4. While both these combination were found significantly better to rest of the combination

other better combinations were M_3G_2, M_2G_2, M_1G_2, M_1G_4 and M_3G_3 lowest diameter was noted in the treatment combination M_1G_o.

Success in rooting of airlayers(%).

Commercial adoptation of any propagation practice responds upon the success with the techniques used in the present experiment. The success was recoded on the basis of airlayers recorded under each treatment at the time of operation. Data for the success in rooting airlayers have been recorded at 50 days after operation and are presented by Fig.11.

Data recorded at 50 days after operation were statistically analysed and the analysis of variance is presented in Appendix-I. The mean success of rooting percentage as affected by different treatment is presented in Table-16 and Fig.11.

TABLE-16 Mean rooting percentage(%) as affected by different rooting media, growth regulators and their combinations.

Treatment	M_1	M_2	M_3	Mean
G_o	41.57	57.96	59.29	52.94
G_1	48.00	73.80	85.26	69.02
G_2	58.90	83.54	92.04	78.16
G_3	55.88	79.90	90.99	75.59
G_4	61.50	88.05	94.50	81.35
Mean	53.15	76.65	84.42	

	S.E.(m)±	C.D.at 5%
For rooting media (M)	1.144	3.313
For growth regulator (G)	1.477	4.277
For interaction (M x G)	2.558	7.408

From the analysis of variance (Appendix-I) is observed that different rooting media, concentration of growth regulator and interaction produced significant effect on the rooting percentage of air layers of Bougainvillea species variety Thimma.

All the rooting media treatment differed statistically each other and the treatment M_3 produced maximum rooting percent as statistically better than M_2 and M_1. Treatment M_2 was also found to have higher

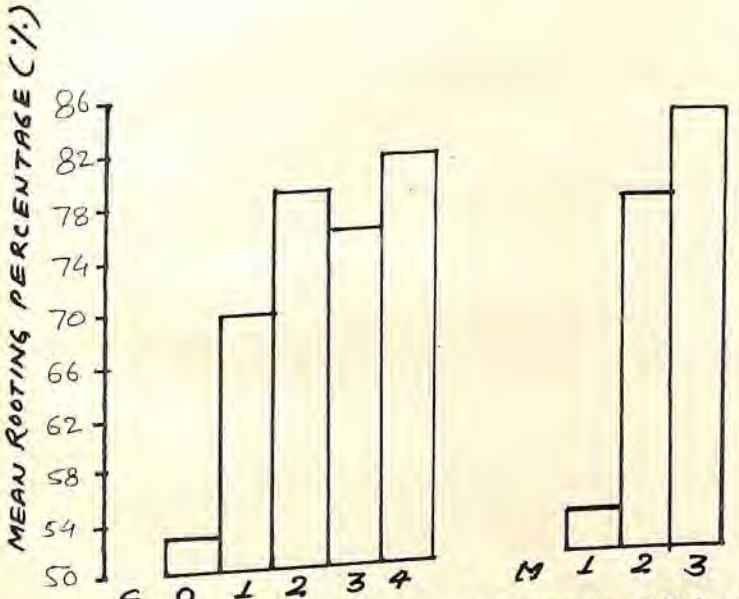


FIG. 11 MEAN ROOTING PERCENTAGE (%) AS AFFECTED BY DIFFERENT ROOTING MEDIA AND GROWTH REGULATORS.

rooting percent significantly better than M_1.

All the concentrations of growth regulators had affected rooting percentage statistically better than G_o (control) and the highest rooting percent was recorded in the treatment G_4 significantly better than G_2, G_3, G_1. Treatment G_2 ranked at second position statistically similar to G_3 and both these treatment were found significantly better than G_1.

Among the treatment combination highest rooting percentage was recorded in M_3G_4 statistically at par with M_3G_2, M_3G_3 and M_2G_4 but it was found significantly superior to rest of the combinations. Lowest rooting percentage was recorded in treatment combination M_1G_o. It is significantly similar to M_1G_1 and other combinations were intermediate in nature.

Mean fresh weight of roots per airlayers (gm):

Fresh weight of the (pri+Sec) roots as well as shoots is very much correlated with the growth and development of roots. In fact it is the indication of growth and therefore, fresh weight of any plant organ, is taken as a measure of the growth of that organ. With this object fresh weight of roots was studied. The data of the last observations are presented in Fig.12.

The data of last observation were also analysed statistically and the analysis of variance is given in Appendix-I. Mean fresh weight of roots as affected by different treatments are presented in Table-17.

TABLE-17 Mean fresh weight of roots (gm) of air layers of B. Thimma as affected by different rooting media, growth regulators and their combinations

Treatment	M_1	M_2	M_3	Mean
G_o	0.83	0.92	0.98	0.91
G_1	0.98	1.13	1.20	1.10
G_2	1.40	1.81	1.78	1.66
G_3	1.17	1.75	1.85	1.59
G_4	1.58	2.30	2.43	2.10
Mean	1.19	1.58	1.65	

	S.E.(m) ±	C.D.at 5%
For Rooting media (M)	0.030	0.088
For growth regulator (G)	0.039	0.114
For interaction (M x G)	0.068	0.198

Perusal of the analysis of variance (Appendix-I) indicates that the different rooting media, growth regulators and interaction had affected fresh weight of roots significantly.

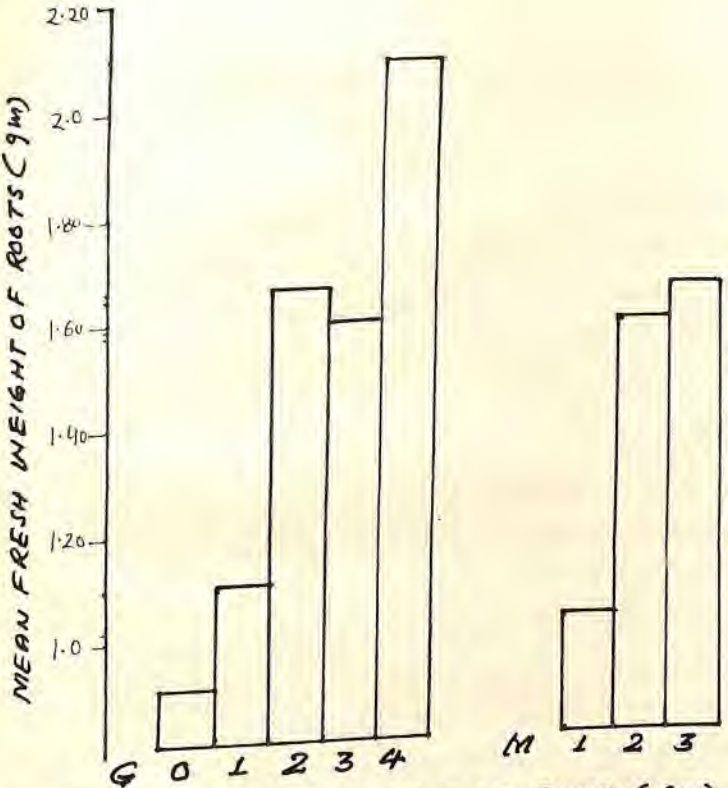


FIG. 12. MEAN FRESH WEIGHT OF ROOTS (gm) AS AFFECTED BY DIFFERENT ROOTING MEDIA AND GROWTH REGULATORS.

In case of rooting media M_3 had given more fresh weight of roots in comparison to M_2. Both found statistically similar and statistically better than M_1.

