

**INFLUENCE OF AUXIN AND 1, 2, 4 ACID ON
ROOTING OF AIR LAYERS IN ROSEAPPLE
(*Syzigium jambos* L.)**

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**DIVISION OF HORTICULTURE
UNIVERSITY OF AGRICULTURAL SCIENCES
BANGALORE
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**INFLUENCE OF AUXIN AND 1, 2, 4 ACID ON
ROOTING OF AIR LAYERS IN ROSEAPPLE
(*Syzigium jambos* L.)**

PRAKASH G.N.

Thesis submitted to the
University of Agricultural Sciences, Bangalore
in partial fulfilment of the requirements
for the award of the Degree of

Master of Science (HORTICULTURE)

in

Pomology

BANGALORE

DECEMBER, 2001

**DEPARTMENT OF HORTICULTURE
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BANGALORE – 560065**

CERTIFICATE

This is to certify that the thesis entitled “Influence of auxin and 1, 2, 4 acid on rooting of air layers in roseapple (*Syzigium jambos* L.)” submitted by **Mr. Prakash G.N.** in partial fulfillment of the requirements for the degree of **Master of Science (Horticulture) in Pomology** to the University of Agricultural Sciences, Bangalore, is a record of bonafide research work done by him during the period of his study in this University under my guidance and supervision and no part of the thesis has been submitted for the award of any degree, diploma, associateship, fellowship or other similar titles.

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ACKNOWLEDGEMENT

*It gives me a great pleasure to express my sincere gratitude to **Dr.V. Nache Gowda**, Associate Professor of Horticulture and Chairman of my Advisory Committee for his inspiring ideas, advice, guidance and great support rendered during the course of this investigation and preparing this manuscript.*

*I express my deep sense of gratitude to **Dr.S. Jaganath**, Associate Professor of Horticulture, GKVK, UAS, Bangalore for his valuable suggestions.*

*I am extremely thankful to **Dr.K. Seenappa**, Statistician, Sunflower unit, GKVK, UAS, Bangalore for his helpful suggestions and encouragement during the course of my Research and thesis preparation.*

*My heart felt gratitude to **Dr. Aftab Hussain**, Assoc. Professor, Department of Crop Physiology, BS&H college, GKVK, UAS, Bangalore for his guidance, suggestions and helping me through this course of investigation.*

I sincerely thank all the staff members of the Division of Horticulture for their suggestions and support during the study.

I owe my gratitude to my Father, Mother and Brothers for their help, inspiration and encouragement throughout the career of my education.

I extend my great thanks to my near and dear friends without whom I could not get through this, especially their kind help and advise to get me to this stage.

I would also like to extend my thanks to Narasimhaiah for his timely support.

Finally, I sincerely thank Mr. and Mrs. Narayan for the neat typing of this manuscript with utmost patience.

Bangalore

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INTRODUCTION

I. INTRODUCTION

The roseapple (*Syzigium jambos* L.) is one of the important minor fruit crop, which is not fully exploited (Singh, 1969). It belongs to the family Myrtaceae, and is said to be a native of southern part of Asia, probably either India or Malaysia. The roseapple trees are mostly found throughout the tropical regions of the world. This fruit crop occurs in wild and cultivated forms. Since the trees are scattered, information regarding the area and production is not available. The average yield of a roseapple tree is 20-25 kg per tree per year. The major roseapple growing states in India are West Bengal, Assam, Manipur and Nagaland.

Roseapple is hardy and can be grown in dry lands, wastelands, marginal and poor soils, where other fruits can not be grown successfully (Marigowda, 1974). The pleasant flavoured fruit is mostly used for table purpose. Apart from eating as fresh, it can also be used for making candy, jam, jelly and sauce. The roseapple fruit is highly nutritious with a composition of moisture (89.1%), protein (0.7%), fat (0.1%), fibre (1.2%), carbohydrates (9.7%), mineral matter (0.3%), calcium (10 mg), iron (0.5 mg), sulphur content (34.1 mg), potassium (50 mg) and vitamin A (235 IU).

In earlier days, roseapple trees were generally raised from seeds. Seedling trees used to have a high level of heterogeneity with a long juvenile phase. In order to obtain fruits of uniformly high quality it is necessary that trees should be propagated vegetatively. Among the vegetative methods of propagation, air layering is most convenient, easy, inexpensive, rapid, simple and does not require any special techniques.

The rooting ability of air layered shoots is decided by several² factors, that vary with the crops, cultivars, biochemical constituents of the clone (viz., carbohydrates, nitrogen, sugars, starch, phenols, auxin levels etc.), and the climatic conditions prevailing during the season (viz., temperature, relative humidity, rainfall etc.) of layering. All these factors should be at an optimum level to attain better rooting of air layers.

Use of appropriate growth regulator, especially auxins in accordance with the crop requirements have made a break through in rooting of cuttings and air layers. To attain better results and to avoid toxicity, the auxins have to be used in the optimum concentrations, which vary from crop to crop. To improve the efficiency of the applied auxins, use of phenolic compounds, carbohydrates, sugars, boron and vitamin C etc., are effective in enhancing rooting of cuttings and air layers.

Phenolic compounds are more effective as synergist with auxins in inducing rooting. Phenolic compounds are endogenously occurring organic compounds in all higher plants. Apart from rooting, the phenolic compounds have been shown to have several other effects on plant metabolism. High amount of certain phenolic compounds are shown to have disease resistance and seed dormancy.

Exogenous application of phenolic compounds have shown to influence growth and development, primarily by altering the endogenous level of auxin concentration. Phenolic compounds are also shown to interact with proteins leading to altered metabolism (Kefeli and Kutacek, 1976).

Though the exact role and mechanism of phenolic compounds rooting phenomenon is not understood, and often they are considered as rooting co-factors. Since, auxins play a pivotal role in differentiation leading to the initiation of the root primordia, the phenolic compounds may have an indirect role in promoting rooting through regulation of auxin levels. Hence, keeping this in view, the present investigation was undertaken to study the effect of auxins viz., Indole butyric acid (IBA) at different concentrations along with potent phenolic compound 1-amino 2-hydroxy phenyl 4 – sulphonic acid (1, 2, 4 acid) during different months of the year on roseapple with the following objectives.

1. To study the effect of Indole butyric acid on rooting of air layers.
2. To study the effect of 1-amino 2-hydroxy phenyl 4-sulphonic acid (1,2, 4 acid) on rooting of air layers.
3. Influence of Indole butyric acid (IBA) and 1-amino 2-hydroxy phenyl 4-sulphonic acid (1,2,4 acid) in combination on rooting of air layers.
4. Influence of season of air layering on rooting.

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

The roseapple is one of the minor fruit crop of India. It thrives well under wide range of climatic and soil conditions. It is propagated almost entirely by seeds, which is although polyembryonic, shown considerable variation in performance (Hayes, 1959). Hence there is a scope for vegetative methods of propagation in this crop in order to maintain clones characters, early bearing, dwarf trees and uniformly better performances of trees.

In this chapter an attempt was made to present the literature on vegetative propagation of roseapple and some related fruit crops with special reference to air layering technique.

2.1 Propagation of roseapple by cuttings

In general, roseapple cuttings are hard-to-root, however, results of earlier investigations have indicated successful propagation from cuttings under mist conditions. Bose and Sadhu (1974) observed that cuttings of roseapple successfully rooted under intermittent mist within 45 days when treated with IBA 5000 ppm in talc. Bhandary and Shivashankar (1971) revealed that roseapple can be propagated by stem cuttings with the help of growth regulator and intermittent mist. Among the growth regulator treatment IBA at 8000 ppm produced maximum rooting of 90 per cent during July month. Saha (1969) reported that in semihard wood cuttings of roseapple, low percentage of rooting (20%) was observed when treated with 1000 ppm NAA. It was suggested that cuttings were established successfully when mist was used for the propagation.

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Hore and Sen (1994) reported that maximum rooting success of 78.5 and 92.3 per cent in the month of May and July with ferulic acid 1000 ppm + IBA 5000 ppm, as against 37.4 and 42.4 per cent rooting success in control in the respective months. However, the maximum survival percentage (92.4%) was noticed in cuttings treated with ethrel 1000 ppm + IBA 10000 ppm. The cuttings taken during July month rooted better. Sharma and Grewel (1989) found that maximum rooting success of 96.8 per cent occurred with ethrel 1000 ppm in combination with NAA 2500 ppm. Treating of cuttings with NAA 1000 ppm resulted in maximum number of primary and secondary roots per cutting. Highest root length was recorded in cuttings with IBA 5000 ppm. The rooting success was more at higher concentrations.

2.2 Propagation of roseapple by air layering

Roseapple layering is commonly followed in Malaysia during February-March with 500 ppm IBA (Singh *et al.*, 1967). However, according to Hore and Sen (1991) air layering during the month of June rooted better, and survival was better in layers made during the month of August in India. Saha (1969) obtained 60 per cent rooting in air layers of roseapple with 500 ppm IBA in the month of February.

Ray *et al.* (1988) recorded 100 per cent rooting with 10000 ppm IBA followed by 10000 ppm NAA (90%) and 5000 ppm IBA (85%) rooting in roseapple airlayers. According to Shanmugavelu (1967) roseapple air layers treated with one per cent IBA + NAA in lanolin paste induced better rooting, while control shoots failed to root.

Hore and Sen (1991) found that P-hydroxy benzoic acid (Synergist) 1000 ppm plus IBA 5000 ppm, ethrel 1000 ppm plus NAA 5000 ppm and ferulic acid 1000 ppm plus NAA 2500 ppm were the most effective treatments with respect to rooting success in roseapple layers. Maximum number of roots (21.42) occurred with ferulic acid 1000 ppm plus NAA 2500 ppm. Maximum survival percentage (98.36%) was recorded with ferulic acid 1000 ppm plus NAA 2500 ppm.

2.3 Propagation of other fruit crops by air layering

2.3.1 Propagation of guava by air layering

Propagation of guava by air layering during the month of June is most suitable (Anon, 1961). The time required for the layers to initiate rooting was minimum and the rooting percentage, root characters such as primary, secondary and tertiary root numbers and length were maximum in guava layers done during June followed by April (Bhandary and Kololgi, 1961). According to Sharma *et al.* (1991) maximum number of roots, diameter, fresh weights of primary and secondary roots in layers done on 10th of July. However, a declining effect was observed in all the above mentioned characters with advancement in date of operation.

Chandrappa and Nachegowda (1998) reported that application of auxins with 1000 ppm of 1, 2, 4 acid during different months of layering were found to be significantly effective in inducing rooting of air layers in guava. Air layers prepared during June month treated with 10000 ppm of IBA plus 1000 ppm of 1,2, 4 acid gave maximum rooting percentage, better root characters and survival. Bhagat *et al.* (1999) reported that IBA

in all the three concentrations (1500, 3000 and 4500 ppm) significantly increased the rooting percentage, number of roots per layer, length of roots and survival percentage over control. IBA 4500 ppm exhibited the best performance with respect to rooting (94.67%) and survival (78.33%).

Bhandary and Kololgi (1961) revealed that, the air layers treated with mixture of IBA and NAA at 5000, 10000, 15000 and 20000 ppm concentration indicated that June is most suitable month for layering. The layers treated with the above concentrations recorded 80, 80, 60 and 20 per cent rooting, respectively. The layers treated with 1000 ppm concentration gave the maximum number of primary, secondary and tertiary roots. Nanda (1975) reported that the air layers of cv. 'Sardar' guava gave low percentage of rooting without growth regulator (IBA).

Venkatesh (1983) found that pre girdling plus etiolation with IBA treatment recorded the maximum percentage of rooting. The average root length and number of roots were highest in shoots that were pre-girdled, etiolated and treated with IBA. The survival rate was also maximum (72.5%) due to pre-girdling and etiolation and IBA treatment. According to Patel *et al.* (1989) guava air layers treated with 3000 ppm IBA followed by wrapping with black polythene resulted in 100 per cent rooting, higher number of roots and better survival. Studies of Sadhu *et al.* (1972) revealed that, P-hydroxy benzoic acid (synergist) alone showed a small increase in the rooting of guava layers but in combination with IBA there was a four fold increase in the number of roots. While, another synergist, salicylic acid, on the other hand inhibited rooting singly and in combination with IBA.

2.3.2 Propagation of litchi by air layering

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According to Li and Li (1949) air layering has been the most successful and commercial method in vogue with nursery men. Rate of success in air layers was reported to be very high (90%) in South Africa, Israel, Taiwan, Mexico, Hawaii and Queensland (Shing *et al.* 1954 ; Kadman and Slor, 1974) in comparison to those in India and Pakistan (27-45%) (Ram and Majumdar, 1981). Air layers prepared on aged (30 years) trees rooted better compared with layers prepared on younger trees (18 years) (Kadman and Slor, 1974).

Litchi can be air layered all around the year in Hawaii although they are usually layered in spring before active growth commences (Yee, 1972). In Florida, air layering is done in June, under prevailing conditions of warm temperature, high humidity and daily rain (Storey, 1973).

Nagendra Naik (1998) found that, application of auxins with 1000 ppm of 1,2,4 acid during different months of layering were found to be significantly effective in inducing rooting of air layers in litchi. Air layers prepared during July month treated with 5000 ppm of IBA plus 1000 ppm of 1,2,4 acid gave maximum rooting percentage, better root characters and survival. Singh and Yadav (1997) studied the influence of etiolation and application of growth substances viz., IBA, NAA and their mixtures at 2500 and 5000 ppm each on rooting of airlayers in litchi cv. Purbi. The results revealed that these treatments had significant effect in inducing rooting and promoting the quality of roots. Maximum rooting (69.87%), survival (69.37%) and improvement in root characters were obtained in etiolated shoots treated with IBA and NAA at 5000 ppm.

