“EFFECT OF PLANT GROWTH REGULATOR AND ROOTING MEDIA ON AIR LAYERING IN GUAVA (*Psidium guajava* L.) CV. LUCKNOW–49 UNDER CHHATTISGARH REGION”

M.Sc.(Ag.) THESIS

by

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INDIRA GANDHI AGRICULTURAL UNIVERSITY

RAIPUR (C.G.)

2005

"EFFECT OF PLANT GROWTH REGULATOR AND ROOTING MEDIA ON AIR LAYERING IN GUAVA (*Psidium guajava* L.) CV. LUCKNOW–49 UNDER CHHATTISGARH REGION"

Thesis

Submitted to the

Indira Gandhi Agricultural University, Raipur

by

JITENDRA CHANDRAKER

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

Master of Science

I*n*

Agriculture
(HORTICULTURE)

Roll No.3193 **ID No. AG /99/22**

SEPTEMBER, 2005

CERTIFICATE – I

This is to certify that the thesis entitled **"EFFECT OF PLANT GROWTH REGULATOR AND ROOTING MEDIA ON AIR LAYERING IN GUAVA (*Psidium guajava* L.) CV. LUCKNOW–49 UNDER CHHATTISGARH REGION"** submitted in partial fulfilment of the requirements for the degree of **"Master of Science in Agriculture"** of the Indira Gandhi Agricultural University, Raipur, is a record of the bonafide research work carried out by **JITENDRA CHANDRAKER** under my guidance and supervision. The subject of the thesis has been approved by Student's 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/ published part has been fully acknowledged. All the assistance and help received during the course of the investigations have been duly acknowledged by him.

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Member : Dr. R. K. Bajpai ________________________

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Member : Dr. A. K. Singh ________________________

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This is to certify that the thesis entitled **"EFFECT OF PLANT GROWTH REGULATOR AND ROOTING MEDIA ON AIR LAYERING IN GUAVA (*Psidium guajava* L.) CV. LUCKNOW–49 UNDER CHHATTISGARH REGION"** submitted by **JITENDRA CHANDRAKER** to the Indira Gandhi Agricultural University, Raipur in partial fulfilment of the requirements for the degree of **M.Sc. (Ag.)** in the **Department of Horticulture** has been approved by the Student's Advisory Committee after oral examination in collaboration with the external examiner.

Date: **EXTERNAL EXAMINER**

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Director of Instructions ________________

ACKNOWLEDGEMENT

I take this golden opportunity to express my heartfelt and deepest sense of gratitude to those who have helped me to complete this manuscript. My debts to many individuals can warmly be acknowledged but never full recompensed.

Any thesis is the culmination of any course of study for Master degree as such it forms the crown piece. This crown piece of my M.Sc.(Ag.) degree has taken its shape due to the assiduous efforts of my Advisor and Chairman of my Advisory Committee Dr.Prabhakar Singh, Associate Professor. His remarkable guidance, ace and fruitful criticism, scholarly and upto the mark recommendations proved to be flame beau showing me the right path towards my destination. It was really generous of him to steal time for this task in the midst of his busy schedule. I convey my thankfulness to him for his fervency and inspiration, which imbued me with the unparallel zeal throughout the whole investigation. Its my fortune to avail the opportunity of working under his guidance.

I am deeply indebted to Dr. A.K. Singh, Associate Professor, Director Research Services, Raipur for his affectionate guidance, unending benevalence, critical comments and constant encouragement bestowed upon me throughout the course of investigation.

I own my gratitude to Dr. D.A. Sarnaik, Professor and Head, Department of Horticulture, College of Agriculture, IGAU, Raipur for his valuable guidance and helpful suggestion during the course of investigation.

I am indebted to Dr. R.K. Bajpai, Dr. Lalji Singh and Dr. Nandan Mehta for their critical comments, everlasting seal and kind help rendered as and when needed. I am highly obliged to Dr. C.R. Hazra Hon'ble Vice-Chancellor and Dr. A.S.R.A.S. Sastri, Dean, College of Agriculture and Dr. Sunil Puri, Director of Instructions, IGAU, Raipur for providing me necessary facilities during the period of investigation.