It is obvious from the above table-17 that growth regulator treatment G_4 produced maximum fresh weight of roots significantly better than rest of treatment. Treatment G_2 was ranked at second place and found statistically similar to G_3, while both these statements were observed statistically better than G_1 and G_o (control). Minimum fresh weight of roots was recorded in G_o (control).

In case of treatment combinations between all the rooting media and concentrations of growth regulators M_3G_4 produced maximum fresh weight of roots statistically similar to M_2G_4. While both these combinations were proved better than remaining combinations. While minimum fresh weight of roots was found in M_1G_o statistically similar to M_2G_o, M_3G_o, M_1G_1. Other combinations were intermediate in nature.

Mean height per plant (cm) of air layers of B.Thimma.

The observation of height of B.Thimma were recorded after transplanting at an interval of 10 days. The final observation under each treatment has been

exhibited by bar diagram in Fig. 13. Data of final (last)observation were analysed statistically and the analysis of variance is given in Appendix-I. Mean height of plant as affected by different treatments is presented in the Table-18.

TABLE-18 *Mean height per plant(cm) of air layers of B. Thimma as affected by different rooting media, growth regulators and their combinations.*

Treatment	M_1	M_2	M_3	Mean
G_o	27.41	28.91	32.82	29.71
G_1	32.81	34.62	35.12	34.18
G_2	37.80	38.90	41.41	39.37
G_3	33.10	34.81	36.20	34.70
G_4	38.28	39.40	42.18	40.16
Mean	33.88	35.32	37.67	

	S.E.(m) ±	C.D.at 5%
For rooting media (M)	0.448	1.297
For growth regulator (G)	0.579	1.678
For interaction (M x G)	1.003	2.906

It is evident from analysis of variance (appendix-I) that different rooting media, growth regulators and their combination between (MxG) affected statistically the height of air layers of B. Thimma.

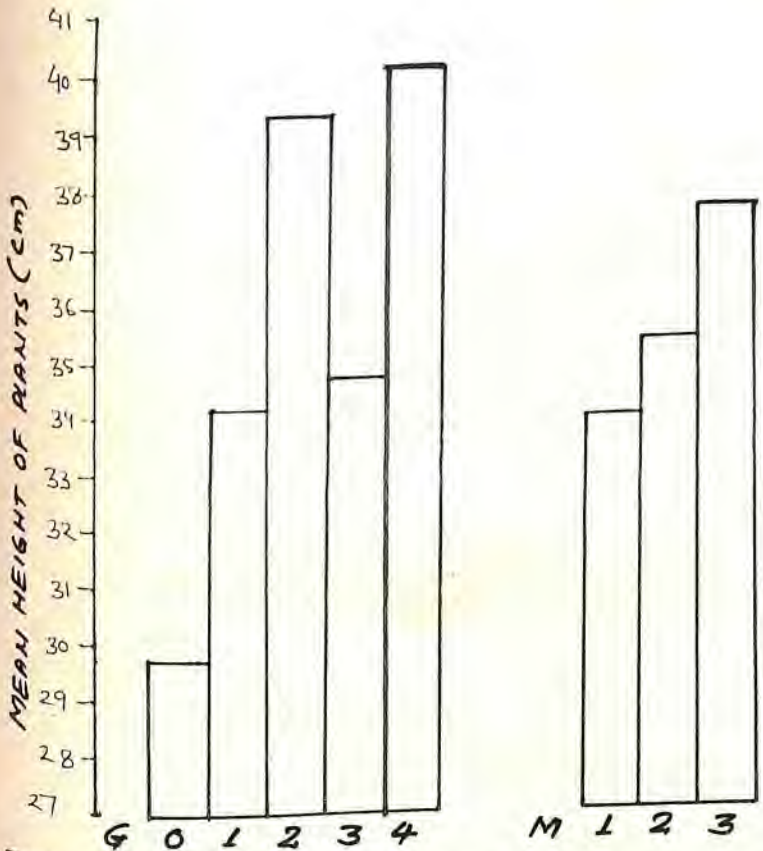


FIG. 13. MEAN HEIGHT OF PLANTS (cm) AS AFFECTED BY DIFFERENT ROOTING MEDIA AND GROWTH REGULATORS.

It is clear from table-18 that the treatment rooting media M_3 produced maximum height of the plant significantly superior to M_2 and M_1, M_2 was also observed significantly superior to M_1.

All the growth regulator treatment induced higher height significantly better than treatment G_o, maximum height was recorded in treatment G_4 which was found statistically similar to G_2 were found both the treatment was proved statistically better to G_3 and G_1. Treatment G_3(NAA 7,500) and G_1 were observed statistically similar.

Among the treatment combinations between M x G different rooting media and growth regulator height of the plant maximum in combination M_3G_4 develop after detechment of air layers. Similar to M_3G_2 and M_2G_4 while it was proved significantly better to rest of combination. Other better combination were M_2G_2, M_1G_4, M_1G_2 , M_3G_3 , M_3G_1 , M_2G_3 , M_2G_1, M_1G_3 , M_3G_o and M_1G_1, lowest height was majored in the combination M_1G_o closely followed by M_2G_o.

Mean number of shoots or branches-

Observations on the number of branches per air layers were recorded at 10 days intervals.

The data of final observation were statistically analysed and the analysis of variance is given in Appendix-II. Number of branches per air layers were observed after transplanting and the data have been depicted by graph in Fig.14. Mean number of branches per air layers of B.Thimma as affected by different treatment is presented in Table-19.

TABLE-19- Mean number of branches per air layers of B. Thimma as affected by different rooting media, concentration of growth regulators and their combinations.

Treatment	M_1	M_2	M_3	Mean
G_o	4.24	5.00	5.28	4.84
G_1	5.50	5.92	5.78	5.73
G_2	7.15	7.40	7.52	7.36
G_3	6.00	6.06	6.26	6.10
G_4	7.06	7.53	7.74	7.44
Mean	5.99	6.38	6.51	

	S.E.(m) ±	C.D.at 5%
For rooting media (M)	0.040	0.117
For growth regulator (G)	0.052	0.151
For interaction (M x G)	0.090	0.262