The growth regulator IBA affected rooting in layers of litchi. A steady raise in moisture content was directly related to increased rooting (Sen and Bose, 1967). The growth regulators IBA and NAA, in equal proportions of 15,000 ppm resulted in early rooting and better root formation. The period of root initiation ranged from 35-45 days in case of untreated litchi layers (Chinnappa, 1962).

Syamal and Singh (1993) recorded highest rooting (98.5%) and survival percentage (92.96%) with IBA at 300 ppm. The maximum number of primary (36.3) and secondary roots (14.3) were observed with IBA 300 ppm. Similarly Kadman (1985) reported that 90 to 100 per cent rooting in litchi was observed within two to three months when treated with 250 ppm IBA compared with 32.8 per cent in control.

The highest number of roots, maximum root length and highest survival of litchi layers was recorded in the nursery (74.2%) when wrapping was done after first week of ringing with 2500 ppm IBA followed by wrapping in the second week after ringing (Sharma *et al.*, 1990). Sharfuddin (1983) reported that, air layers detached from mother plant and pruned heavily recorded maximum (72.7%) survival, compared with moderate (45.4%) and light (33.6%) pruned layers. Sadhu *et al.* (1972) reported that the rooting in litchi could be increased to some extent by increasing the concentration of auxin but high auxin concentration adversely affect the branching of the roots and the quality of the root system. Hence, suggested the use of lower concentration of auxin along with a synergist to improve the efficiency of auxin action.

2.4 Mode of action of phenolics

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It is very well established that the activity of peroxidase and IAA oxidase can be altered by many naturally occurring compounds such as phenolics (both free and bound) coumarins, manganese salts, and plant acids. Investigations with phenolics generally support the view that monophenols act as co-factor of IAA oxidase, while O- and P-dihydrophenols and poly phenols are IAA oxidase inhibitors, thereby protecting the endogenous IAA from destruction (Pilet, 1964, Runkova *et al.*, 1972).

Polyphenols act as substrates for oxidase or peroxidase oxidation and thus prevent IAA oxidation resulting in promotion of growth (Thimann, 1934).

Other possible mechanisms proposed were that phenolics in the presence of phenolase and oxygen get converted into quinones, and these quinones in combination with tryptophan helps in the synthesis of Indole pyruvic acid that in turn is converted into IAA (Gorden and Paleg, 1961). Hess (1969) attempted to systematize the knowledge on the structural requirement of phenolics for rooting activity, and concluded those compounds with a free para positions and with hydroxyl groups in the ortho-position are most effective.

In general, various phenolic compounds that occur in plants can stimulate adventitious root formation especially when applied with an auxin (Hess, 1964). Monophenols are known to promote IAA oxidase activity thereby reducing either growth or level of IAA by IAA oxidation.

One of the compounds used in the present investigation was 1,2,4-trihydroxybenzoic acid, which is a monophenol. However, when 1,2,4 acid alone or in combinations was used, there was an increase in root numbers. The results are contradictory to the established concept that monophenols are known to cause reduction in growth by promoting IAA oxidase activity and there by reducing the levels of IAA content in the system. However, the following findings, suggested that monophenols promoted growth in synergism with IAA (Vijaya, 1992).

In most plants it has been reported that the enzyme polyphenol oxidase can introduce second -OH into the ring of a monophenol (Goodwin, 1976) and convert it into diphenol. Wilkins (1969) also suggested phenolics oxidases like tyrosinase enzyme specifically can insert a second hydroxyl into phenols and thus can alter an oxidation accelerator (Monophenol) into an inhibitor (diphenol). These monophenols also cause inhibition of IAA oxidation of high concentration, this has been ascribed to the presence of tautomeric structures (Thimann, 1934). This suggests, that a monophenol can increase root growth either alone or in combination with auxins, which may be due to the mechanism as mentioned above or an unknown reason for its action on rooting of cuttings.

In most of the studies the combination of phenolics and auxin resulted in better rooting. The similar effects were also observed by Sadhu *et al.* (1972) and Reddy and Majumdar (1978). The synergism of phenolic compounds with auxins has been noticed in phalsa by Rabbovi *et al.* (1983).

2.5 Effect of carbohydrates/nitrogen ratios in rooting

The carbohydrates and nitrogen contents in the stock plants have a profound influence on rooting of cuttings. Carbohydrate and nitrogenous substances are required for cell-division, differentiation and formation of root primordia. High carbohydrate content and a moderate level of nitrogen in the cuttings favours optimum rooting. Hence, a low nitrogen, high carbohydrate balance in the stock plants should be maintained for optimum shoot and root regeneration in cutting (Hartmann and Kester, 1972).

Basu *et al.* (1967) carried out analytical studies in callusing and root emergent stages of mango air layers treated with IBA and found that they had relatively greater quantity of carbohydrates in root forming regions that stimulated rooting. High carbohydrates and low nitrogen content have been reported to favour the adventitious root formation in many fruit trees (Knight, 1962). Venkatesh (1983) reported that high sugars and carbohydrates/nitrogen ratio favours better roots in air layer of guava. Mitra *et al.* (1982) found that carbohydrates accumulated in the shoot has long been known to favour the formation of adventitious root formation.

Ganapathi *et al.* (1997) reported that high sugars and carbohydrates/nitrogen ratio favours better roots in the air layer of tamarind. High carbohydrates content and a moderate level of nitrogen in the bent grass favours optimum rooting (Cooper *et al.*, 1998).

MATERIAL AND METHODS

III. MATERIAL AND METHODS

The investigation on the air layering in roseapple (*Syzigium jambos* L.) was carried out during the year 2000-2001 at the Horticultural Research Station, Division of Horticulture, Gandhi Krishi Vignana Kendra, University of Agricultural Sciences, Bangalore, which is situated at an elevation of 930m from mean sea level and at 120° 58' north and 77°35' east latitude. Details of material used and methodologies adopted during this investigation are as follows.

3.1 Propagation of roseapple air layers

Healthy and vigorously growing, mature shoots with stem thickness of 1.25 cm were selected for air layering. The experiment was conducted in different months of the rainy season. Air layering was done every month starting from June to October.

The selected shoots for air layering were girdled and treated with Indole butyric acid (IBA) and other combinations with 1-amino 2-hydroxy phenyl 4-sulphonic acid (Synergist). Twenty four air layers were tried in each treatments with 6 replications. The details of the growth regulator treatment are as follows.

1. IBA – 7500 ppm
2. IBA – 5000 ppm
3. IBA – 2500 ppm
4. IBA 7500 ppm + 1,2,4 acid 500 ppm
5. IBA 5000 ppm + 1,2,4 acid 500 ppm

6. IBA 2500 ppm + 1,2,4 acid 500 ppm
7. IBA 7500 ppm + 1,2,4 acid 1000ppm
8. IBA 5000 ppm + 1,2,4 acid 1000 ppm
9. IBA 2500 ppm + 1,2,4 acid 1000 ppm
10. Control (without IBA and 1,2,4 acid)

3.1.2 Preparation of growth regulator

The required quantities of IBA and 1,2,4 acid were weighed separately. IBA and 1,2,4 acid were first dissolved separately in 5 ml of absolute alcohol and then volume is made up to 100 ml with distilled water to get required concentration of growth regulators.

3.1.3 Air layering technique

Selected shoots were girdled below the node, about 25 to 30cm from the tip. A complete ring of 2.5 cm width strip of bark was removed by making two cuts. Continuity of the cambial layer was disrupted by gently rubbing the exposed wood portion. Growth regulators were applied with a soft cotton to 1 cm region of the upper cut end. The exposed portion of control shoots was treated with distilled water. The girdled portion was immediately covered uniformly with sphagnum moss and secured firmly in position with a polythene sheet of 250 gauge thickness and both the ends were tied firmly using gunny thread.

3.2 Observations recorded on the air layers of roseapple

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3.2.1 Number of days taken for rooting

The number of days taken for appearance of first root in air layers, which were visible through the transparent polythene sheet was recorded by periodic observation. The number of days taken for rooting of air layers on each treatment was calculated.

3.2.2 Percentage of rooted layers

After three months, air layers were detached from the mother plants, rooted and unrooted layers were separated and counted for further calculation of percentage of rooted layers in each treatment lot.

3.3.3 Number of roots per air layer

Five rooted layers were randomly sampled from each treatment. The polythene sheet and the rooting media were removed carefully using forceps and care was taken to avoid damage to roots, number of primary, secondary and tertiary roots were counted in each rooted layer.

3.3.4 Length and girth of roots

Length of primary root was measured from the collar region to the tip of primary roots. Length of secondary roots developed from the primary root was also measured. Girth of the primary and secondary roots was measured using vernier calipers at the region of maximum girth.

3.2.5 Percentage of survival

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The rooted air layers were planted individually in polythene covers using potting mixture containing compost and soil (1:3 ratio) and kept inside the mist chamber for establishment. The observations on survival of layers in each treatment was noted at an interval of one month. The final observation on their survival was made after two months and expressed in percentage.

3.3 Biochemical analysis

At the time of air layering shoot samples were collected in different months for the estimation of total sugars, starch, total nitrogen, total carbohydrates and total phenols.

3.3.1 Determination of sugars

Total sugars in plant material was estimated on dry weight basis. The estimation of total sugars was carried out by phenol sulphuric acid method.

3.3.2 Estimation of starch

The residual plant material remaining after extraction of sugars with ethyl alcohol was dried at 80°C and weighed. A representative sample of the dried residue (50 mg) was suspended in water with five to seven drops of 10 N NaCl and boiled for half an hour in a water bath to hydrolyze starch. It was cooled under tap water, centrifuged and the

supernatant liquid was decanted and the volume was made to 100 ml. The starch content was estimated by using Nelson and Somgyi's method, glucose equivalent obtained was multiplied by 0.9 to get total starch content.

3.3.3 Total carbohydrates

Total carbohydrates was expressed as the sum of total sugars and total starch content.

3.3.4 Estimation of total nitrogen

The dried and powdered shoot samples were used for the estimation of nitrogen. The nitrogen content was determined by following micro kjeldahl method as outlined in AOAC (1970) and the results were expressed in percentage.

3.3.5 Carbohydrate – nitrogen ratio

The total carbohydrates present in the shoot sample was divided by that of the total nitrogen to obtain the carbohydrate – nitrogen ratio.

3.3.6 Estimation of total phenols

Total phenols were estimated by Folin Denis method as described by Swain and Hills (1959) and the results were expressed in percentage.

3.4 Statistical analysis

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The observation collected during the investigation were subjected to statistical analysis with suitable transformation, interpretation of data as outlined by Panse and Sukhatme (1967). The level of significance used in 'F' test was $P=0.05$. Critical differences were calculated, whenever the 'F' test was found significant.

EXPERIMENTAL RESULTS

IV. EXPERIMENTAL RESULTS

Results of the investigation on air layering of roseapple as influenced by months of layering, auxin concentration with or without 1-amino 2-hydroxy phenyl 4 – sulphonic acid (1,2,4 acid) are presented in this chapter.

4.1 Number of days taken for root initiation

The number of days taken for root initiation in roseapple air layers as influenced by months of layering, auxin concentrations with or without 1,2,4 acid and their interactions are presented in Table 1.

Among the different months of air layering the number of days taken for root initiation was found to be statistically significant. However, the layers done during July month recorded the least number of days (43.61) for root initiation, followed by August (44.29 days). Where as, the layers prepared during September took more number of days (45.20) for root initiation.

The interaction influence of months of layering, auxin concentrations and 1,2,4 acid on number of days taken for root initiation was significant. The layers prepared during July and treated with 5000 ppm IBA plus 1000 ppm 1,2,4 acid took less number of (38.08) days for root initiation, followed by the layers prepared in August month and treated the 5000 ppm IBA plus 500 ppm, 1,2,4 acid (38.58 days). While the layers prepared in October month with 2500 ppm IBA took more number of days (59.73) for root initiation.

Table1. Influence of months of layering and auxin concentrations with or without 1,2,4 acid on number of days taken for rooting in roseapple air layers

Treatments	June	July	August	September	October	Mean
IBA 7500 ppm	44.38 (6.69)	45.73 (6.80)	46.93 (6.89)	47.58 (6.93)	48.58 (7.01)	46.63 (6.83)
IBA 5000 ppm	44.73 (6.73)	43.73 (6.65)	47.38 (6.91)	45.32 (6.77)	45.11 (6.75)	45.25 (6.76)
IBA 2500 ppm	46.67 (6.87)	43.65 (6.64)	51.38 (7.20)	41.58 (6.49)	59.73 (7.76)	48.60 (6.99)
IBA 7500 ppm + 1,2,4 acid 500 ppm	43.93 (6.67)	45.31 (6.77)	43.58 (6.64)	47.23 (6.91)	50.00 (7.11)	46.01 (6.82)
IBA 5000 ppm + 1,2,4 acid 500 ppm	44.31 (6.69)	43.93 (6.67)	38.58 (6.25)	44.87 (6.91)	46.38 (6.85)	43.61 (6.64)
IBA 2500 ppm + 1,2,4 acid 500 ppm	42.52 (6.56)	42.23 (6.54)	47.73 (6.94)	49.01 (7.04)	52.98 (7.31)	46.89 (6.87)
IBA 7500 ppm + 1,2,4 acid 1000 ppm	43.73 (6.65)	42.78 (6.58)	44.23 (6.69)	39.93 (6.36)	48.58 (7.01)	43.85 (6.66)
IBA 5000 ppm + 1,2,4 acid 1000 ppm	43.30 (6.62)	38.08 (6.21)	40.64 (6.41)	44.86 (6.73)	47.86 (6.85)	42.95 (6.59)
IBA 2500 ppm + 1,2,4 acid 1000 ppm	45.65 (6.79)	47.58 (6.93)	41.93 (6.40)	47.58 (6.93)	50.57 (7.15)	46.58 (6.87)
Control	49.86 (7.09)	43.08 (6.60)	40.93 (6.64)	44.08 (6.68)	0.00 (0.71)	35.59 * (5.50)
Mean	44.91 (6.74)	43.61 (6.64)	44.29 (6.69)	45.20 (6.75)	44.97 (6.46)	

	SEm±	CD at 5%
Months (M)	0.11	0.43
Treatments (growth regulators)	0.15	0.30
Interaction (months x growth regulators)	0.35	0.96
Cv %		1.90

* = Denotes mean of June to September month

Note - Values in the paranthesis indicate square root transformed values.