I would like to thanks my promoter Dr. Neeraj Shukla, Dr. J. Singh, Dr. H.G. Sharma, Dr.C.P.Khare, Shri P. Dubey, Shri Vijay Jain, Shri T. Tirkey, Shri Jitendra Trivedi, Shri Satish Verma for their valuable suggestions and co-operation during the investigation.

I would like to recognise the unrelating support of non-technical staff and labours of my department Shri Sinhajee, Purushottam, Pahalad, Bala and Tirath for their kindness, permission in using the departmental facilities and encouragement helped me in all the time of research.

My profound thanks goes to Dr. Madhav Pandey and Surendra Bhaiya who helped me in finding necessary literature and for their cheerful assistance.

I would like to pay my cordial thanks to Mr Ajay Kaushik for excellent typing and formatting of this manuscript in time.

I am having nostalgic feelings for my bosom friend, Ranjana, Abha and Purushottam who always gave me supporting hand during my course of investigation.

I feel especially indebted to my seniors Dr.Shalindra Agrawal, Dr.Ashitosh Pandey, Shri R.K. Sonkar, Shri Shishir, Shri Narendra, Gourav, Ghanshyam, Amit and Dinesh for giving me their helping hand, affection and encouragement during my course of investigation. My friendly thanks is forwarded to seniors, Mannu, Bodhendra, Ravendra, Kalash, Madan, Anant, Vikram, Bandana and Gunjan, juniors Hemant, Ganesh, Mohan, Puja, Deepti, Pushpa, Vandana, Bharti, and my friends Rajendra, Keshav, Alice, Sujansingh, Virendra, Surendra, Derendra and Basant for helping me and giving me good company during my study.

I express due thanks to my sister Gamini and brother Amit whose tireless prayers have enabled me to come out with this priceless achievement.

At last I am quite at sea, as I cannot express my feelings to my parents, who taught me the value of hard work, their obstinate sacrifices and blessings in each and every breath makes my path easier. Their continuous encouragement, patience, support, love, advice and faith in my abilities has helped me to set higher goals for myself.

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LIST OF ABBREVIATIONS

Abbreviations	Description
%	Per cent
^{0}C	Degree Celsius
CD	Critical difference
Cm	Centimetre
Cv.	Cultivar
DAL	Days after air layering
DAT	Days after transplanting
et al.	And others/ co-workers
Fig.	Figure
FYM	Farmyard manure
g	gram
ha	Hectare
i.e.	That is
IBA	Indole 3-butyric Acid
kg	Kilogram
m	Metre
mg	Milligram
NS	Non significant
PGR	Plant growth regulator
PM	Poultry manure
ppm	Part per million
SEm	Standard error of mean
viz.	For example

CHAPTER-I

INTRODUCTION

Guava (*Psidium guajava* Linn.) is an important fruit of India in area and production after mango, banana and citrus. It is fifth important fruit crop covering an area of 1.5 lakh ha. with a total production of 18.00 lakh tonnes in India during 1998-99 (Chadha,2002). The guava, a native of tropical America, belongs to family myrtaceae. It is a quite hardy, prolific bearer and highly remunerative even without much care as compared to many other fruit crops. Besides, it is also a cheap and a rich source of vitamin 'C', carbohydrate, iron, calcium, phosphorus as well as pentatonic acid, riboflavin, thiamin and niacin.

The major guava producing countries are of southern Asia. In India it is successfully grown all over the country, the most important guava-growing states are Uttar Pradesh (102000 ha), Bihar (21700 ha), Madhya Pradesh (6122 ha), and Maharashtra (2700 ha). Uttar Pradesh is the most important guava-producing state of India.

In Chhattisgarh guava is cultivated as in limited area which has an area of about 671.40 ha. with a production of 11810 metric tonnes and productivity 17.60 tones / ha. (Anon, 2004). Guava is a very delicious fruit and many products like jelly, jam, nectar and salad are prepared from it. It is available during the period when other important fruits like mango, apple etc. are not available in the market.