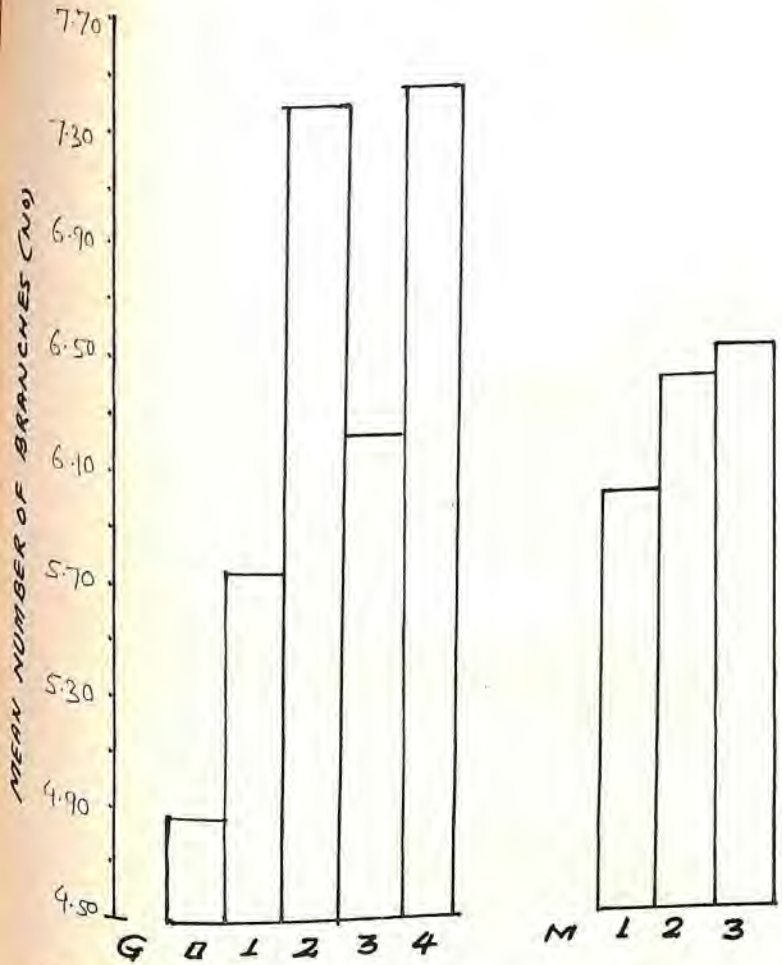


FIG. 14 MEAN NUMBER OF BRANCHES (NO) AS AFFECTED BY DIFFERENT ROOTING MEDIA AND GROWTH REGULATORS

Study of analysis of variance (Appendix-I) clearly shows that different rooting media, growth regulators concentration and interaction between media and growth regulators concentration treatment had produced significant effect on the number of branches developed from air layers of B.Thimma planted after detachment.

It is observed from table-19 that all the three rooting media differed significantly and the treatment M_3 gave highest number of branches per air layer statistically higher than other rooting media. While rooting media M_2 was placed at second position but also proved significantly better than M_1.

Different concentrations of growth regulators produced significantly better than treatment G_o(control). Treatment G_4 produced higher number of branches per air layers . Which was found statistically better than rest of the treatments. G_4 and G_2 were found statistically higher than rest of the concentrations. Treatment G_3 was reduced at 3rd position and also proved statistically superior to G_1.

When different rooting media and grwoth regulator were combined a significant increase was noted among

treatment combinations between M x G. Treatment combination M_3G_4 produced maximum number of branches statistically similar to M_2G_4 and M_3G_2, and M_1G_o gave minimum number of branches. Among all the combination M_3G_4 promoted number of branches to a greater extent statistically higher than rest of the combinations except M_2G_4 but observed significantly superior to rest of the combinations.

Mean length of branches per air layer (cm):

Length of branches is an important character of vegetative phase. It is directly related with the performance of plants. The length of shoots was recorded at 10 days interval and the data recorded at successive stage of growth are presented by graph in Fig.15. Finally length of branches was measured in last observation. The data of last observation were analysed statistically and the analysis of variance is given in Appendix-I. Mean length of branches (shoots) per air layers as affected by different treatments is presented in table-20.

Perusal of analysis of variance in the Appendix-I clearly shows that all the rooting media, concentration of growth regulators and their combinations between rooting media and growth regulator treatment had produced significant effect on the length of branches developed

from air layers B. Thimma planted after detachment.

TABLE-20: Mean length of branches (cm) of air layers of B. Thimma as affected by different rooting media, growth regulators and their combinations.

Treatment	M_1	M_2	M_3	Mean
G_o	19.45	19.47	19.83	19.58
G_1	19.86	20.55	21.95	20.78
G_2	23.94	24.82	25.54	24.76
G_3	18.80	20.85	23.10	20.91
G_4	25.22	25.90	26.40	25.84
Mean	21.45	22.32	23.36	

	S.E.(m) ±	C.D.at 5%
For rooting media (M)	0.189	0.549
For growth regulators (G)	0.244	0.709
For interaction (M x G)	0.424	1.228

It is observed from table-20 that all the three rooting media differ significantly and treatment M_3 gave maximum length of branches per air layer statistically higher than other rooting media. While rooting media M_2 was ranked at second place but also proved significantly better than M_1.

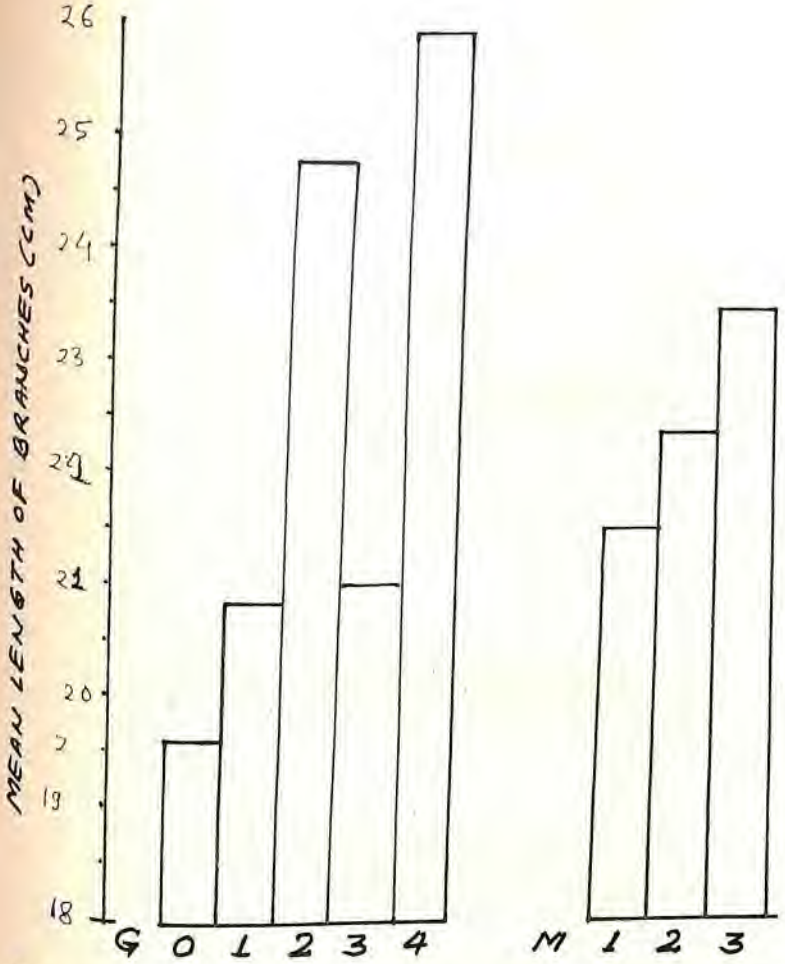


FIG.15 MEAN LENGTH OF BRANCHES (cm) AS AFFECTED BY DIFFERENT ROOTING MEDIA AND GROWTH REGULATORS.

Different concentrations of growth regulators produced significantly different among the length of branches treatment G_4 produced more length of branches found significantly better than rest of the treatment. Treatment G_2 ranked at second place found significantly superior than $G_3 G_1$ and G_o treatment. G_3 produced significantly superior to G_o but similar to G_1. Treatment G_o (control) was found significantly inferior to all the concentration and gave smallest shoots or branches as tried in the experiment.

While comparing treatment combination between concentrations of growth regulators and rooting media M_3 , maximum length of branches was recorded in the combination M_3G_4 which was statistically at par to M_3G_2 but significantly superior to rest of the treatment combinations. Combination M_3G_3 at par with M_3G_1 and superior over control(M_3G_o). M_3G_o was found statistically inferior to rest of the combinations.

In case of concentration of growth regulators and rooting media M_2, treatment combination M_2G_4 produced longest branches significantly similar to M_2G_2 and statistically superior to rest of the combinations. Treatment combination M_2G_3 and M_2G_1 observed statistically at par and combination, M_2G_1 and M_2G_o found statistically similar.