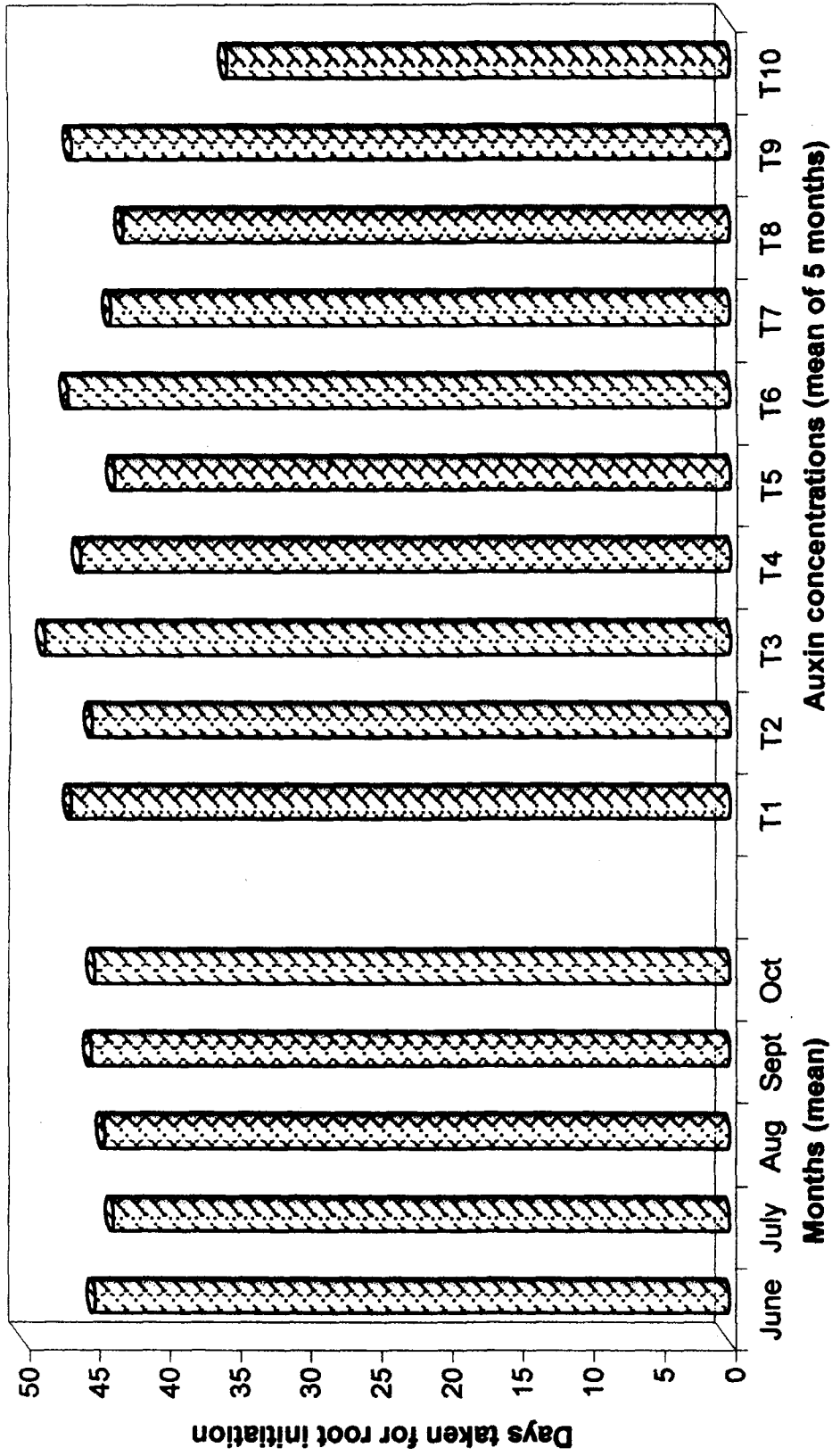


Fig.1a. Influence of months of layering and auxin concentration with or without 1,2, 4 acid on the number of days taken for root initiation in rose apple layers

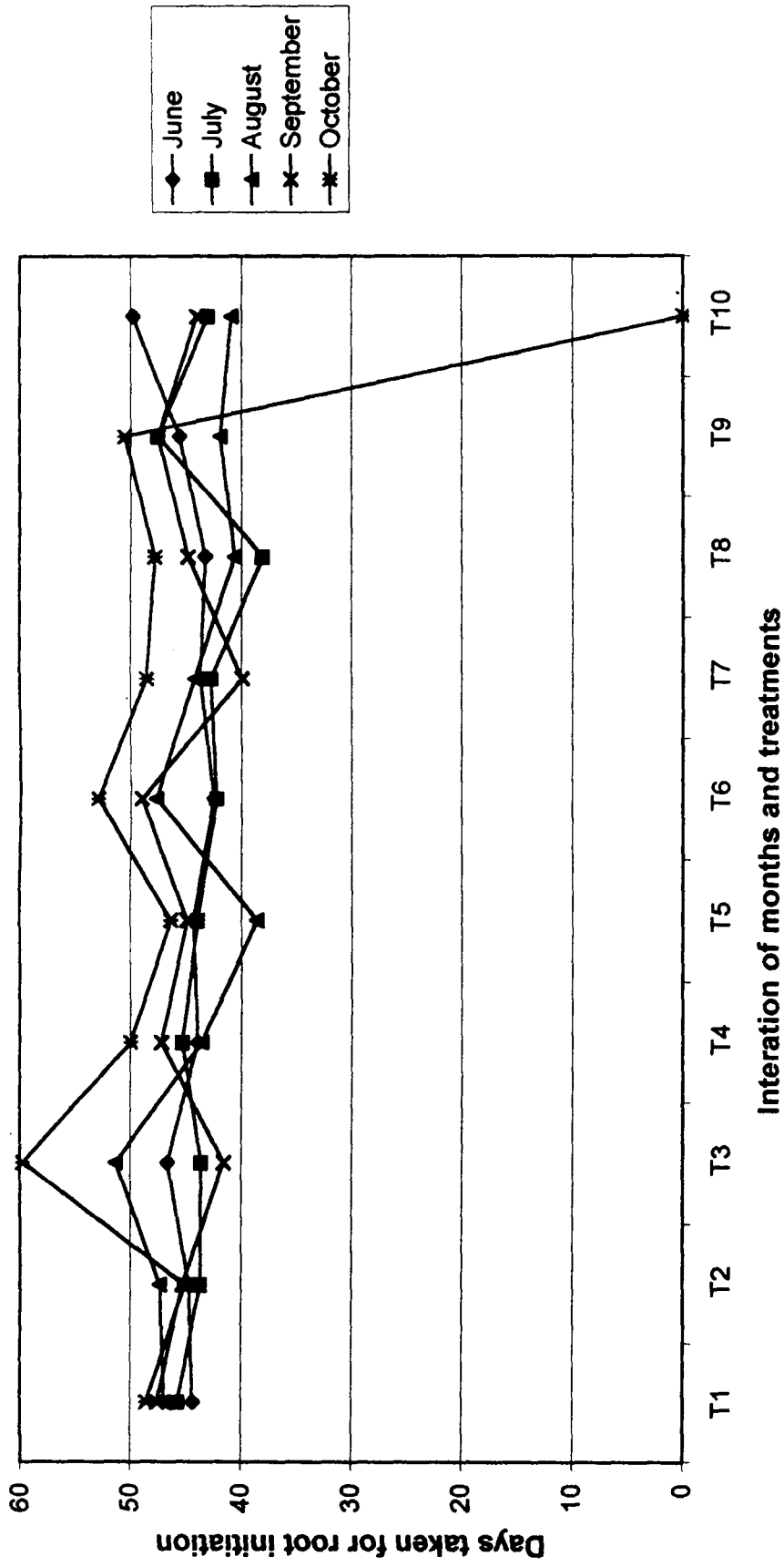


Fig. 1b. Influence of months of layering and auxin concentrations with or without 1,2,4 acid on the number of days taken for root initiation in roseapple air layers

4.2 Percentage of rooting in roseapple air layers

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The results obtained on the percentage of rooting as influenced by months of layering, auxin concentrations with 1,2,4 acid are presented in Table 2.

Among the different months of air layering the percentage of rooting was found to be significant. The rooting percentage was higher when air layers were prepared during June (46.96%). While, the percentage of rooting was comparatively low in layers prepared during September and October months (29.85 and 18.82 per cent respectively). This clearly exhibits a declining trend in percentage of rooting from June month onwards.

Layers treated with different auxin concentrations with or without 1,2,4 acid showed significant difference. Layers treated with 5000 ppm IBA plus 1000 ppm 1,2,4 acid recorded highest rooting percentage (52.08%), followed by the layers treated with 7500 ppm IBA plus 1000 ppm 1,2,4 acid (48.91%) and least 17.58 percentage of rooting was recorded in untreated layers. The layers treated with IBA along with 1,2,4 acid resulted in better rooting compared to IBA alone. However, IBA at a concentration of 5000 ppm also recorded maximum rooting (40.55%).

The interaction effect of months of layering, auxin concentration with or without 1,2,4 acid on percentage of rooting of roseapple airlayers was found significant. However, layers treated with 5000 ppm IBA plus 1000 ppm 1,2,4 acid in the month of August recorded highest rooting

Table 2. Influence of months of layering and, auxin concentrations with or without 1,2,4 acid on percentage of rooting of roseapple air layers

Treatments	June	July	August	September	October	Mean
IBA 7500 ppm	58.44 (7.68)	42.28 (6.54)	37.67 (6.18)	25.58 (5.11)	27.70 (5.49)	38.73 (6.21)
IBA 5000 ppm	53.53 (7.34)	45.64 (6.79)	43.28 (6.62)	39.42 (6.31)	20.88 (4.42)	40.55 (6.33)
IBA 2500 ppm	33.50 (5.83)	24.92 (5.04)	33.88 (5.86)	25.00 (5.05)	12.42 (3.59)	25.95 (5.07)
IBA 7500 ppm + 1,2,4 acid 500 ppm	49.92 (7.09)	49.73 (7.08)	42.11 (6.53)	38.25 (6.21)	16.45 (4.11)	39.29 (6.21)
IBA 5000 ppm + 1,2,4 acid 500 ppm	50.17 (7.12)	41.28 (6.46)	50.33 (7.13)	20.81 (4.61)	25.08 (5.06)	37.53 (6.07)
IBA 2500 ppm + 1,2,4 acid 500 ppm	33.55 (5.83)	25.25 (5.07)	41.62 (6.49)	25.08 (5.06)	8.12 (2.92)	26.72 (5.08)
IBA 7500 ppm + 1,2,4 acid 1000 ppm	58.38 (7.67)	58.47 (7.68)	52.08 (7.25)	41.61 (6.49)	33.97 (5.87)	48.91 (6.99)
IBA 5000 ppm + 1,2,4 acid 1000 ppm	61.75 (7.89)	58.38 (7.67)	66.45 (8.18)	44.97 (6.74)	28.85 (5.42)	52.08 (7.18)
IBA 2500 ppm + 1,2,4 acid 1000 ppm	40.94 (6.44)	33.88 (5.86)	28.86 (5.41)	25.33 (5.08)	12.67 (3.62)	28.34 (5.28)
Control	58.44 (5.46)	42.28 (5.08)	37.67 (4.61)	25.58 (3.58)	27.70 (0.71)	17.58 (3.89)
Mean	46.96 (6.84)	40.52 (6.33)	41.71 (6.43)	29.85 (5.43)	18.82 (4.14)	

	SEm±	CD at 5%
Months (M)	0.24	0.94
Treatments (growth regulators)	0.33	0.66
Interaction (months x growth regulators)	0.76	2.09
Cv (%)		5.21

Note - Values in the paranthesis indicate square root transformed values($\sqrt{x+0.5}$)