Guava is relatively a disease free fruit crop, subjected to only a few diseases and insects. It requires less plant protection and irrigation as compared to other important fruit crops. These qualities make guava an important and one of the most popular fruits of India.

Guava is commonly propagated by two types of propagation sexual and asexual. Seed propagated plants become extra-tall and come into bearing after a long period. Seed propagation is a method of sexual reproduction. The formation of seed from sexual reproduction involves the union of male and female sex cells and creation of new genotypes. The unique characteristics of given plant depend upon the particular combination of gene present on the chromosomes in the cells. In general, reproduction by seed can be expected to result in a certain amount of variation. Various new plants with differing characteristics are created.

Guava is also propagated vegetatively through inarching, layering, cutting, budding and grafting. These methods have their own merits and demerits. Inarching is usually cumbersome and requires time, labour and is difficult. In cuttings, rooting and survival is low. Budding has also been used to a limited extent, but layering and that too air-layering remains the best method of propagation for this crop.

With the advancement in knowledge of genetics and other sciences, the value of vegetative multiplication to obtain uniformity in the progeny from selected plants, the method of air layering has become very important.

For standardization of fruit industry and improving the production, selection and maintenance of nucleus materials are, in general the two basic steps. Air layering suitably meets both of these requirements.

Therefore, to meet the demand of genetically pure cultivars, it is necessary to go for an asexual method of propagation. Air layering have been found very successful in guava, litchi and many other fruit species, so it is easy and economic means of vegetative propagation.

Factors like : (i) Nutritional status of parent plants, (ii)Time of operation, (iii) Environmental conditions (rainfall, range of temperature, moderate sunshine and wind velocity in the atmosphere). (iv) Age of stock-plant, (v) Rooting media etc. play a vital role in success of propagation.

The use of plant growth regulators to increase the efficacy of propagation in cutting and layering are now common and moreover, use of growth regulators has opened a new vista for nurserymen for propagating fruit trees. Growth substances accelerate the rooting, produce a large root system and increase the percentage of survival. Growth regulators like IAA, NAA and IBA have been used to stimulate plant growth and specially root formation in layering. IBA has been found to be most effective in producing maximum number of roots with better vigour.

While using growth regulators, use of their proper concentration is vital importance as excessive concentration for the species may result in injury. This may nearly inhibit development or it may cause yellowing and dropping of leaves, blacking of stems and eventual death of layers. From standardization point of view, it is, therefore necessary to determine the suitable concentration of plant growth regulators for better performance in plant propagation by way of experimentation.

Air-layers of many species root easily in a variety of rooting media, but those more difficult to root may be greatly influenced by the kind of rooting media used not only in the percentage of layers rooted but in quality of root system formed.

For air-layers, the rooting media like sand, soil, peat moss, compost, farm yard manure, coconut pith, sphagnum moss are used.

An ideal rooting media plays an important role to provide sufficient porosity to allow good aeration, and has a high water holding capacity. The rooting media should be free from harmful fungus and bacteria.

Enough work is available on these aspects in many fruit crops. However, an important fruit like guava requires specific investigation on scientific lines to solve the various problems related to raising plants to meet out the increasing demand of fruit growers. Thus, keeping in view the importance of plant growth regulators and rooting media in propagation of guava through air layering, the present investigation entitled **"Effect of plant growth regulator and rooting media on air layering in Guava (*Psidium guajava* L.) cv. Lucknow – 49 under Chhattisgarh region"** was laid out with following objectives :

1. To find out the most effective concentration of IBA for inducing roots in air-layers of guava,
2. To find out the most effective rooting media for rooting of air layers of guava,
3. To find out the optimum combination of IBA concentration and rooting media for rooting of air layers of guava.

CHAPTER-II

REVIEW OF LITERATURE

In the recent years many workers have tried different plant growth regulators for propagating the horticultural plants by air-layering in order to supply nucleus material for commercial exploitation. The use of plant growth regulators is one of the modern horticultural techniques, being employed by the commercial nurserymen and plant propagators in all the agriculturally advanced countries. Among the plant growth regulators, auxin stimulates cell division, cell elongation and cell enlargement in the apical region.