Under combination between concentration of growth regulators and rooting media M_1, maximum length of branches was observed in the combination M_1G_4 statistically superior to rest of the combinations, treatment M_1G_2 ranked at second position and superior to rest of the combinations. Minimum length of branches noted in combination M_1G_3.

Among the treatment combination between rooting media and growth regulators M_3G_4 produced longest branches similarly M_2G_4 and M_3G_2 but significantly superior to rest of the combination between growth regulator and rooting media. Treatment combination M_3G_2 were placed and M_2G_2 were placed second and third position respectively. Minimum length of branches was noted in the combination M_1G_3. When all the rooting media were used with and without growth regulators indicating a tend of increase in the length when all growth regulators were combined with all the three rooting media.

Mean number of leaves per air layers:

Number of leaves is an important character of vegetative phase. It is directly related with performance of plants. With this object number of leaves were studied. Mean number of leaves was recorded at 10 days interval

and the data recorded at successive stages of growth are represented by graph in Fig.16.

TABLE-21: Mean number of leaves as affected by different rooting media growth regulators and their combinations.

Treatment	M_1	M_2	M_3	Mean
G_0	43.00	45.40	48.40	45.50
G_1	47.90	53.32	57.00	52.74
G_2	59.03	69.63	73.00	67.22
G_3	55.00	64.61	68.65	62.75
G_4	60.40	75.60	77.40	71.13
Mean	53.06	61.71	64.89	

	S.E.(m) ±	C.D.at 5%
For rooting media (M)	0.820	2.375
For growth regulators (G)	1.059	3.066
For Interaction (M x G)	1.834	N.S.

Analysis of variance presented in Appendix-I indicates that different rooting media, concentrations of growth regulators had affected the number of leaves per air layers and interaction between rooting media and concentration of growth regulators had not affected the number of leaves per air layers of B. Thimma.

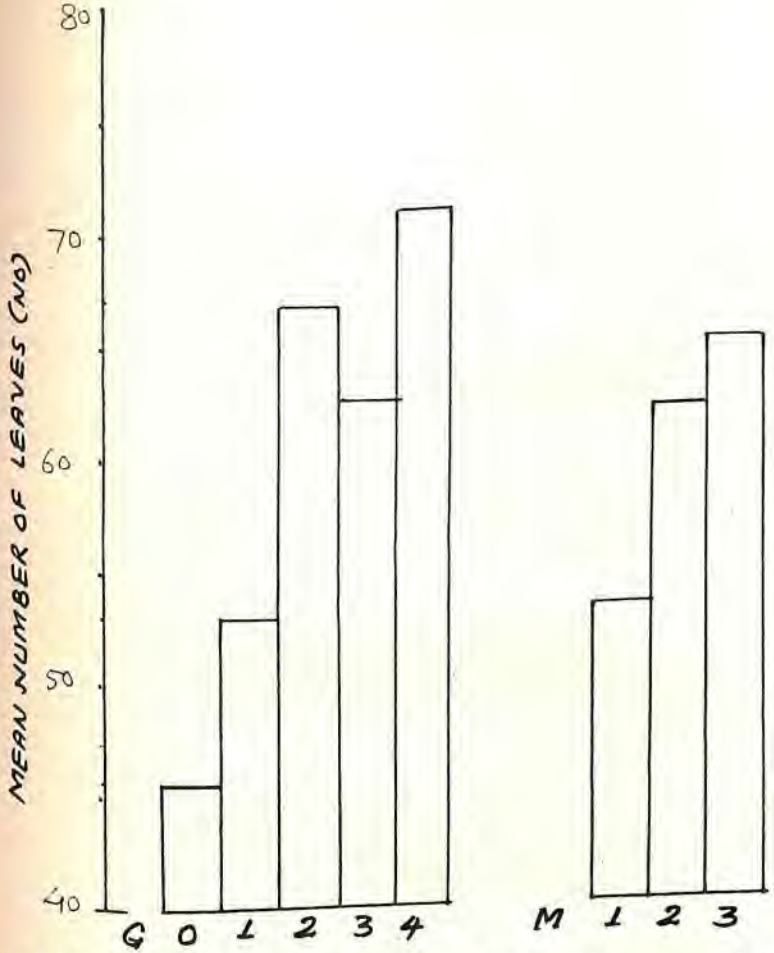


FIG.16 MEAN NUMBER OF LEAVES (NO) AS AFFECTED BY DIFFERENT ROOTING MEDIA AND GROWTH REGULATORS.

All the three rooting media used in the trial exhibited significant differences among themselves with regard number of leaves per air layers and treatment M_3 developed higher number of leaves significantly superior to M_2 and M_1, while M_2 was placed second position and observed statistically better than M_1.

All the growth regulators concentration used found significantly superior to G_o(control). Treatment G_4 was found having higher number of leaves significantly superior to rest of the combinations. Treatment G_2 was found at second placed and found statistically better than G_3 and G_1. Treatment G_3 occupied third position which was observed statistically superior to G_1.

Treatment combination between rooting media and concentration of growth regulator showed not any significant difference but maximum number of leaves were found in combination M_3G_4, while minimum under the treatment combination M_1G_o.

Mean survival percentage of B. air layers(%):

The observation on survival percentage of B. Thimma were recorded upto 100 days after planting of air layers at 10 days intervals and there after the number of layers survived under each treatment were noted

out of twenty air layers planted and then per cent survival was calculated for each treatment. The final survival percentage under each treatment has been exhibited by bar diagram in Fig. 17. Data of final survival percentage were analysed statistically and the analysis of variance is given in Appendix-I. Mean survival percentage under each treatment of B.Thimma air layer as affected by different treatments is also presented in Table-22.

TABLE-22: Mean survival percentage as affected by different rooting media, growth regulators and their combinations.

Treatment	M_1	M_2	M_3	Mean
G_o	20.00	53.45	59.30	44.25
G_1	24.40	61.80	65.39	50.53
G_2	33.19	72.53	85.29	63.67
G_3	28.80	68.77	80.03	59.20
G_4	35.66	76.00	87.33	66.33
Mean	28.41	66.51	75.47	

	S.E.(m) ±	C.D.at 5%
For rooting media (M)	0.807	2.339
For growth regulator(G)	1.042	3.019
For interaction (MxG)	1.806	5.229