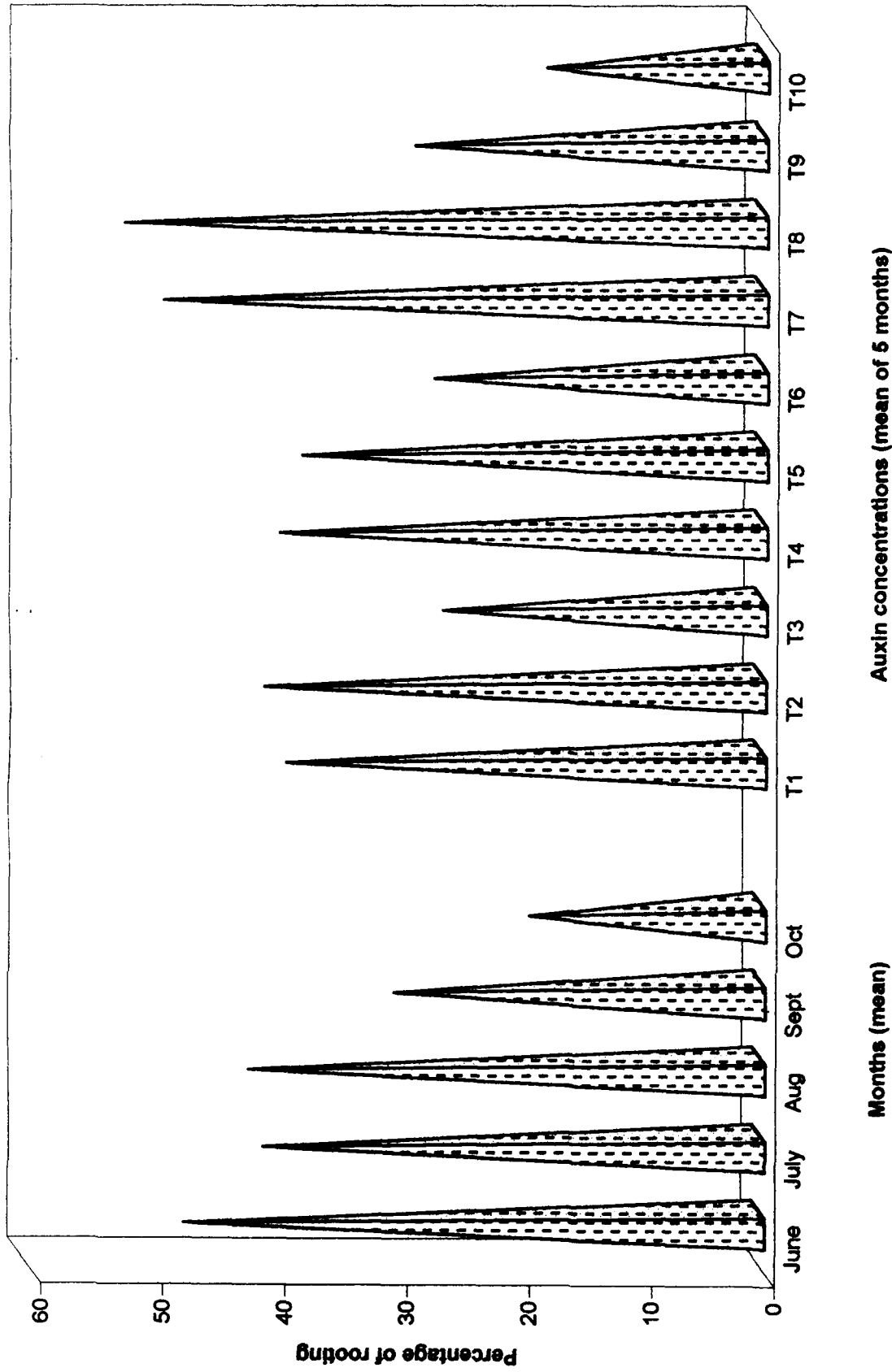
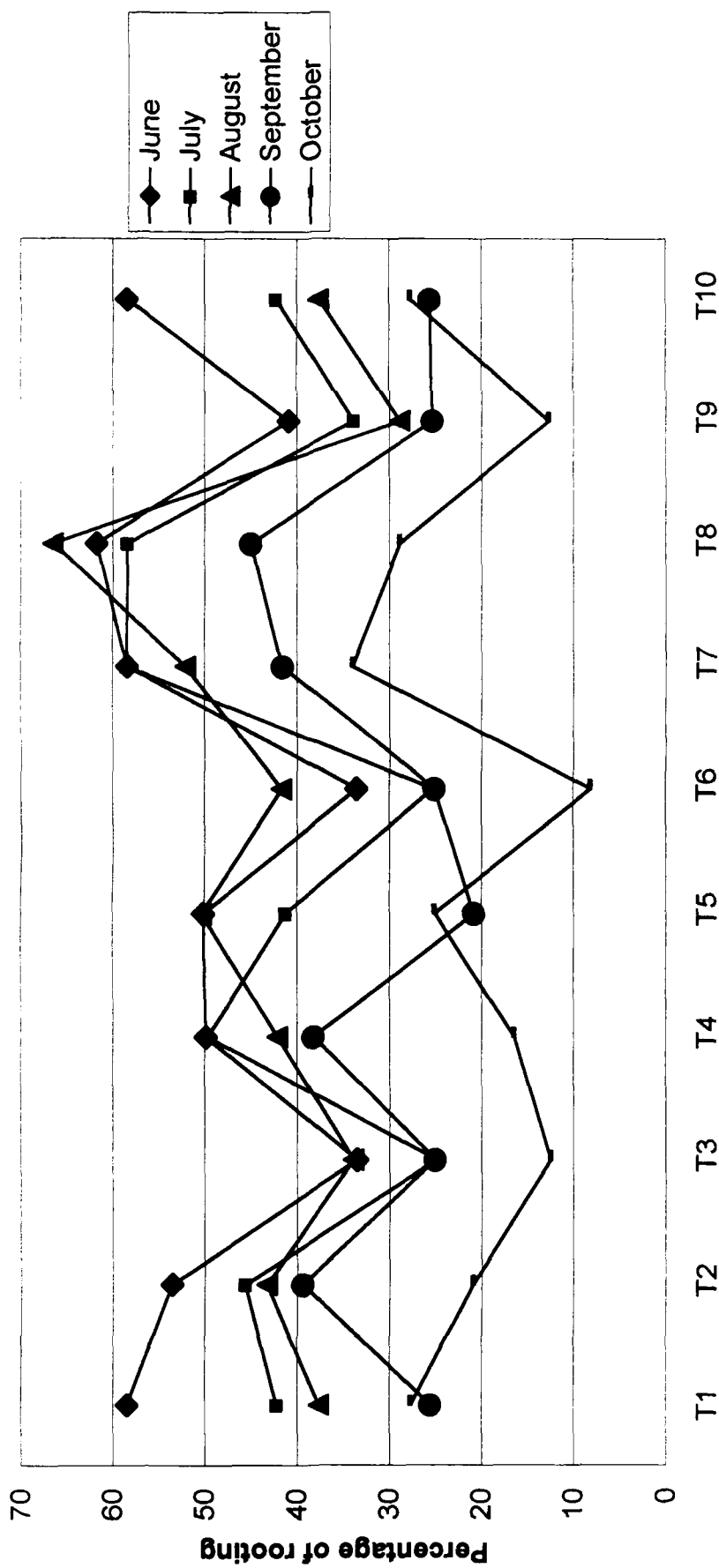


Fig.2a. Influence of months of layering and auxin concentrations with or without 1,2,4 acid on the percentage of rooting of roseapple air layers



Interaction of months and treatments

Fig. 2b. Influence of months of layering and auxin concentrations with or without 1, 2, 4 acid on the percentage of rooting of roseapple air layers

percentage (66.45%) and least in untreated control (0.00%) in the month of October.

4.3 Number of primary roots per air layer

The data recorded on number of primary roots per layer as influenced by different months, auxin and their concentrations along with 1,2,4, acid are presented in Table 3.

Among the different months of air layering the number of primary roots per layer was found to be significant. The layers prepared during June recorded higher number of primary roots (4.97) per layer, which are on par with the layers prepared in July, August and September (4.88, 4.52 and 4.66). Where as the least number of primary roots (4.00) were in October.

In layers treated with different auxin concentrations with or without 1,2,4 acid showed significant difference. Layers treated with 5000 ppm IBA plus 1000 ppm 1,2,4 acid recorded the highest number of primary roots (8.69) which is on par with the layers treated with 7500 ppm IBA plus 1000 ppm 1,2,4 acid (8.67). While, the least number of primary roots were recorded in control (1.15).

The interaction effect of months of layering, auxin and their concentration with or without 1,2,4 acid on number of primary roots was found significant. However, the layers treated with 7500 ppm IBA plus 1000 ppm 1,2,4 acid during July month recorded the highest (10.47) number of primary roots which is on par with the layers treated with the

Table 3. Influence of months of layering and auxin concentrations with or without 1,2,4 acid on the number of primary roots per roseapple air layers

Treatments	June	July	August	September	October	Mean
IBA 7500 ppm	3.61 (2.02)	3.45 (1.98)	3.12 (1.90)	3.11 (1.90)	3.06 (1.89)	3.27 (1.94)
IBA 5000 ppm	3.17 (1.91)	3.14 (1.91)	3.17 (1.91)	3.67 (2.03)	3.14 (1.91)	3.26 (1.93)
IBA 2500 ppm	3.21 (1.93)	2.72 (1.79)	3.14 (1.91)	3.13 (1.91)	1.85 (1.50)	2.81 (1.81)
IBA 7500 ppm + 1,2,4 acid 500 ppm	6.33 (2.57)	5.11 (2.32)	5.64 (2.44)	4.61 (2.23)	3.21 (1.92)	4.98 (2.29)
IBA 5000 ppm + 1,2,4 acid 500 ppm	6.53 (2.62)	5.70 (2.45)	4.66 (2.25)	6.14 (2.55)	3.11 (1.90)	5.23 (2.35)
IBA 2500 ppm + 1,2,4 acid 500 ppm	4.64 (2.27)	4.43 (2.21)	2.95 (1.85)	4.49 (2.23)	1.82 (1.52)	3.66 (2.02)
IBA 7500 ppm + 1,2,4 acid 1000 ppm	8.61 (3.00)	10.47 (3.31)	7.62 (2.85)	8.72 (3.04)	7.92 (2.90)	8.67 (3.02)
IBA 5000 ppm + 1,2,4 acid 1000 ppm	9.47 (3.15)	9.74 (3.41)	9.81 (3.21)	8.79 (3.05)	5.64 (2.47)	8.69 (3.01)
IBA 2500 ppm + 1,2,4 acid 1000 ppm	2.81 (1.81)	2.39 (1.70)	3.57 (2.01)	2.81 (1.81)	1.55 (1.42)	2.63 (1.75)
Control	1.36 (1.36)	1.66 (1.47)	1.54 (1.42)	1.67 (1.27)	0.00 (0.71)	1.15 (1.25)
Mean	4.97 (2.26)	4.88 (2.23)	4.52 (2.18)	4.66 (2.20)	3.13* (1.81)	

	SEm±	CD at 5%
Months (M)	0.14	0.38
Treatments (growth regulators)	0.19	0.54
Interaction (months x growth regulators)	0.44	1.21
Cv (%)		21.05

Note - Values in the paranthesis indicate square root transformed values($\sqrt{x+0.5}$)

Plate 1 & 2 : Influence of auxin and their concentrations with or without 1,2,4 acid on rooting of roseapple air layers in the month of June (S₁)

Treatment details :

1. IBA – 7500 ppm
2. IBA – 5000 ppm
3. IBA – 2500 ppm
4. IBA 7500 ppm + 1,2,4 acid 500 ppm
5. IBA 5000 ppm + 1,2,4 acid 500 ppm
6. IBA 2500 ppm + 1,2,4 acid 500 ppm
7. IBA 7500 ppm + 1,2,4 acid 1000ppm
8. IBA 5000 ppm + 1,2,4 acid 1000 ppm
9. IBA 2500 ppm + 1,2,4 acid 1000 ppm
10. Control (without IBA and 1,2,4 acid)



Plate 3 & 4 : Influence of auxin and their concentrations with or without 1,2,4 acid on rooting of roseapple air layers in the month of July (S₂)

Treatment details :

1. IBA – 7500 ppm
2. IBA – 5000 ppm
3. IBA – 2500 ppm
4. IBA 7500 ppm + 1,2,4 acid 500 ppm
5. IBA 5000 ppm + 1,2,4 acid 500 ppm
6. IBA 2500 ppm + 1,2,4 acid 500 ppm
7. IBA 7500 ppm + 1,2,4 acid 1000ppm
8. IBA 5000 ppm + 1,2,4 acid 1000 ppm
9. IBA 2500 ppm + 1,2,4 acid 1000 ppm
10. Control (without IBA and 1,2,4 acid)



Plate 5 & 6 : Influence of auxin and their concentrations with or without 1,2,4 acid on rooting of roseapple air layers in the month of August (S₃)

Treatment details :

1. IBA – 7500 ppm
2. IBA – 5000 ppm
3. IBA – 2500 ppm
4. IBA 7500 ppm + 1,2,4 acid 500 ppm
5. IBA 5000 ppm + 1,2,4 acid 500 ppm
6. IBA 2500 ppm + 1,2,4 acid 500 ppm
7. IBA 7500 ppm + 1,2,4 acid 1000ppm
8. IBA 5000 ppm + 1,2,4 acid 1000 ppm
9. IBA 2500 ppm + 1,2,4 acid 1000 ppm
10. Control (without IBA and 1,2,4 acid)



Plate 7 & 8 : Influence of auxin and their concentrations with or without 1,2,4 acid on rooting of roseapple air layers in the month of September (S₄)

Treatment details :

1. IBA – 7500 ppm
2. IBA – 5000 ppm
3. IBA – 2500 ppm
4. IBA 7500 ppm + 1,2,4 acid 500 ppm
5. IBA 5000 ppm + 1,2,4 acid 500 ppm
6. IBA 2500 ppm + 1,2,4 acid 500 ppm
7. IBA 7500 ppm + 1,2,4 acid 1000ppm
8. IBA 5000 ppm + 1,2,4 acid 1000 ppm
9. IBA 2500 ppm + 1,2,4 acid 1000 ppm
10. Control (without IBA and 1,2,4 acid)



Plate 9 & 10 : Influence of auxin and their concentrations with or without 1,2,4 acid on rooting of roseapple air layers in the month of October (S₅)

Treatment details :

1. IBA – 7500 ppm
2. IBA – 5000 ppm
3. IBA – 2500 ppm
4. IBA 7500 ppm + 1,2,4 acid 500 ppm
5. IBA 5000 ppm + 1,2,4 acid 500 ppm
6. IBA 2500 ppm + 1,2,4 acid 500 ppm
7. IBA 7500 ppm + 1,2,4 acid 1000ppm
8. IBA 5000 ppm + 1,2,4 acid 1000 ppm
9. IBA 2500 ppm + 1,2,4 acid 1000 ppm
10. Control (without IBA and 1,2,4 acid)



5000 ppm IBA + 1000 ppm 1,2,4 acid during August (9.81). While the least number of primary roots was recorded in the control (1.36) during the month of June.