Air-layering is a common method of vegetative propagation of woody plants. This is a common practice for producing new plants true to their parents, clonal propagation for standardization of root stocks and also evolving the practical methods for clonal multiplication of important fruits in India. The work pertaining to different aspects of rooting in guava and other works relevant to the present investigation have been reviewed under the following heads:

2.1 Effect of plant growth regulators on rooting of air-layers of guava

2.2 Effect of plant growth regulators on rooting of air-layers of other fruit crops

2.3 Effect of rooting media on rooting of air-layers of fruit crops

2.1 Effect of plant growth regulators on rooting of air-layers of guava

Bhujabal (1972) reported that IBA (1000-4000 ppm) concentration in marcotting experiment of guava variety Lucknow-49, were obtained best results with IBA 3,000 ppm which gave 86.6 per cent rooting and 76.6 per cent survival.

Patel *et al.* (1989) found with air layers of guava using IBA at 3,000 ppm and wrapping with black polythene resulted in 100 per cent rooting and the maximum number of roots.

Ram-Chandra *et al.* (1991) reported that air layers of guava treated with sucrose (5 or 10%) with or without coconut milk, IBA (4,000 or 8,000 ppm) or 4,000 ppm IBA + 4,000 ppm IAA, the highest number of primary and secondary roots and the greatest primary root diameter were obtained with the IBA + IAA treatment.

Sharma *et al.* (1991) reported in air layering of guava 1000 ppm IBA treatments resulted in the highest percentage success (75.55%).

Kamleshkar and Jain (1996) observed that percentage rooting and survival were highest (78.75 and 75% respectively) for etiolated shoots treated with IBA at 6,000 ppm in guava air-layer

According to Chandrappa and Gowda (1998) rooting was best in air layers taken in June and treated with 10,000 ppm IBA + 1,000 ppm 1, 2, 4 acid (a phenolic acid) in guava.

Bhagat *et al.* (1999) reported that air layers of guava treated with IBA at 4,500 ppm exhibited the best performance with respect to rooting (94.67%) and survival (78.33%) as well as other attributes like number of roots per layers, length of root and total number of leaves.

Tomar *et al.* (1999) observed in air-layers of guava cultivar Gwalior-27 that survival rates were highest (71.65%) with 15,000 ppm NAA in 1995, whereas, in 1996 survival rates were highest (70.29%) on the application of 15,000 ppm IBA.

Athani *et al.* (2001) concluded that treatment with IBA at 5000 ppm in guava cv. Sardar, the highest values for rooting percentage (90%), number of roots (18.23) and length of longest root (9.56 cm) were observed upon treatments with 30 days of air layering in guava.

Mahabir *et al.* (2002) found that IBA was most effective for the rooting, establishment, survival and vegetative growth of the air layers than IAA and NAA. Callus formation, rooting length, diameter, weight of roots and survival of air layers were highest with 20,000 ppm IBA + black polythene film.

According to Tyagi and Patel (2004), IBA used separately gave beneficial effect in all roots and growth attributes as compared to NAA and control in guava air-layers. In two concentrations (10,000 ppm and 5,000 ppm), 10,000 ppm was found significantly superior as compared to 5,000 ppm and control.

2.2 Effect of plant growth regulators on rooting of air-layers of other fruit crops

Acharya and Dash (1972) observed that IBA at 3,000 ppm resulted in 84.6 per cent success in marcotting of cashew and also resulted in the largest roots, the greatest number of roots and the shortest period of root emergence.

Chhonkar and Singh (1972) reported that IBA treated with 5000 ppm was markedly more effective than NAA in promoting rooting and establishment of mango marcots.

Sharfuddin and Hussian (1973) obtained 100 per cent rooting with IBA at 5,000 ppm in litchi layering.

According to Kadman and Slor (1974) 55 per cent layers rooted with the use of 1 per cent IBA. Whereas, only 45 per cent rooted without any treatment.

Chatterjee and Rao (1978) reported that in air-layers of *Ziziphus jujuba*, IBA at 10,000 ppm gave the best results in terms of rooting percentage, average number of primary roots, average length of the longest primary roots and average number of secondary roots/primary roots.