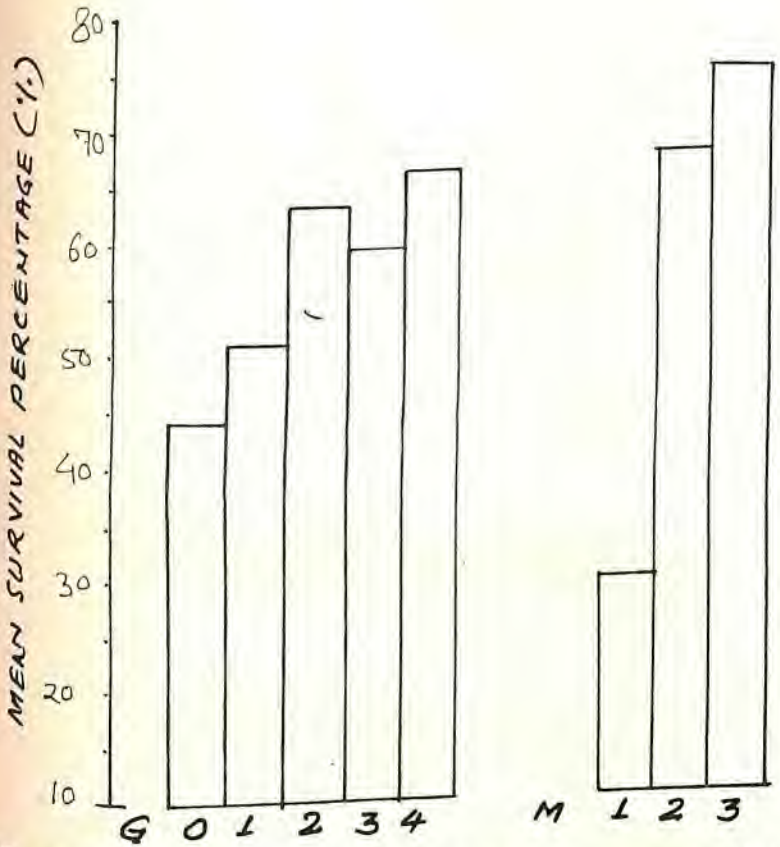


FIG.17 MEAN SURVIVAL PERCENTAGE (%) AS AFFECTED BY DIFFERENT ROOTING MEDIA AND GROWTH REGULATORS.

From the analysis of variance presented in Appendix-I, it is observed that different concentrations of growth regulators had affected significantly the mean survival percentage of B.Thimma air layers. On the other hand different rooting media, concentration of growth regulators and their interaction between M x G had statistically higher influence the survival percentage of air layer of B. Thimma.

Rooting media M_3 produced significantly higher percentage of survival of air layers as compared to M_2 and M_1. Treatment M_2 was also proved statistically superior to M_1. Minimum survival percent was found under rooting media M_1.

Among the different concentration of growth regulators, treatment G_4 gave the highest survival percentage of air layers of B. Thimma which was found statistically similar to G_2 but proved significantly superior to rest of the treatments. Treatment G_3 was placed at second order also found statistically superior to G_1. While treatment G_o(control) was found statistically inferior to all the treatment of concentrations of growth regulators.

Among the treatment combinations between rooting

media and growth regulators concentrations, (M x G), maximum survival of plants was noted in treatment combination M_3G_4 which was found statistically at par with M_3G_2. While it was proved significantly better than all remaining treatment combinations. Minimum survival percentage was noted in M_1G_o and other treatment combinations intermediate in nature.

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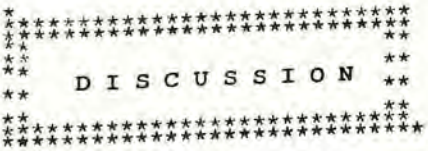
DISCUSSION

C H A P T E R - V

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D I S C U S S I O N

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In this chapter on attempt has been made to elucidate the possible reasons of variability obtained due to treatment differences in the present trial. On the basis of the findings descrived in the preceding chapter the results have been discussed herewith critically in the following lines in the light of literature pertaining to the findings of eminent scientist for the different character and are presented under suitable heads.

Effect of rooting media on callusing, rooting and survival of air layers of B.Thimma :

In this investigation three rooting media viz. 1. Soil 2. Soil + Leaf mould 3. Soil + FYM were selected for study in connection with their role in callusing, rooting per cent and survival of air layer of B.Thimma. While going through the preceding chapter it was observed that maximum extent of callusing, largest number of root primordias, longest length of primary roots, thickest primary roots, thickest secondary roots, maximum rooting per cent, tallest plants, higher number of branches and number of leaves, longest branches, maximum survival percentage of air layers of B.Thimma were recorded statistically higher due to rooting media M_3 (Soil + FYM) to rest of the treatments.

Other characters like higher number of primary and secondary roots, longest secondary roots, highest fresh weight of roots were also observed in the treatment rooting media M_3 significantly superior to M_1. Treatment M_2 was found statistically at par to M_3.

Differences in root attributing parameters were mainly observed due to wide differences in the rooting media. These exist much difference in soil, and their combination with FYM and leaf mould. These

differences created physiological conditions having wide differences in the contents of air, moisture in the surroundings of the parts of the branches operated as air layers. It is evident from the experiments conducted by several workers that due to addition of organic matter in the soil or sand creates different physical conditions like increase in volume in which more air, and moisture can be retained. Air and moisture in higher volume creates conditions identical or favourable for the new growth leading from callusing to development of root primordia and from root primordia to primary roots and also promotes further development of branch roots particularly secondary roots etc. It seens this was the main reason that organic metter like well rotten FYM and leaf mould both were found in abundance in our conditions playing a significant different role. FYM was found statistically better than leaf mould because in the well roted FYM, more organic matter and nitrogenous content were available than leaf mould. While both are statistically superior to soil. Well roted FYM and leaf mould played role like that of peat moss found in abundance in the higher rainfall area where due to heavy rains more organic matter can up on the earth surface as well as on the surface of stones and branches of trees. This type of organic matter creates conditions leading to acidic pH of the soil of that area. In our area very low rainfall

occurs and also there is a great scarecity of organic matter. Due to scarecity of organic matter in the soil well rotten FYM and leaf mould which were easily made available in this tract were included in the trial for mixing with soil. Thus both the rooting media soil + FYM(M_3) and soil + leaf mould (M_2) proved extremely useful for better callusing, rooting and survival of air layers were reported in the trial. If better callusing occurs next step is the initiation of root primordia, number of primary roots, longest length of primary roots and its further branches also occurs. Better callusing and rooting automatically lead to higher per cent success in rooting. After words detached air layers of B.Thimma are planted in the throughly prepared beds, well laid out for planting. Here some observations like number of branches and number of leaves length of branches height of plants were noted. Beside survival per cent was also recorded and it was observed that all these attributes were also improved to a greater extent and thus lead to similar increase in the survival of air layers of B. Thimma. Finding of Hatchcock (1928), Eaper and Roof (1931), Chadwick(1932), Long (1933), Hubert, et al. (1939). Swingle Dobrovitzkaya (1940), and Grace and Farror (1941).

Later on Deboer (1947), Opitz (1951), Dickey (1952) Puccini (1954), Ford (1954), Adriance and Brisen (1955), Deboer (1955), Evans (1958), Hartmann and Kester (1959), Singh (1959), Singh (1960), Singh and Singh (1961), Pennock and Meldonado (1963), Clay (1964), Foster (1965) and Florer and Kester (1966), Mukherjee (1967), Mukherjee (1972), Rathore (1982), Banerjee et al. (1963), Gurjar (1983), Tomar (1985) observed efficiency of organic matter due to better aeration, their acid reaction of proper balance of pH Their results seem similar to the results recorded in the present trial.

Effect of growth regulators on callusing, rooting and survival of air layers of B. Thimma :

Five concentrations of both the growth regulators included control were used for treatment air layers of B. Thimma. It is evident from the results reported in the proceding chapter that various concentrations of growth regulators have significantly affected the callusing, number of primary roots, longest primary roots, maximum diameter of primary roots, longest and thickest secondary roots, maximum fresh weight of roots, longest branches, maximum number of leaves and highest rooting percent. Greatest improvement was brought about due to

the treatment G_4 (NAA -10,000 ppm) as compared to rest of the treatments. Other important characters like higher number of root primordia, tallest plants, maximum number of branches, higher per cent of survival were also increased due to NAA - 10,000 ppm (G_4) comparatively bettter than rest of the treatments. In this respect it was also found statistically similar with IBA 10,000 ppm (G_2). Maximum number of secondary roots per air layer was found increasing due to NAA 10,000 ppm but this increase was observed statistically similar to treatment NAA- 7,500 ppm (G_3), both these treatments i.e. NAA- 10,000 ppm and NAA. 7,500 ppm were proved significantly superior to G_1, G_2, and G_o control.