4.4 Length of primary roots (cm)

The data on length of primary roots as influenced by months of layering, auxin concentration and their interaction with 1,2,4 acid are presented in Table 4.

Among the different months of air layering the length of primary roots was found to be significant. The root length was found maximum in layers prepared during the month of June (3.80 cm). While, the layers prepared during the month of October recorded least root length of 2.71 cm.

In layers treated with different auxin concentrations with or without 1,2,4 acid showed significant difference. The primary roots was maximum length of 5.92 cm in layers treated with 5000 ppm IBA plus 1000 ppm 1,2,4 acid, followed by the layers treated with 7500 ppm IBA plus 1000 ppm 1,2,4 acid (5.17 cm). While the root length was found least (1.51 cm) in untreated layers.

The interaction effect on primary root length was found to be significant. However, the layers prepared during the month of June and treated with 5000 ppm IBA plus 1000 ppm 1,2,4 acid recorded the highest root length of 6.48 cm, followed by the layers treated with same treatment during the month of August (6.38 cm). While the layers

Table 4. Influence of months of layering and auxin concentrations with or without 1,2,4 acid on length of primary roots (cm) of roseapple air layers

Treatments	June	July	August	September	October	Mean
IBA 7500 ppm	3.29 (1.95)	3.63 (2.03)	3.62 (2.03)	3.38 (1.97)	3.36 (1.96)	3.46 (1.99)
IBA 5000 ppm	3.40 (1.97)	2.89 (1.84)	2.39 (1.70)	3.63 (2.03)	2.92 (1.85)	3.05 (1.88)
IBA 2500 ppm	2.86 (1.83)	2.38 (1.69)	2.96 (1.86)	2.31 (1.68)	1.54 (1.43)	2.41 (1.70)
IBA 7500 ppm + 1,2,4 acid 500 ppm	3.96 (2.11)	4.42 (2.21)	3.42 (1.98)	4.29 (2.19)	2.82 (1.82)	3.78 (2.06)
IBA 5000 ppm + 1,2,4 acid 500 ppm	3.44 (1.99)	3.23 (1.93)	4.14 (2.15)	4.6 (2.26)	3.96 (2.11)	3.87 (2.08)
IBA 2500 ppm + 1,2,4 acid 500 ppm	3.31 (1.95)	2.86 (1.83)	2.98 (1.86)	2.58 (1.76)	1.21 (1.31)	2.58 (1.74)
IBA 7500 ppm + 1,2,4 acid 1000 ppm	5.68 (2.48)	5.70 (2.48)	5.18 (2.38)	4.43 (2.22)	4.98 (2.34)	5.19 (2.38)
IBA 5000 ppm + 1,2,4 acid 1000 ppm	6.48 (2.64)	6.27 (2.60)	6.38 (2.62)	5.79 (2.51)	4.67 (2.27)	5.92 (2.53)
IBA 2500 ppm + 1,2,4 acid 1000 ppm	3.42 (1.98)	2.87 (1.84)	2.81 (1.82)	2.96 (1.86)	1.61 (1.45)	2.73 (1.79)
Control	2.09 (1.61)	1.96 (1.57)	1.71 (1.49)	1.77 (1.5)	0.00 (0.71)	1.51 (1.38)
Mean	3.80 (2.05)	3.62 (2.00)	3.56 (1.99)	3.58 (1.99)	2.71 (1.73)	

Months (M)	SEm± 0.008	CD at 5% 0.023
Treatments (growth regulators)	0.012	0.033
Interaction (months x growth regulators)	0.027	0.073
Cv (%)		1.88

Note - Values in the paranthesis indicate square root transformed values($\sqrt{x+0.5}$)

prepared during the month of October and treated with 2500 ppm IBA plus 500 ppm 1,2,4 acid recorded a least root length of 1.21 cm.

4.5 Girth of primary roots (mm)

The data on girth of primary roots as influenced by months of layering, auxin and their interaction with 1,2,4 acid are presented in Table 5.

The different months of air layering have a significant influence on girth of primary roots. However, layers prepared during August month recorded maximum primary root girth (2.01 mm), followed by the layers prepared in the month of June (1.88 mm) and July (1.89 mm). While the layers prepared in October recorded the least girth (1.21 mm).

In layers treated with different auxin concentrations with or without 1,2,4 acid showed significant difference. However, maximum girth of primary root was recorded in layers treated with 5000 ppm IBA plus 1000 ppm 1,2,4 acid (2.25 mm), followed by the layers treated with 7500 IBA plus 1000 ppm 1,2,4 acid (2.08 mm). While, the minimum was recorded in untreated layers (0.94 mm).

The interaction effect of months of layering, auxin concentrations with 1,2,4 acid on girth of primary roots was significant. The layers prepared during the month of August and treated with 5000 ppm IBA plus 1000 ppm 1,2,4 acid recorded the maximum root girth of 2.43 mm, followed by the layers treated with the same treatment during July (2.34

Table 5. Influence of months of layering and auxin concentrations with or without 1,2,4 acid on primary root girth (mm) of roseapple air layers

Treatments	June	July	August	September	October	Mean
IBA 7500 ppm	1.93 (1.55)	1.89 (1.55)	1.98 (1.58)	1.60 (1.45)	1.68 (1.48)	1.82 (1.52)
IBA 5000 ppm	2.13 (1.62)	2.08 (1.61)	2.19 (1.64)	1.89 (1.55)	1.65 (1.65)	1.99 (1.58)
IBA 2500 ppm	1.89 (1.55)	1.88 (1.54)	1.67 (1.47)	1.42 (1.38)	0.73 (1.11)	0.52 (1.41)
IBA 7500 ppm + 1,2,4 acid 500 ppm	2.10 (1.61)	2.03 (1.59)	2.12 (1.62)	1.69 (1.48)	0.93 (1.4)	1.78 (1.50)
IBA 5000 ppm + 1,2,4 acid 500 ppm	1.68 (1.48)	1.83 (1.53)	1.98 (1.58)	2.18 (1.64)	1.61 (1.45)	1.86 (1.53)
IBA 2500 ppm + 1,2,4 acid 500 ppm	1.81 (1.52)	1.77 (1.51)	1.87 (1.54)	1.71 (1.49)	6.73 (1.07)	1.56 (1.42)
IBA 7500 ppm + 1,2,4 acid 1000 ppm	2.17 (1.63)	2.18 (1.63)	2.23 (1.65)	2.08 (1.61)	1.78 (1.51)	2.08 (1.61)
IBA 5000 ppm + 1,2,4 acid 1000 ppm	2.23 (1.65)	2.34 (1.68)	2.43 (1.71)	2.18 (1.64)	2.05 (1.59)	2.25 (1.66)
IBA 2500 ppm + 1,2,4 acid 1000 ppm	1.80 (1.52)	1.75 (1.50)	1.88 (1.54)	1.60 (1.45)	0.98 (1.21)	1.60 (1.44)
Control	1.44 (1.28)	1.11 (1.27)	1.73 (1.49)	0.65 (1.11)	0.00 (0.71)	0.94 (1.18)
Mean	1.88 (1.54)	1.89 (1.54)	2.01 (1.58)	1.71 (1.48)	1.21 (1.28)	

	SEm±	CD at 5%
Months (M)	0.008	0.023
Treatments (growth regulators)	0.012	0.031
Interaction (months x growth regulators)	0.026	0.071
Cv (%)		3.62

Note - Values in the paranthesis indicate square root transformed values($\sqrt{x+0.5}$)

mm). While the layers tied in the month of September and untreated recorded minimum girth of 0.65 mm.

4.6 Number of secondary roots per air layer

The data recorded on number of secondary roots per air layer as influenced by different months, auxins and their concentrations along with 1,2,4 acid are presented in Table 6.

Among the different months of layering the number of secondary roots per air layer was found to be significant. The layers prepared during the month of July recorded significantly higher number of secondary roots (8.36) per layer, followed by the layers prepared in August (7.91) and the lowest number of secondary roots (3.99) were in October.

In layers treated with different concentrations of auxins with or without 1,2,4 acid showed significant difference. Layers treated with 5000 ppm IBA plus 1000 ppm 1,2,4 acid recorded the highest number of secondary roots (11.97), followed by the layers treated with 7500 ppm IBA plus 1000 ppm 1,2,4 acid (10.48) and least number of secondary roots were recorded in control (2.89).

The interaction effect of months of layering, auxin and their concentrations with 1,2,4 acid on number of secondary roots was found significant. The layers treated with 5000 ppm IBA plus 1000 ppm 1,2,4 acid during July recorded the highest (16.56) number of secondary roots, followed by the layers prepared during August with the same treatment

Table 6. Influence of months of layering and auxin concentrations with or without 1,2,4 acid on the number of secondary roots per roseapple air layers

Treatments	June	July	August	September	October	Mean
IBA 7500 ppm	7.14 (2.76)	7.08 (2.75)	6.23 (2.59)	7.58 (2.84)	5.62 (2.47)	6.73 (2.69)
IBA 5000 ppm	7.70 (2.86)	7.73 (2.87)	7.86 (2.89)	9.34 (3.14)	4.73 (2.29)	7.47 (2.81)
IBA 2500 ppm	5.73 (2.49)	4.58 (2.25)	5.23 (2.39)	4.73 (2.29)	1.36 (1.36)	4.32 (2.16)
IBA 7500 ppm + 1,2,4 acid 500 ppm	8.86 (3.06)	9.71 (3.21)	8.87 (3.06)	8.08 (2.93)	3.86 (1.97)	7.87 (2.87)
IBA 5000 ppm + 1,2,4 acid 500 ppm	10.14 (3.06)	11.31 (3.44)	10.83 (3.36)	8.83 (3.05)	3.38 (1.35)	8.89 (3.02)
IBA 2500 ppm + 1,2,4 acid 500 ppm	6.50 (2.65)	7.00 (2.70)	6.72 (2.69)	6.00 (2.55)	1.34 (3.01)	5.51 (2.40)
IBA 7500 ppm + 1,2,4 acid 1000 ppm	9.57 (3.17)	11.00 (3.39)	11.02 (3.39)	12.21 (3.56)	8.58 (3.01)	10.48 (3.31)
IBA 5000 ppm + 1,2,4 acid 1000 ppm	10.00 (3.25)	16.56 (4.13)	13.21 (3.70)	11.58 (3.48)	8.51 (3.00)	11.97 (3.57)
IBA 2500 ppm + 1,2,4 acid 1000 ppm	4.86 (3.31)	4.58 (2.12)	4.73 (2.28)	5.30 (2.41)	2.50 (1.73)	4.39 (2.21)
Control	4.75 (2.28)	4.00 (2.12)	4.42 (2.21)	1.31 (1.34)	0.00 (0.71)	2.89 (1.73)
Mean	7.53 (2.81)	8.36 (2.91)	7.91 (2.86)	7.49 (2.76)	3.99 (1.99)	

	SEm±	CD at 5%
Months (M)	0.023	0.066
Treatments (growth regulators)	0.033	0.093
Interaction (months x growth regulators)	0.75	0.21
Cv (%)		2.60

Note - Values in the paranthesis indicate square root transformed values ($\sqrt{x+0.5}$)

(13.21). While the least number of secondary roots was recorded in the untreated layers (1.31) in September month.

4.7 Length of secondary roots (cm)

The data on length of secondary roots as influenced by months of layering, auxin concentrations with 1,2,4 acid are presented in Table 7.

Among the different months of air layering the length of secondary roots was found to be significant. The root length was found maximum in layers prepared during the month of August (1.67 cm), which are on par with the June (1.66 cm), July (1.62 cm) and September (1.43 cm). While, the layers prepared during the October month recorded least root length of 0.99 cm.

The layers treated with different auxin concentrations with or without 1,2,4 acid showed significant differences. The length of secondary roots were maximum (1.79 cm) in layers treated with 5000 ppm IBA plus 1000 ppm 1,2,4 acid which is on par with the layers treated with 7500 ppm IBA plus 1000 pm 1,2,4 acid (1.76 cm). While, the minimum length of secondary roots was found in control (0.91 cm).