Patil and Chakrawar (1979) studied on bearing and non-bearing one year old shoots of seedless lemon, 25-40 cm long and 1.0-1.5 cm in diameter were ringed, treated with IBA or NAA each at 500-2000 ppm and covered with moss grass and polythene. The highest number of roots/ air layer (81.14) and greatest survival (96.67%) of air-layers occurred in variants treated with IBA + NAA each at 1000 ppm. Bearing shoots produced slightly fewer roots than non-bearing shoots.

Tomar (1979) obtained the maximum length of primary roots, number and length of secondary roots in karonda (*Carissa carandus* L.) air-layers with 10,000 ppm of IBA.

According to Chatterjee (1982) the best rooting (75%) and survival after one year (55%) were obtained in mango air-layers at 10,000 ppm IBA.

Patel and Singh (1982) observed that the combination of IBA at 20,000 ppm + NAA 5,000 ppm gave the highest rooting (66.6%) in air-layering of mango cv. Langra.

According to Rajan and Ram (1983) good rooting was obtained in the difficult to root cv. Langra by applying IBA at 15,000 ppm to air-layers of mango.

Ram and Majumdar (1983) noted 97.1 per cent rooting and 94.3 per cent survival in stool layering of litchi with IBA at 2,500 ppm.

According to Desai and Patil (1984) NAA + IBA (2500 + 5000 ppm) along with black polythene resulted in the best rooting of jackfruit by air-layering.

Dhua and Sen (1984) observed 98.30 per cent rooting in air-layers of jackfruit when treated with ferulic acid + 1000 ppm IBA. However, survival per cent (88.88) of layers was also obtained with IBA 3000 ppm.

Hanamashetti *et al.* (1984) observed that very good rooting (80-100%) was obtained with IBA at 100 and 200 ppm or IAA at 300 ppm in air-layers of cashewnut. Maximum number of root (46) and maximum root length (10.6 cm) were obtained with IAA 300 ppm.

According to Palaniswami *et al.* (1985) IBA at 500 ppm improved rooting, forty to fifty per cent success was achieved by air-layers of one year old shoot of cashewnut shoots during July to September.

Valsalakumari *et al.* (1985) found that air-layering in cashewnut between February-April and treatment with IBA at 250 ppm or NAA at 500 ppm gave maximum number of rooted layers.

Mukherjee *et al.* (1986) reported maximum rooting (80-90%) and maximum survival of air-layers in bael by treating the etiolated shoot with IBA 10,000 ppm.

Hedge and Sulikeri (1989) examined the effect of IBA at 250-1500 ppm on air-layers of pomegranate cv. Jyothi. Rooting increased with IBA concentration from 84.38 per cent at 250 ppm to 93.75 per cent at 1500 ppm, with 68.75 per cent in control.

Chhatterjee *et al.* (1990) reported etiolation treatment and application of 1000 ppm IBA gave 91.7 per cent rooting success and 90.9 per cent survival of air-layers of sapota.

Mishra and Singh (1990) found that highest percentage of rooting was obtained with 5000 ppm IBA (95% compared with 21.7% in the control) in air layers of karaunda. This treatment also resulted in the highest percentage survival of rooted air-layers (68.3% compared with 5% in the control). IBA was more effective than NAA in promoting rooting in air-layers.

Navaneetha *et al.* (1991) observed in air-layers of tamarind treated with IBA (1000 ppm) applied in May, the rooting was best (75%) and subsequent survival was highest.

Mishra and Jaiswal (1992) examined the influence of plant growth regulators on rooting, root characteristics and survival of air layers of natal plum. The concentration of IBA significantly increased rooting compared with controls, with 100% rooting being obtained with IBA 5000 ppm.

Bisen and Barholia (1995) recorded the highest percentage of rooting (92.5%), length of primary roots (29.7 cm), number of primary roots (29.0) and survival percentage (87.5%) treated with IBA 15,000 ppm in air layers of jackfruit.

Lavania *et al.* (1995) observed the best rooting (highest number of primary, secondary and tertiary roots) and highest survival of plants (52.5%) in air-layer of jackfruit treated with IBA 7500 ppm.