Improvement in above root inducing parameters was observed to greatest extent when air layers of B. Thimma were treated with NAA 10,000 ppm followed by G_2(IBA- 10,000 ppm),this increasing trend in which both the highest concentration of NAA and IBA produced comparatively superior results than both the lower concentration of NAA and IBA. Both the concentrations of NAA and IBA were found most effective due to production of suitable balance of auxin which increased better rooting. Besides NAA is well known for its improvement

in the root characters and some other characters. This action of NAA at 10,000 ppm is supported by the findings of several workers like Singh (1950) in Guava with 1% NAA, Singh and Teotia (1957) in mango with 1% and 2% NAA, Singh et al. (1954) in Loquate with 3% NAA, Singh and Sharma (1954) with 3% NAA in loquate. Jauhari and Nigam (1958). Sen and Bose (1959) in jack fruit with 5,000 ppm and 10,000 ppm NAA, Jauhari and Jit (1960), Jauhari (1960). Sen and Hore (1963) with 1,000 to 10,000 ppm NAA in several ornamental plants. Rathore (1964) in Guava with 2% Chinnappa (1966) with NAA 15,000 ppm in Litchi, Salladnath and Kolagi (1969) with NAA 5,000 - 20,000 ppm in Chicku, Mishra and Jauhari (1970) got best rooting with 7,500 ppm NAA in Morus alba while Lal, et al. (1971) got survival rate 18.3 from 20 cuttings with 15,000 ppm.

While Maiti (1977) concluded 32% success in Ixora signaporensis against 22% in control. Rathore, Singh and Chhabra (1975) with NAA 0 to 20,000 ppm in the soft wood cuttings of Guava, while Sharma (1981) with 7,500 ppm and 10,000 ppm of NAA in karonda got similar result findings of above workers gave an indication that NAA at higher concentrations like 10,000 and 7,500 ppm was found most effective in producing roots in cuttings as well as in layers of above mentioned fruit and ornamental

plants. While results obtained by Lal et al.(1971) and Maithi (1971) indicates favourable results with lower concentration and this is contrary to the results of the present experiment. In this context it is worth mentioning that several groups of types of Bougainvillea varieties are available. They differ in their ability to produce roots in cuttings and air layers. Varieties used in this experiment are different. Beside physiological maturity of these varieties differ from the variety used by Lal et al. In addition to this several other factors like environmental conditions, rooting media, method of treatment may have contributed variation in the results this justified the results obtained in the present present trial.

Treatment G_2 (IBA- 10,000 ppm) was ranked at second place with regard all the above mentioned characters except maximum number of secondary roots which were found statistically similar to NAA-7,500 ppm (G_3). Treatment G_2 also produced higher number of root primordia, tallest plants, maximum number of branches and higher per cent of survival statistically similar to G_4(NAA-10,000 ppm). While both these treatment G_2 and G_4 were found significantly better than G_1 and G_3

and G_o (control) of these growth regulators.

It was also observed that IBA at 10,000 ppm was found most effective for above mentioned root inducing characters and also for higher per cent success in rooting and survival of plants. Some growth parameters were also improved due to better rooting. Findings of Sen (1939). Singh and Teotia (1951) with 1% IBA in Mango. Singh, et al. (1954) with 3% IBA in laquate. Singh (1955) with 1% IBA in Jack fruit and Kagzi lime, Jauhari and Nigam (1958) with 10,000 ppm of IBA in Karonda, Jauhari (1960) with IBA at 2,500, 5,000, 6,500 ppm found IBA useful for inducing rooting in karonda. Jauhari and Jit (1960) 20,000 to 30,000 ppm IBA in loquate, Jauhari (1960a) 10,000 ppm in IBA in Zizyphus, Sen and Hore (1963) with 1,000 - 10,000 ppm IBA in several ornamental plants. Rathore (1964) with 2% IBA in Guava, Chinnappa (1966) with IBA 10,000 ppm in litchi, Mukherjee (1967) with 5,000 ppm of IBA Salladnath and Kologi (1969) with 5,000 to 20,000 ppm IBA, Mishra and Jauhari (1970) IBA 7,500 ppm, 7,500 ppm with Boron, Lal et al. (1971) with IBA 1,000 ppm in Bougainvillea Verma et al. (1971) IBA at 7,500 ppm in Mango, Guava, Citrus, Chhonkar and Singh (1972) IBA 5,000 ppm, Quadeer (1974) 2% IBA, Vijay Kumar and Chouhan (1974) with 8,000 ppm of IBA in Guava cuttings,

Rathore, Singh and Chhabra (1975) with 0 to 20,000 ppm IBA in cuttings of Guava, Tomar (1979) at 10,000 ppm IBA Maithi (1977) 1,000; 2,000 and 3,000 in Exora, Khaskalam (1978) with IBA at 5,000 ppm, Sharma(1981) with 10,000 ppm of IBA in Karonda, Tomar (1981) with 5,000 IBA in Kagzi lime, Rathore (1982) 15,000 ppm in Guava, Gurjar (1983) with 10,000 ppm IBA in Kagzi lime, Bhadoria (1985) with 10,000 ppm IBA in Guava and Gurjar (1986) with 10,000 ppm IBA in B. spp. got better rooting & survival, plants as reported above. Though in most cases higher concentrations of IBA are used and better results are achieved. However, in some cases lower concentration gave as good results as higher. Some of the workers like Parihar (1942), Kempanna and Chandrasekhariah (1959), Bhattacharjee and Bhaduri (1960). Jouhari (1960) Singh (1960), Shanmugavelu (1960 and 1961). Lingaraj and Chandrasekhariah (1961) Singh et al.(1961), Jolieour (1962), Singh (1963), Rao et al.(1963), Lal et al.(1971), Nanda (1975) suggested use of lower concentrations for better rooting and success. While quick dip or soak method was adopted. In this method cuttings are dipped in hormones solution for a longer period. Lower concentrations are also followed when lanoline paste is used. While in dust from higher concentrations are used. Besides plants having soft

wood and also in case of shoot cuttings, lower concentrations gave as good results as higher concentrations in case of woody plants. Number of plant species treated by above workers varied very much with regard their maturity of wood, type of wood, environmental conditions prevailing in different parts of country and due to so many other factors. Varieties of same plant also differ with regard genetic makeup. In this experiment, three rooting media were treated with five levels of growth regulators. Among these concentration IBA at 10,000 ppm responded well in producing better root system resulting in higher per cent success of rooted plant. Due to aforesaid reasons the variation in rooting due to concentrations of IBA seems reasonable and justified. Almost all the root inducing parameters improved by the highest concentrations of NAA and IBA.

Effect of interaction between rooting media and growth regulators on the callusing rooting and survival of air layers B. Thimma.

When treatment combinations between rooting media and different levels of growth regulators combined they influence differ characters significantly with regard some root inducing parameters. Among these

higher number of root primordia, number of secondary roots, thickness of secondary roots, fresh weight of roots were increased significantly more due to treatment combination M_3G_4 (Soil + FYM + NAA-10,000 ppm) significantly better than rest of the combinations except M_2G_4 (Soil + leafmould + IBA - 10,000 ppm).