The interaction effect on root length was found to be significant. The layers prepared during the month of August and treated with 5000 ppm IBA plus 1000 ppm 1,2,4 acid recorded the highest root length of 2.10 cm, which is on par with the layers prepared during the month of June and treated with 2500 ppm IBA plus 1000 ppm 1,2,4 acid (1.98 cm). While, the layers prepared during the month of October and treated with

Table 7. Influence of months of layering and auxin concentrations with or without 1,2,4 acid on length of secondary roots (cm) of roseapple air layers

Treatments	June	July	August	September	October	Mean
IBA 7500 ppm	1.20 (1.29)	1.21 (1.29)	1.18 (1.28)	1.12 (1.26)	1.33 (1.34)	1.21 (1.30)
IBA 5000 ppm	1.90 (1.55)	1.70 (1.48)	1.72 (1.48)	1.55 (1.43)	1.57 (1.40)	1.69 (1.47)
IBA 2500 ppm	1.21 (1.63)	1.23 (1.31)	1.28 (1.33)	1.08 (1.26)	0.52 (0.97)	1.34 (1.30)
IBA 7500 ppm + 1,2,4 acid 500 ppm	1.83 (1.52)	1.82 (1.52)	1.62 (1.45)	1.73 (1.49)	0.92 (1.11)	1.58 (1.42)
IBA 5000 ppm + 1,2,4 acid 500 ppm	1.72 (1.49)	1.65 (1.46)	1.83 (1.51)	1.82 (1.52)	1.45 (1.36)	1.69 (1.47)
IBA 2500 ppm + 1,2,4 acid 500 ppm	1.82 (1.52)	1.77 (1.49)	1.78 (1.50)	1.60 (1.44)	0.40 (0.40)	1.47 (1.37)
IBA 7500 ppm + 1,2,4 acid 1000 ppm	1.85 (1.52)	1.87 (1.53)	1.93 (1.55)	1.63 (1.45)	1.53 (1.39)	1.76 (1.49)
IBA 5000 ppm + 1,2,4 acid 1000 ppm	1.73 (1.48)	1.90 (1.54)	2.10 (1.61)	1.63 (1.45)	1.58 (1.92)	1.79 (1.50)
IBA 2500 ppm + 1,2,4 acid 1000 ppm	1.98 (1.55)	1.92 (1.53)	1.90 (1.53)	1.40 (1.37)	0.58 (0.99)	1.56 (1.39)
Control	1.42 (1.38)	1.12 (1.23)	1.35 (1.35)	0.68 (1.00)	0.00 (0.71)	0.91 (1.14)
Mean	1.66 (1.49)	1.62 (1.44)	1.67 (1.46)	1.43 (1.37)	0.99 (1.15)	

	SEm±	CD at 5%
Months (M)	0.09	0.25
Treatments (growth regulators)	0.13	0.36
Interaction (months x growth regulators)	0.28	0.79
Cv (%)		4.67

Note - Values in the paranthesis indicate square root transformed values ($\sqrt{x+0.5}$)

2500 ppm IBA plus 500 ppm 1,2,4 acid recorded a least root length of 0.40 cm. 33

4.8 Girth of secondary roots (mm)

The influence of different months of layering on the girth of secondary roots was found to be significant. Maximum girth of secondary roots was recorded in August (0.99 mm) prepared layers, which is on par with the layers prepared in all the months except October (0.62 mm) which was found minimum root girth. Layers treated with different auxin concentration with or without 1,2,4 acid also shown significant difference. The maximum girth of secondary roots (1.26 mm) recorded in layers treated with 5000 ppm IBA plus 500 ppm 1,2,4 acid, which is on par with the layers treated with 5000 ppm IBA plus 1000 ppm 1,2,4 acid (1.14mm). While, the minimum was observed in control (0.45 mm).

The interaction effect of months with different treatments showed significant difference. Maximum girth of secondary roots (1.42 mm) was in layers treated with 5000 ppm IBA plus 500 ppm 1,2,4 acid in September month of layering and minimum (0.32 mm) was in the month of October with 2500 ppm IBA plus 500 ppm 1,2,4, acid.

4.9 Number of tertiary roots

The data on number of tertiary roots per air layers as influenced by different months of air layering, auxin concentrations with or without 1,2,4 acid is presented in Table 9.

Table 8. Influence of months of layering and auxin concentrations with or without 1,2,4 acid on girth of secondary roots (mm) of roseapple air layers

Treatments	June	July	August	September	October	Mean
IBA 7500 ppm	0.95 (1.20)	0.93 (1.19)	0.88 (1.67)	0.95 (1.21)	0.73 (1.10)	0.89 (1.17)
IBA 5000 ppm	1.05 (1.23)	0.94 (1.19)	0.92 (1.18)	0.85 (1.18)	0.88 (1.15)	0.93 (1.18)
IBA 2500 ppm	0.72 (1.10)	0.65 (1.07)	1.00 (1.21)	0.63 (1.06)	0.57 (0.99)	0.71 (1.09)
IBA 7500 ppm + 1,2,4 acid 500 ppm	0.92 (1.19)	0.91 (1.19)	1.05 (1.23)	1.06 (1.23)	0.38 (0.91)	0.86 (1.15)
IBA 5000 ppm + 1,2,4 acid 500 ppm	1.32 (1.34)	1.33 (1.34)	1.40 (1.37)	1.42 (1.38)	0.85 (1.14)	1.26 (1.31)
IBA 2500 ppm + 1,2,4 acid 500 ppm	0.62 (1.05)	0.57 (1.02)	0.80 (1.14)	0.75 (1.11)	0.32 (0.87)	0.61 (1.04)
IBA 7500 ppm + 1,2,4 acid 1000 ppm	0.82 (1.12)	0.93 (1.19)	1.08 (1.25)	1.01 (1.23)	0.97 (1.18)	0.96 (1.21)
IBA 5000 ppm + 1,2,4 acid 1000 ppm	1.20 (1.29)	1.13 (1.27)	1.15 (1.28)	1.14 (1.28)	1.07 (1.25)	1.14 (1.28)
IBA 2500 ppm + 1,2,4 acid 1000 ppm	0.97 (1.21)	0.90 (1.18)	0.91 (1.18)	0.83 (1.15)	0.45 (0.94)	0.81 (1.14)
Control	0.65 (1.05)	0.60 (1.03)	0.67 (1.07)	0.35 (0.90)	0.00 (0.71)	0.45 (0.95)
Mean	0.92 (1.18)	0.88 (1.17)	0.99 (1.21)	0.90 (1.17)	0.62 (1.02)	

	SEm±	CD at 5%
Months (M)	0.05	0.13
Treatments (growth regulators)	0.07	0.19
Interaction (months x growth regulators)	0.15	0.41
Cv (%)		4.23

Note - Values in the paranthesis indicate square root transformed values($\sqrt{x+0.5}$)

Table 9. Influence of months of layering and auxin concentrations with or without 1,2,4 acid on number of tertiary roots per roseapple air layers

Treatments	June	July	August	September	October	Mean
IBA 7500 ppm	5.08 (2.36)	4.58 (2.25)	6.86 (2.71)	5.36 (2.42)	4.58 (2.25)	5.29 (2.40)
IBA 5000 ppm	4.58 (2.25)	4.23 (2.17)	4.36 (2.21)	4.23 (2.17)	3.73 (2.06)	4.21 (2.18)
IBA 2500 ppm	4.23 (2.17)	4.08 (2.14)	3.08 (1.89)	3.09 (1.89)	1.73 (1.49)	3.25 (1.92)
IBA 7500 ppm + 1,2,4 acid 500 ppm	7.44 (2.82)	7.23 (2.78)	7.08 (2.75)	7.23 (2.78)	4.44 (2.43)	6.69 (2.67)
IBA 5000 ppm + 1,2,4 acid 500 ppm	11.58 (3.48)	13.73 (3.77)	7.44 (2.82)	6.58 (2.66)	8.31 (2.97)	9.53 (3.14)
IBA 2500 ppm + 1,2,4 acid 500 ppm	4.73 (2.29)	5.17 (2.38)	5.58 (2.47)	5.17 (2.38)	2.58 (1.76)	4.65 (2.25)
IBA 7500 ppm + 1,2,4 acid 1000 ppm	7.58 (2.84)	7.59 (2.84)	8.44 (2.99)	9.58 (3.18)	7.58 (2.84)	8.16 (2.94)
IBA 5000 ppm + 1,2,4 acid 1000 ppm	11.31 (3.44)	14.44 (3.87)	12.36 (3.59)	12.75 (3.64)	6.86 (2.71)	11.54 (3.45)
IBA 2500 ppm + 1,2,4 acid 1000 ppm	5.31 (2.41)	4.75 (2.29)	5.08 (2.36)	4.31 (2.19)	2.08 (1.61)	4.31 (2.17)
Control	5.08 (2.36)	3.31 (1.95)	3.17 (1.91)	1.86 (1.54)	0.00 (0.71)	2.68 (1.69)
Mean	6.69 (2.64)	6.91 (2.64)	6.35 (2.57)	6.02 (2.48)	4.18 (2.06)	

	SEm±	CD at 5%
Months (M)	0.015	0.044
Treatments (growth regulators)	0.023	0.063
Interaction (months x growth regulators)	0.051	0.14
Cv (%)		2.06

Note - Values in the paranthesis indicate square root transformed values ($\sqrt{x+0.5}$)

Among the different months of layering, the number of tertiary roots per air layers was found significant. The number of tertiary roots per layer was higher (6.91) in layers prepared during July month, followed by June month (6.69). Where as the layers prepared during October month recorded least number of tertiary roots per layer (4.18).

The layers treated with different auxin concentration with or without 1,2,4 acid showed a significant difference. The layers treated with the 5000 ppm IBA + 1000 ppm 1,2,4 acid recorded highest number of roots (11.54), followed by the layers treated with 5000 ppm IBA plus 500 ppm 1,2,4 acid (9.53) treated layers and least was recorded in untreated layers (2.68).

The interaction effect of months of layering with different treatment was found significant. The layers prepared in the month of July and treated with the 5000 ppm IBA plus 1000 ppm 1,2,4 acid significantly recorded highest number of tertiary roots (14.44). While, the least number of tertiary roots per layer was recorded in the month of October in 2500 ppm IBA (1.73).

4.10 Survival percentage of rooted layers

The results obtained in the survival percentage of rooted air layers as influenced by months of air layering and auxin concentrations with or without 1,2,4 acid are presented in Table 10.

The month of layering was found to have a significant influence on survival of layers. The layers prepared during June recorded significantly

Table10. Influence of months of layering and auxin concentrations with or without 1,2,4 acid on survival percentage of roseapple air layers

Treatments	June	July	August	September	October	Mean
IBA 7500 ppm	32.88 (5.78)	30.69 (5.58)	32.56 (5.75)	25.00 (5.05)	16.11 (4.07)	27.45 (5.24)
IBA 5000 ppm	41.11 (6.45)	30.50 (5.51)	34.38 (5.90)	32.07 (5.76)	25.17 (5.06)	32.77 (5.73)
IBA 2500 ppm	25.08 (5.06)	16.11 (4.07)	29.28 (5.45)	29.29 (5.46)	4.53 (2.19)	20.84 (4.45)
IBA 7500 ppm + 1,2,4 acid 500 ppm	37.25 (6.14)	33.18 (5.80)	32.21 (5.72)	31.89 (5.69)	8.06 (2.91)	28.52 (5.25)
IBA 5000 ppm + 1,2,4 acid 500 ppm	32.38 (5.73)	16.36 (4.10)	37.13 (6.13)	21.03 (5.43)	16.28 (4.07)	26.23 (5.09)
IBA 2500 ppm + 1,2,4 acid 500 ppm	41.18 (6.45)	20.06 (4.53)	33.56 (5.83)	12.67 (3.63)	8.60 (3.02)	23.21 (4.69)
IBA 7500 ppm + 1,2,4 acid 1000 ppm	58.38 (7.67)	45.31 (6.77)	54.03 (7.38)	50.08 (7.11)	25.58 (5.10)	46.47 (6.81)
IBA 5000 ppm + 1,2,4 acid 1000 ppm	41.27 (6.46)	56.11 (7.52)	61.83 (7.89)	33.06 (5.78)	16.36 (4.10)	41.30 (6.35)
IBA 2500 ppm + 1,2,4 acid 1000 ppm	33.39 (5.82)	29.36 (5.46)	25.33 (5.08)	12.75 (3.64)	12.83 (3.65)	21.73 (4.73)
Control	25.00 (5.05)	20.31 (4.56)	16.51 (4.12)	4.43 (2.23)	0.00 (0.71)	13.27 (3.33)
Mean	36.79 (6.06)	29.80 (5.39)	35.68 (5.93)	26.09 (4.98)	13.34 (3.49)	

	SEm±	CD at 5%
Months (M)	0.28	0.79
Treatments (growth regulators)	0.40	1.12
Interaction (months x growth regulators)	0.90	2.50
Cv (%)		7.78

Note - Values in the paranthesis indicate square root transformed values ($\sqrt{x+0.5}$)

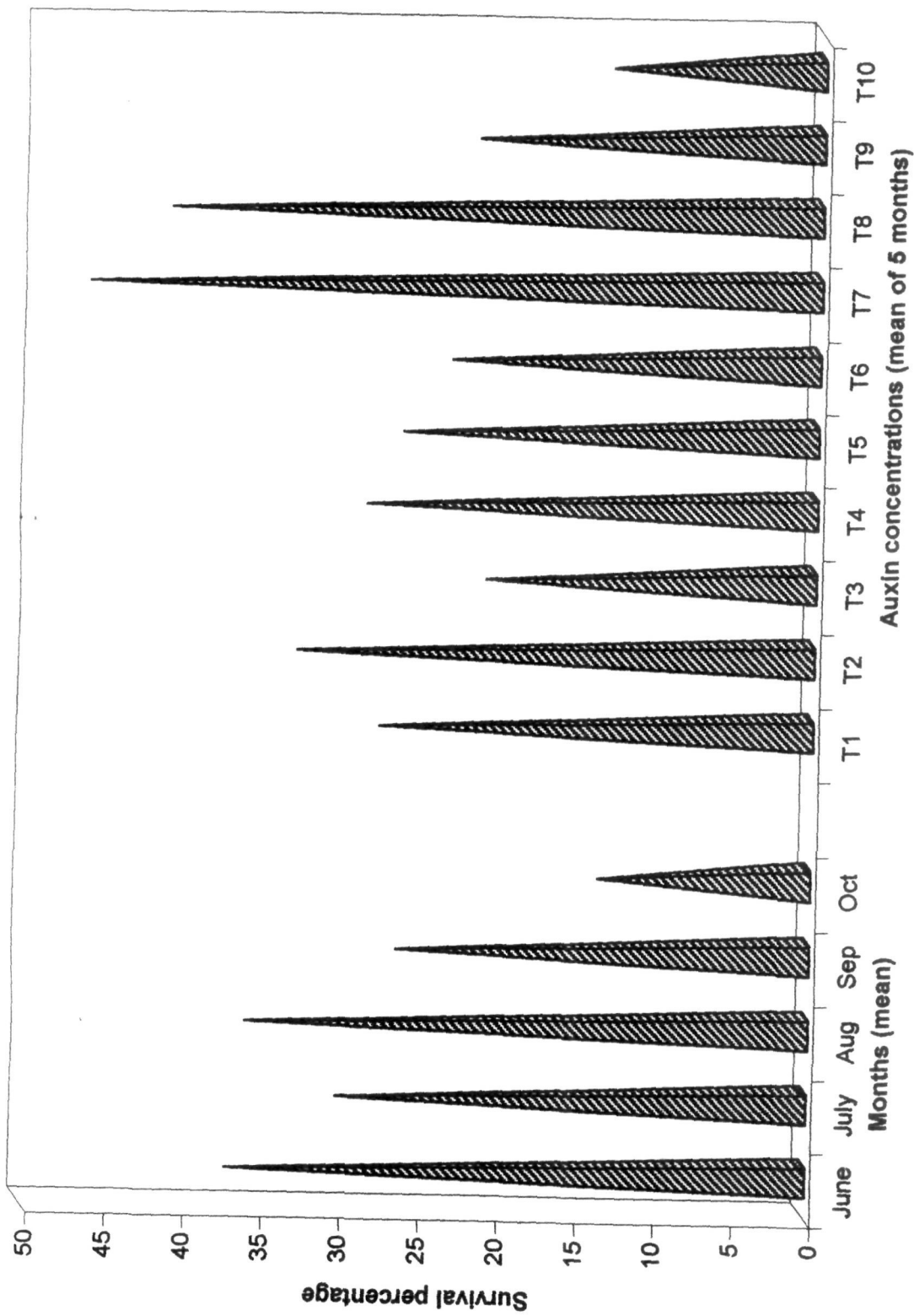
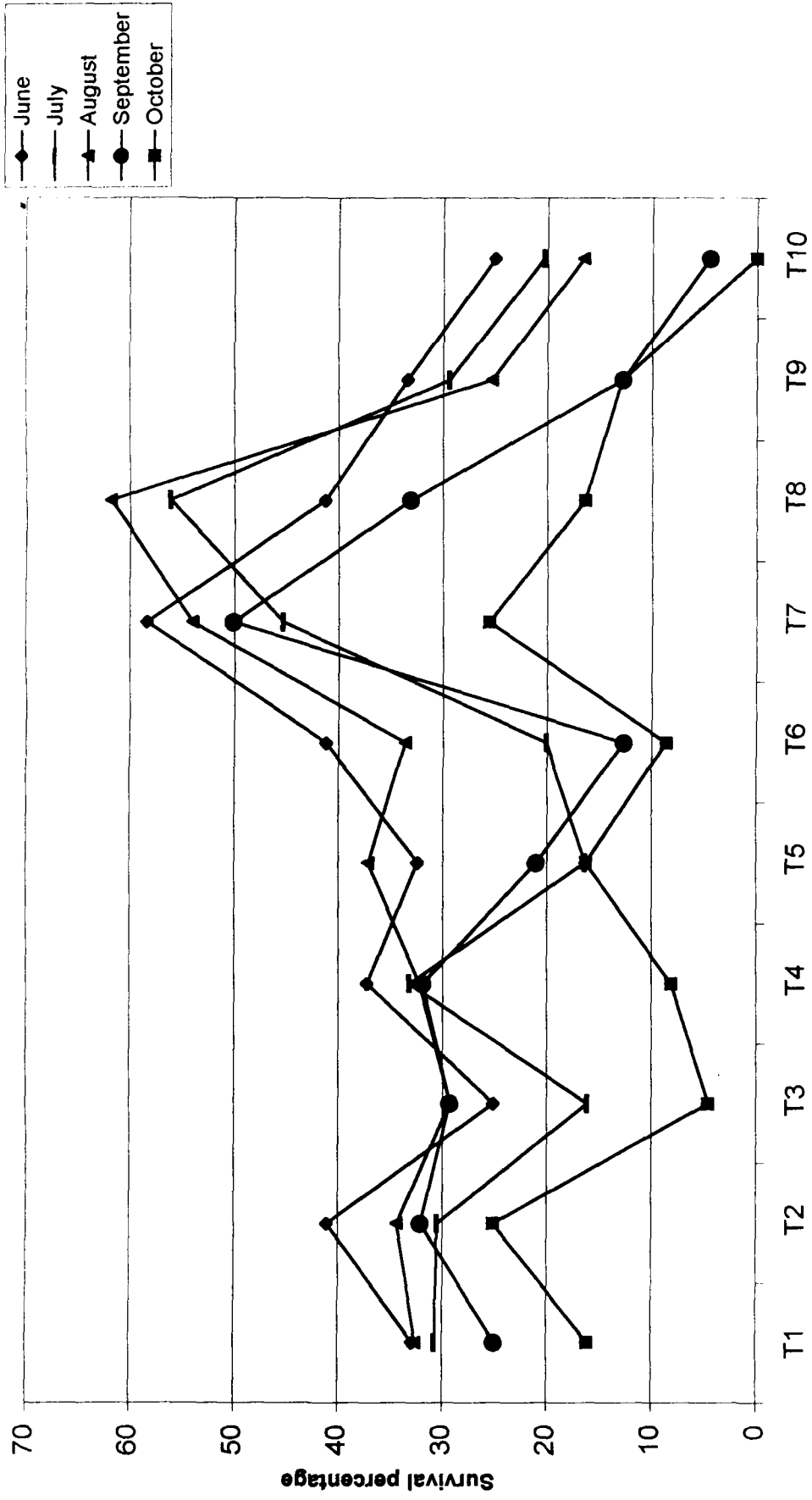


Fig.3a. Influence of months of layering and auxin concentrations with or without 1,2,4 acid on the survival percentage of roseapple air layers



Interaction of months and treatments

Fig.3b. Influence of months of layering and auxin concentrations with or without 1, 2, 4 acid on the survival percentage of rooted roseapple air layers

highest (36.79%) survival rate followed by layers tied in August (35.68%). While, the lowest survival percentage was recorded in the month of October (13.34%).

The survival of air layers was significantly influenced by auxin concentrations with or without 1,2,4 acid treatment. The highest survivality was observed in layers treated with 7500 ppm IBA plus 1000 ppm 1,2,4 acid (46.47%) followed by the layers treated with 5000 ppm IBA + 1000 pm 1,2,4 acid (41.30%) and lowest survival percentage of layers was recorded in control (13.27%). Among the auxins the highest survival percentage of layers was recorded in layers treated with 5000 ppm IBA (32.77%) and lowest was recorded with 2500 ppm IBA (20.84%).

The interaction effect of months of layering, auxin concentrations with or without 1,2,4 acid on survival percentage of rooted air layers was significant. Maximum survivality (61.83%) was observed in layers treated with 5000 ppm IBA plus 1000 ppm 1,2,4 acid in the month of August prepared layers, followed by the layers treated with 7500 ppm IBA plus 1000 ppm 1,2,4 acid in the month of June (58,38%). While, the lowest survivality was observed in control (4.43%) during September month.

4.11 Biochemical composition of roseapple shoots during different months

At the time of each month of layering roseapple shoots were sampled and analysed for the biochemical constituents viz., starch, total

sugar, carbohydrates, total nitrogen, computed C:N ratio and total phenol content are presented in Table 11.

4.11.1 Total sugars

A perusal of the data reveals that sugar content in the shoots of roseapple during different months was significant. In the month of July, the sugar content was more (9.13%) in shoots followed by August (8.81%). The least sugar content in shoots was recorded during October (8.16%) month.

4.11.2 Starch content

The starch content during different months in roseapple shoots was significant. The highest starch content was in the shoots collected during the month of July (8.40%), followed by August (8.24%). The least starch content was recorded during October (8.18%).

4.11.3 Carbohydrates

The carbohydrates content during different months of roseapple shoots was significant. During July month shoots recorded the highest amount of carbohydrates (17.04%), which is on par with the carbohydrate content in August (17.03%). The carbohydrate content during these two months was significantly higher than June, September and October. The least carbohydrate content was recorded during October (15.84%).

**Table 11. Biochemical composition of roseapple shoots at the time of layering
(% dry weight) during different months**

Months	Total sugar g/100 g	Starch g/100 g	CHO g/100 g	Total N g/100 g	C:N ratio	Phenols (g/100 g)
June	8.47	8.19	16.44	1.29	12.91	3.57
July	9.13	8.40	17.04	1.44	11.83	3.63
August	8.81	8.24	17.03	1.35	12.62	3.57
September	8.18	8.19	16.02	1.21	13.36	3.49
October	8.16	8.18	15.84	1.31	12.12	3.23
SEm±	0.09	0.04	0.37	0.05	0.46	0.12
CD at 5 %	0.27	0.13	1.06	0.14	1.33	0.35

4.11.4 Total nitrogen

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The total nitrogen content in shoots of roseapple during different months was significant. However, highest total nitrogen content was recorded during July (1.44%) which is on par with the total nitrogen content during August (1.35%). While, the lowest nitrogen content of 1.21 per cent was in September.

4.11.5 C:N ratio

The computed data on C:N ratio in shoots of roseapple during different months varied significantly. The C:N ratio was more during September month (13.36), followed by June (12.91) and least was in the month of July (11.83).

4.11.6 Total phenols

The total phenol content in roseapple plant shoots during different months varied significantly. The total phenol content was more in July (3.63) month followed by August (3.57) and least was in October (3.23).

DISCUSSION

V. DISCUSSION

The results of investigation conducted to study the seasonal influence, role of different auxins with or without the synergists 1-amino 2-hydroxy phenyl 4-sulphonic acid on rooting of roseapple air layers is discussed in this chapter.

5.1 Number of days taken for root initiation

The layers prepared during July recorded fewer number of days (43.61) for rooting than those prepared during September (45.20 days). This difference in number of days for rooting may be attributed to varying weather conditions viz., increase in relative humidity (75%) coupled with higher atmospheric temperature (19.3°C). It is also associated with occurrence of monsoon rains (97.3 mm) during July month (Appendix) favoured quick rooting of layers. Similarly, Alkhatib (1986) found in mango that higher temperature favoured meristematic activity in mango layers and higher relative humidity and high rain fall provided favourable environment for root initiation and development. During September, low temperature and low humidity were not quite favourable for meristematic activity and hence root initiation and development was delayed. The layering studies of Bhandary and Kololgi (1961) in guava required longer periods for root initiation during September than during the month of May, June and July.

Current studies indicated a significant difference in concentration of IBA on number of days taken for root initiation in roseapple. The layers treated with 5000 ppm and 7500 ppm of IBA along with 1000 ppm

1,2,4 acid resulted in early root initiation. So it could be concluded that 5000 ppm of IBA along with 1000 ppm 1,2,4 acid is optimum for early root initiation in roseapple by air layering.

The interaction effect of the month of layering, auxin concentration with or without 1,2,4 acid revealed that the layers prepared with 5000 ppm IBA + 1000 ppm 1,2,4 acid initiated early rooting in all the months of layering compared with auxins alone and control. Similar results were also obtained by Suryanarayana and Rao (1984). They observed that time taken for rooting was shortest when treated with IBA 5000 ppm in fig air layers. Chinnappa (1962) reported that in air layers of litchi, IBA and NAA combined in equal proportions at 15000 ppm concentration resulted in early rooting and better root initiation.

The variation in days taken for root initiation and development may be influenced by weather factors, biochemical constituents of the plant and severity of girdling.

5.2 Percentage of rooting in roseapple air layers

The layers prepared during June month recorded highest rooting percentage (46.96%) followed by those prepared in August (41.71%). Lowest percentage of rooting was recorded during October (18.82%). There was a significant difference in the per cent rooting in layers prepared during different months. These differences in percentage of rooting may be attributed to the varying weather conditions such as temperature relative humidity and rainfall. During June and July, relative higher temperature, humidity and rainfall might have provided conducive

environment for root initiation. In addition, bio-chemical constituents of plant such as higher sugar content, C:N ratio and phenol content might have accounted for the observed differences. The studies of Narayana Reddy (1993) in roseapple and wood apple showed that layers prepared during the month of June recorded the highest percentage of rooting compared with layers prepared during October and February months due to congenial humidity and temperature conditions. Similar results were also obtained by Bhandary and Kololgi (1961) in guava and Sen and Bose (1967).