While maximum number of branches were observed in the combination M_3G_4 significantly better than remaining combinations except M_2G_4 (Soil + Leaf mould + NAA- 10,000 ppm) and M_3G_2 (Soil + FYM and IBA-10,000 ppm), maximum height of plant and survival per cent were reported in combination M_3G_4 statistically better than rest of the combinations except M_3G_2.Higher number of primary roots was counted in the treatment combination M_2G_4 significantly superior to rest of the combinations. Treatment combination M_3G_2 was proved statistically superior to rest of the combinations except M_3G_4 with respect to length of primary roots. Treatment combination M_3G_4 developed maximum diameter of primary roots which was found significantly superior to rest of the combinations. Highest rooting per cent was recorded in treatment combination M_3G_4 significantly superior to remaining treatment combinations except M_3G_2 (Soil + FYM + 10,000 ppm IBA) M_3G_3 and M_2G_4. Maximum number of leaves were

recorded in combination M_3G_4 but statistically it was proved at par to rest of the treatments. Maximum length of branches were recorded in combination M_3G_4 statistically better to remaining treatments except M_2G_4, M_3G_2 and M_1G_4.

While observing rooting per cent under combinations between different concentration of growth regulator and rooting media a systematic increase in rooting per cent was noted. It clearly shows that influence of interaction between different concentration of growth regulator and rooting media was found responsible for the gradual increase in the rooting per cent of air layers of B. Thimma.

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SUMMARY, CONCLUSION AND SUGGESTIONS FOR FUTURE WORK

C H A P T E R - VI

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SUMMARY, CONCLUSION AND SUGGESTIONS

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An experiment "Effect of rooting media and growth regulators on the callusing, Rooting and survival of air layers of Bougainvillea spp. variety-Thimma" was conducted during the year 1988-89 in the experimental area of the deptt. of Horticulture, College of Agriculture, Gwalior.

Randomized block design with three replications was adopted. Treatment consists of (I) Rooting

media at three levels and (II) concentration of growth regulators at five levels.

Treatments and their combinations:

(A) **Rooting media (three)** -

(1)	Soil	M_1
(2)	Soil+Leaf mould (1:1)	M_2
(3)	Soil+FYM (1:1)	M_3

(B) **Concentrations of growth regulators** -

(1)	Control (without growth regulator)	G_0
(2)	IBA-7,500 ppm	G_1
(3)	IBA-10,000 ppm	G_2
(4)	NAA-7,500 ppm	G_3
(5)	NAA-10,000 ppm	G_4

(C) **Treatment Combinations** -

(1)	$M_1 G_0$	(6)	$M_2 G_0$	(11)	$M_3 G_0$
(2)	$M_1 G_1$	(7)	$M_2 G_1$	(12)	$M_3 G_1$
(3)	$M_1 G_2$	(8)	$M_2 G_2$	(13)	$M_3 G_2$
(4)	$M_1 G_3$	(9)	$M_2 G_3$	(14)	$M_3 G_3$
(5)	$M_1 G_4$	(10)	$M_3 G_4$	(15)	$M_3 G_4$

For trial purpose nine plants of Bougainvillea Thimma (three plants under each replication) of uniform size and vigour were selected. On these plants well

matured and healthy branches of penicles thickness were selected. The average length of branches was 45 Cm and diameter 1 Cm approx. Three hundred branches were layered on three bougainvillea plants unde each replication with twenty selected branches in each treatment. Thus total number of branches layered were nine hundred in all the three replications. Air layering was done on 15 July to 17 July, 88.

Observations on the following characters were recorded at 10 days interval on three randomly selected air layers under each treatment. The data of final observations were statistically analysed and are given in Appendix-I

(1) Callus formation (Cm.)

(2) Number of root primordia (No.)

(3) Number (No.), length (Cm.) and Diameter (mm) of primary roots.

(4) Number (No.), length (Cm.) and Diameter (mm) of secondary roots.

(5) Fresh weight of roots(primary & secondary).

(6) Percent success of rooting(%).

(7) Length (Cm.) & Number of branches(No.).

(8) Number of leaves (No.).

(9) Height (Cm.) of plant.

(10) Percent survival after transplanting.

Air layers were detached from mother plants after 50 days of operation and transplanted in statistically laid out plot and observations were recorded at 10 days of intervals on rootage and growth. Data of the subsequent observations were exhibited graphically by figures and diagrammes. While the data of the final observations were statistically analysed and the analysis of variance is given in Appendix-I. The results obtained are summarised under following appropriate heads.

Effect of rooting media :

1. Maximum extent of callusing, largest number of root primordia, longest length of primary roots, thickest primary roots, thickest secondary roots, Maximum rooting percent, Tallest plants, Higher number of branches & number of leaves, Longest branches, Maximum survival percent of air layers of B. Thimma were recorded in the treatment rooting media M_3 (Soil+FYM) statistically superior to remaining treatments.

2. Maximum number of primary and secondary roots, longest secondary roots, Highest fresh weight of roots were observed in the treatment rooting media M_3 significantly superior to M_1, treatment M_2 was found statistically, at par to M_3.

Effect of growth regulators :

1. Thickness of callus cells, Number of primary roots, Longest primary roots, Maximum diameter of primary roots, Longest secondary roots, Thickest secondary roots, Maximum fresh weight of roots, Longest branches, Maximum Number of leaves, Highest rooting percent were found to be improved to a greater extent in the treatment concentrations of growth regulators G_4 and significantly superior to rest of treatments.

2. Regarding Higher number of root primordia, Tallest plants, Maximum number of branches, Higher percent of survival treatment concentrations of growth regulators G_4 was observed significantly superior to remaining treatments except G_2.

3. Maximum number of secondary roots was recorded in treatment G_4 significantly superior to rest of treatments. Treatment G_3 was found statistically at par to G_4.

Effect of interaction between rooting media and growth regulator :

1. When different rooting media combined with different concentrations of growth regulators, Higher number of root primordia, Number of secondary roots, Thickness of secondary roots, Maximum fresh weight of roots were recorded in the combination M_3 G_4 statistically superior to remaining treatment combinations except M_2 G_4.

2. Other character like maximum number of branches were observed in the treatment combination M_3 G_4, significantly better to remaining treatment combinations except M_2 G_4 and M_3 G_2.

3. Maximum height of the plants and survival percent was recorded in treatment combination M_3 G_4 statistically superior to rest of the treatment combinations except M_3 G_2.

4. Higher number of primary roots was reported in treatment combination M_2 G_4 (Soil+Leaf mould + NAA 10,000 ppm) significantly superior to rest of treatment combinations.

5. Treatment combination M_3 G_2 was found significantly superior to rest of the treatment combinations except M_3 G_4 with respect to length of primary roots.

6. Treatment combination M_3 G_4 possesses Maximum diameter of primary root and was found significantly superior to rest of the treatment combinations.

7. Highest rooting percent was recorded in treatment combination M_3 G_4 (Soil+FYM+NAA 10,000 ppm) significantly superior to remaining treatment combinations except M_3 G_2, M_3 G_3 and M_2 G_4.

8. Maximum length of branches was reported in treatment combination M_3 G_4 statistically better to remaining treatment combinations except M_2 G_4, M_3 G_2 and M_1 G_4.

9. Number of leaves were found maximum in treatment combination M_3 G_4 statistically at par to rest of the treatments.

CONCLUSION

Rooting media M_3 (Soil+FYM) produced statistically better callusing, Maximum rootimg percent and Maximum survival percent than M_2 and M_1.

Concentrations of growth regulators G_4 *(NAA-10,000 ppm) showed great improvement in most of* the characters like callusing, rooting & survival of air layers of B. Thimma statistically better than other treatments.