Current studies indicated that significant influence of different concentrations of IBA with or without 1,2,4 acid on percentage of rooting in roseapple. The layers treated with 5000 ppm IBA plus 1000 ppm 1,2,4 acid proved to be the best concentration for obtaining maximum (52.08%) rooting percentage in roseapple. Concurrently, Hore and Sen (1991) along with P-hydroxybenzoic acid (synergist) increased the percentage of rooting in roseapple to as high as 98.36 per cent compared with 41.28 per cent in control.

The interaction influence of months of layering auxin concentrations with or without 1,2,4 acid revealed that irrespective of the month of air layering, highest rooting of 66.45 per cent was recorded when the layers were treated with 5000 ppm IBA + 1000 ppm of 1,2,4 acid. The lowest rooting percentage was recorded in control (0.00%). The studies of Sadhu *et al.* (1972) indicated that P-hydroxybenzoic acid (synergist) alone showed a small increase in the rooting of guava air layers but in combination with IBA, there was a four fold increase in rooting. Similar results were also obtained by Narayana Reddy (1993).

The results obtained from this study confirmed the advantage of exogenous application of auxins alone and with a synergist (1,2,4 acid) to enhance the rooting of roseapple air layers. Similarly, significant influence of IBA and NAA along with 1,2,4 acid to promote rooting was observed by Vijaya (1992) in *Acalypha*, *Pongamia* and *Mulberry* rooting.

5.3 Root characters

The root characters such as number, length and girth of primary, secondary and tertiary roots varied with the month of layering and auxin concentration with or without 1,2,4 acid. The layers prepared during June recorded highest number of primary roots (4.97) and longest primary roots (3.80 cm). Maximum number of secondary roots (8.36) and tertiary roots (6.91) was recorded during July month. Longest secondary roots (1.67 cm) were obtained during August. The maximum girth of primary roots (2.01 mm) and secondary roots (0.99 mm) were also higher during this month. The above characters were lower when plants were air layered during October. Studies of Bhandary and Kololgi (1961) in guava showed that root characters such as root number and length of primary, secondary and tertiary roots were maximum in air layers prepared during June month in Dharwad conditions.

Current studies indicated significant influence of different concentrations of auxins with or without 1,2,4 acid on root characters in roseapple, auxins alone at different concentrations showed a small improvement with respect to root characters but in combination with synergist (1,2,4 acid), there was a greater increase in number, length and girth of primary, secondary and tertiary roots. This suggests that, the

monophenol (1,2,4 acid) can increase root growth in combination with auxin as the enzyme polyphenol oxidase can induce second -OH group in to the ring of a monophenol (Goodwin, 1976) and convert it into diphenol, this in turn induces better rooting. Similar effects were observed by Rabbovi *et al.* (1983) in phalsa and many hard to root plants (Sadhu *et al.*, 1972).

The interaction effect of the period of layering, auxin and its concentrations with or without 1,2,4 acid revealed that layers prepared with 5000 ppm IBA plus 1000 ppm 1,2,4 acid recorded maximum number, length and girth of primary and secondary roots compared with auxin alone and untreated control. These results were agree with the results of Sadhu *et al.* (1972).

5.4 Survival percentage of rooted air layers

The survival percentage of roseapple air layers during different months varied significantly. The layers prepared during June recorded significantly higher (36.79%) percentage of survival than layers prepared during other months. This could be due to higher number and early initiation of roots, resulting in improved vigour and establishment. However, the lowest of 13.34 per cent survival was recorded during the month of October. The root characters such as number of roots, root length and girth were lowest in the layers prepared during the month of October. Hence, the better root characters in turn ensures higher survival of air layers prepared during June.

Current studies indicated the significant influence of different concentrations of auxin with or without 1,2,4 acid on survival percentage of roseapple. The layers treated with 7500 ppm IBA with 1000 ppm of 1,2,4 acid recorded significantly higher survival percentage (46.47%) compared to other concentrations including control. Hence, 7500 ppm IBA + 1000 ppm 1,2,4 acid proved to be the best concentration for obtaining maximum survival percentage in roseapple. The results of the present investigation are in conformity with the results of Narayana Reddy (1993) in Jamun and wood apple air layers.

The interaction influence of months of layering, auxin and their concentrations with or without 1,2,4 acid showed less influence on final survival percentage of layers.

5.5 Bio-chemical composition of roseapple shoots during different months

The bio-chemical constituents viz., total sugars, starch, carbohydrates, total nitrogen, C:N ratio and total phenols in roseapple shoots varied considerably during different months.

The shoots during the months of June, July and August contained more sugars, carbohydrates, total nitrogen, starch and phenol resulting in better rooting. While, the shoots during the months of September and October contained lower total nitrogen, starch, sugars, carbohydrate, phenol and C:N ratio resulting in lower percentage of rooting. These bio-chemical constituents of shoots have a direct relationship with the rooting

of roseapple air layers. These results are in agreement with the results of Hartman and Kester (1972), Hess (1969) and Basu *et al.* (1967) in mango.

Practical utility of the investigation

Under Bangalore conditions roseapple can be successfully propagated by air layering as large scale. The best month for air layering is June with the assistance of 5000ppm IBA with 1000ppm 1,2,4 acid (synergist).

Future line of work

The monophenol, 1,2,4 acid (1-amino 2-hydroxy phenyl 4-sulphonic acid) used in the investigation significantly increased the rooting in air layers of roseapple, which supports the established concept, that monophenols at higher concentration can cause inhibition of IAA oxidase activity, thereby increasing the auxin content and helping in rooting. Since 1,2,4 acid is playing an important role in the rooting of layers, further studies by using this compound in other methods of propagation like rooting of cuttings has to be studied.

SUMMARY

VI. SUMMARY

Investigations on air layering studies in roseapple were carried out at the Horticultural Research Station, Gandhi Krishi Vignana Kendra, University of Agricultural Sciences, Bangalore during the year 2000. The influence of different months of layering, applications of different auxins and their concentrations along with 1,2,4 acid on rooting of layers were studied with a view to find out their suitability. The role of bio-chemical components of shoots such as, total sugars, starch, carbohydrates, total nitrogen, C:N ratio and total phenols on rooting of air layers was also studied. The summarized results of the investigations are as follows.

1. The air layers of roseapple prepared during July 2000 took significantly fewer number of days (43.61 days) for root initiation than those prepared during September (45.20 days). The layers treated with 5000 ppm IBA plus 1000 ppm 1,2,4 acid recorded early root initiation irrespective of month of layering compared to auxin alone and control.
2. The layers prepared during June produced highest rooting (46.96%) followed by August (41.71%) and lower percentage of rooting was recorded during October (18.82%). The layers treated with 5000 ppm of auxin separately and along with 1000 ppm 1,2,4 acid resulted in significantly higher rooting compared to other concentrations and untreated control. The layers treated with 5000 ppm IBA in combination with 1,2,4 acid recorded maximum rooting of 66.45 per cent during August and it was lowest in untreated control (0.00%) during October.

3. The influence of different months of layering, auxins and its concentrations with or without 1,2,4 acid on root characters reveals that, the layers prepared during the month of June, July and August with 5000 ppm IBA + 1000 ppm 1,2,4 acid produced highest number of primary (4.97), secondary (8.36) and tertiary (6.91) roots, the length and girth of primary, secondary and tertiary roots were also maximum. The layers prepared during the month of October and untreated control recorded the least root characters with respect to root number, length and girth.
4. The effect of seasons of layering (month) on survival percentage of layers was also found significant. The layers prepared during June recorded significantly higher percentage (36.79%) of survival. Application of auxins to air layers had significant influence in different months. The maximum of 46.47 per cent survival was recorded in 7500 ppm IBA + 1000 ppm 1,2,4 acid treated layers. The interaction effect of season of layering, auxin and its concentrations with or without 1,2,4 acid treatment and revealed only a negligible influence on final survival percentage of layers.
5. Bio-chemical composition of roseapple shoots during different months revealed a considerable difference in total sugars, starch, carbohydrates, total nitrogen, C:N ratio and total phenols during different months. Total sugars, starch, carbohydrates, total nitrogen, C:N ratio and phenol contents were higher during June, July and August, which had direct influence on root initiation and its characters, ironically during September and October months these constituents were lower.

Based on this investigation, it may be concluded that under Bangalore conditions, roseapple can be successfully propagated by air layering during the month of June by treating the layers with 5000 ppm IBA in combinations with 1000 ppm 1,2,4 acid.

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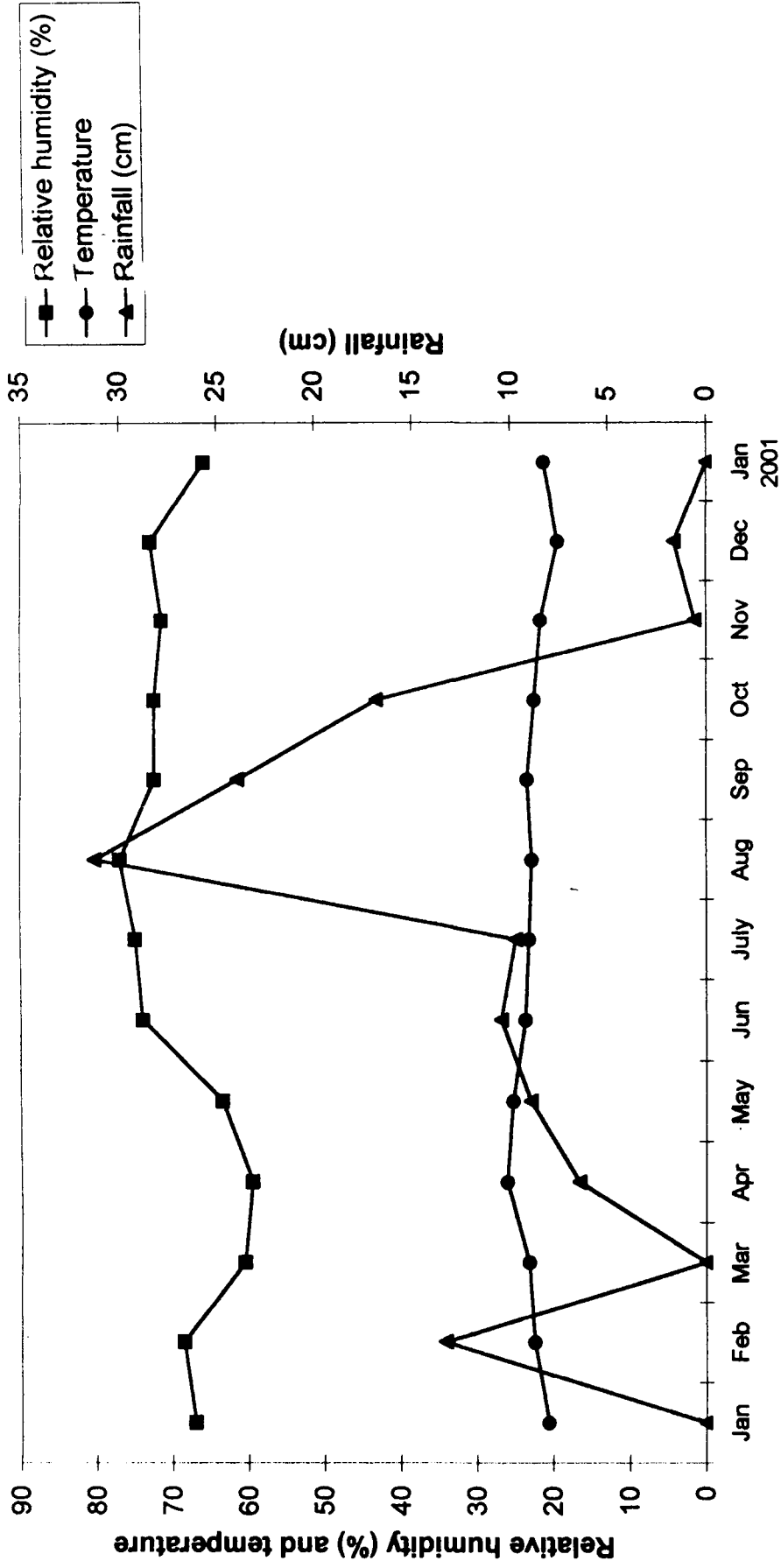
APPENDIX

APPENDIX

**Meteriological data for the experiential period of the year 2000-2001 at
GKVK Farm, UAS, Bangalore-65**

Months	Relative humidity (%)	Total rainfall (mm)	Temperature	
			Maximum	Minimum
January, 2000	67	0.00	27.2	14.1
February	68.5	133	28.6	16.4
March	60.5	0.00	31.3	15.6
April	59.5	64.8	33.3	18.9
May	63.5	89.6	31.8	19.0
June	74	104.8	28.0	19.5
July	75	97.3	27.3	19.3
August	77	312.4	26.6	19.3
September	72.5	239.8	27.7	19.3
October	72.5	168.4	27.1	18.0
November	71.5	5.8	26.9	16.5
December	73	16.2	25.7	13.1
January, 2001	66	0.0	27.2	15.4

APPENDIX-I



Months

Graphical representation of relative humidity (%), temperature and rainfall (cm) (2000-01)