Treatment combination between rootimg media & growth regulators concentrations M_3 G_4 (Soil+FYM and NAA-10,000 ppm) was found a better combination for maximum callusing, rooting and survival percent of air layers of B. Thimma.

SUGGESTIONS FOR FURTHER WORK :

Since this was the first year of the trial hence the experiment should be repeated again to confirm the results of this trial.

Mixture of the growth regulators i.e. (i) IBA + IAA (ii) IBA + NAA (iii) IAA + NAA should also be trial, some other higher concentrations may be used.

Some other rooting media, different time of layering and detachement, different method of growth regulators treatment and other varieties of bougainvillea spp, method of propagations should be included in the trials.

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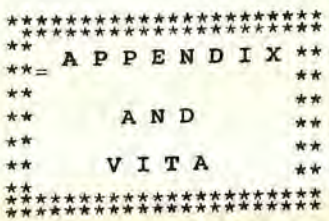
APPENDIX
AND
VITA

APPENDIX - I

ANALYSIS OF VARIANCE

Mean sum of square for rooting, growth and survival studies

Source of variation	D.F.	Diameter of cellusing	No. of root primordias	No. of primary roots	Length of primary roots	Diameter of primary roots	No. of secondary roots.	Length of secondary root
1. Replication (R)	2	0.01098	0.947	0.065	0.000216	0.0015	0.255	0.01982
2. Rooting media (M)	2	0.02166**	51.525**	19.55**	1.23595**	1.2545**	162.7**	0.20616**
3. Growth regulators (G)	4	0.01593**	40.12**	8.845**	1.55317**	6.9045**	216.95**	0.11877**
4. Interaction (G X M)	8	0.002835^{NS}	1.141*	0.270**	0.0199125**	0.0767**	7.9409**	0.0321^{NS}
5. Error	28	0.001258	0.438	0.083	0.00441	0.00246	0.3026	0.0170635

Contd...2/-

Source of variation	D.F.	Dia. secondary root.	Rooting percent	Fresh weight of roots.	Height of plant	Number of branches	Length of branches	Number of leaves	Survival percent.
1. Replication (R)	2	0.0062	63.08	0.0417933	0.8594	0.01235	2.2843	38.138	24.823
2. Rooting media(M)	2	0.5105**	3969.83**	0.91098**	51.139**	1.12075**	13.722**	561.65**	93.64**
3. Growth regulators (G)	4	2.756**	1144.55**	2.02692**	158.9107**	11.0559**	67.8807**	998.2503**	766.335**
4. Interaction(GXM)	8	0.07445**	46.97**	0.083505**	1.5738**	0.10286**	1.668*	22.9376NS	32.3592
5. Error.	28	0.00343	19.6370	0.0140246	0.024556	0.0247442	0.5401	10.094	9.785

* Significant at 5% level.

** Significant at 1% level.

NS Non significant.

MEAN VALUE OF THE VARIOUS LEVELS OF ROOTING MEDIA & CONCENTRATION OF GROWTH REGULATOR

ROOTING MEDIA

Treatments.	Daimeter of calli-using (cm.)	Number of root primordia. (No.)	Number of Primary roots. (No.)	Length of Primary roots. (cm.)	Daimeter of Primary roots. (mm.)	Number of Secondary roots (No.)	Length of Secondary roots (cm.)	Diameter of Secondary Roots. (mm)
M_1	0.81	18.93	16.24	5.38	1.64	15.53	2.18	0.88
M_2	0.83	20.96	18.19	5.68	2.01	21.02	2.35	1.13
M_3	0.87	22.62	18.25	5.95	2.21	21.43	2.51	1.24
S.E.(m) ±	0.009	0.170	0.074	0.017	0.012	0.142	0.033	0.015
C.D.at 5%	0.026	0.494	0.215	0.049	0.037	0.411	0.097	0.043
			GROWTH REGULATORS					
G_o	0.79	17.38	16.37	5.01	0.93	11.37	2.14	0.45
G_1	0.82	20.38	16.85	5.54	1.44	18.55	2.25	0.74
G_2	0.85	22.61	18.06	5.98	2.12	20.07	2.36	1.60
G_3	0.84	21.00	17.66	5.78	1.98	23.14	2.30	0.89
G_4	0.89	22.80	18.88	6.04	3.28	23.50	2.51	1.73
S.E.(m) ±	0.011	0.220	0.095	0.022	0.016	0.183	0.043	0.019
C.D. at 5%	0.034	0.638	0.277	0.064	0.047	0.530	0.126	0.056
			Interaction (M x G)					
S.E.(m) ±	0.020	0.382	0.166	0.038	0.028	0.317	0.075	0.033
C.D. at 5%	N.S.	1.106	0.481	0.110	0.082	0.919	N.S.	0.098

Cont..2/-

Treatment.	Rooting Percent (%)	Fresh Weight of roots (gm)	Height of Plants (cm)	Number of Branches per Plant (No.)	Length of Branches (cm)	Number of Leaves/ Bran. (No.)	Survival Percentage. (%)
M_1	53.15	1.19	33.88	5.99	21.45	53.06	28.41
M_2	76.65	1.58	35.32	6.38	22.32	61.71	66.51
M_3	84.42	1.65	37.67	6.51	23.36	64.89	75.47
S.E.(m) ±	1.144	0.030	0.448	0.040	0.189	0.820	0.807
C.D. at 5%	3.313	0.088	1.297	0.117	0.549	2.375	2.339
			GROWTH REGULATORS				
G_o	52.94	0.91	29.71	4.84	19.58	45.50	44.25
G_1	69.02	1.10	34.18	5.73	20.78	52.74	50.53
G_2	78.16	1.66	39.37	7.36	24.76	67.22	63.67
G_3	75.59	1.59	34.70	6.10	20.91	62.75	59.20
G_4	81.35	2.10	40.16	7.44	25.84	71.13	66.33
S.E.(m) ±	1.477	0.039	0.579	0.052	0.244	1.059	1.042
C.D.at 5%	4.277	0.114	1.678	0.151	0.709	3.066	3.019
			Interaction (M X G)				
S.E. (m) ±	2.558	0.068	1.003	0.090	0.424	1.834	1.806
C.D. at 5%	7.408	0.198	2.906	0.262	1.228	N.S.	5.229

Acc no. 33283

V I T A

Name of the candidate : **MUKESH KUMAR RATHORE**

Father's Name : Shri Nanuram Rathore

Date of Birth : 22 June'1965

Place of Birth : Susner, Dist- Shajapur (M.P.)

Educational Institutions Attended :

Name of the Institutions	Year of joining	Year of passing
Govt. Middle School Susner, Dist-Shajapur (M.P.)	1975	1978
Govt. H.S.S., Susner Dist- Shajapur (MP.)	1978	1982
R.A.K. College of Agriculture, Sehore (M.P.)	1982	1986
College of Agriculture Gwalior (M.P.)	1987	1988-89 Final

Educational Qualifications :

Name of Examination	Name of Board/ University	Year of passing	% of Marks and Division
H.S.S. Certificate Examin.	M.P.Board of Edu., Bhopal	1982	63.87 First
B.Sc.(Ag.)	J.N.K.V.V., Jabalpur	1986	65.22 First
M.Sc.(Ag.) Horticulture	J.N.K.V.V., Jabalpur	1988-89	OCGA out of 4.0 Scale

He was an active participant in N.C.C. and got his 'B' certificate with rank L.C. (Best cadet) in 1984.

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