Mahabir *et al.* (1995) observed in terms of percentage of rooting and establishment of layers in the nursery with the combination of IBA and NAA treatment was more effective than IBA and control.

Sabyasachi *et al.* (1996) found that IBA at 7500 ppm applied to hardwood stems produced the most rooted air layers (upto 88%, 45 days) in jackfruit.

Brahmachari *et al.* (1997) studied the influence of etiolation and application of growth substances in air-layers of litchi cv. Purbi, the maximum rooting, survival and improvement in root characters were obtained by etiolating shoots 30 days before layering and treating with IBA + NAA at 5000 ppm.

Preeti *et al.* (1997) reported that the best growth and development of roots and highest survival rates (80%) in jackfruit were obtained with IBA 5000 ppm.

Ganapathi *et al.* (1998) conducted a study for air-layering on a 20 year old tree of tamarind treated with 1,250, 2,500, 5,000 or 7,500 ppm IBA alone or in combination with NAA. The rooting percentage (86.7%) was highest with 2500 ppm IBA. This treatment also produced the maximum number of roots per shoot.

Tomar *et al.* (1999) reported that when the air-layers were treated with powder containing 0, 600, 1200, 2400 or 4800 ppm IBA in kagzi lime, the concentration of 2400 ppm IBA gave more successful results in air-layering.

Alila *et al.* (2000) determine the effect of growth regulators and etiolation on air layers of jack fruit (*Artocarpus heterophyllus*), it was concluded that the treatment with IBA at 5000 ppm can be used for adventitious root formation in air-layering of jackfruit in combination with etiolation for a period of 30 days.

According to Chovatia and Singh (2000) application of IBA at 10,000 ppm on air layering of custard apple proved significantly superior in percentage of rooted layer and their survival, formation of main and secondary roots, their length and diameter of root, fresh weight of root and dry weight of root.

Ray *et al.* (2001) investigated the effect of IBA on air layering of Litchi cv. Purbi. IBA at 5500 ppm gave the highest percentage of rooted air layers (90.0%), number of primary (25.0) and secondary roots (25.0) per layer, primary root length (4.22 cm), root fresh weight (4.37 g), number of new branches (2.17) and green leaves (7.92) per layer and survival of rooted air layers (69.0%).

According to Sengupta and Thakur (2001) IBA + NAA at 5000 ppm produced the highest number of rooted layers (90%), number of primary and secondary roots per layer (19.00 and 46.30, respectively), length of primary (11.39 cm) and secondary roots (8.29 cm), fresh weight (6.59 g) and dry weight (0.878 g) of roots. The lowest primary and secondary root diameter (0.10 and 0.06 cm, respectively) were also observed in IBA + NAA at 5000 ppm IBA treatment in etiolated air-layers of jackfruit.

Duarte and Suchini (2002) recorded that air layer in litchi with mature terminal leaves and 5000 ppm IBA were superior to those with immature leaves. Rooting was 80.0, 91.6, 100.0 and 91.6 per cent for June, August, September and November, respectively.

Sinha and Ray (2002) studied the effects of plant growth regulators on the rooting and survival of litchi cv. Bombai, the highest rooting percentage (94.93%), number of roots (52.00 per layer) and survival percentage (88.3%) were obtained with 5000 ppm NAA + 200 ppm PHB.

Jain *et al.* (2003) observed that the greatest number of roots per plant (32.97), root length (9.59 cm), root weight (4.00 g), root volume (4.86 ml), root diameter (1.77 cm), shoot length (29.27 cm), shoot diameter (4.98 mm), number of leaves (15.63) and plant survival (75.23%) were recorded for air layer of litchi treated with 2500 ppm of IBA.

Uptal *et al.* (2003) studied the survival of eight cultivars of litchi through air layering. Shoots treated with plant growth regulators showed better survival (90.56 and 80.26% under NAA + PHB and IBA + PHB, respectively) compared to the control (37.45%).

Bandana kumari (2004) observed that 10,000 ppm treatment of IBA stimulated maximum percentage of rooting, root growth and development of air-layering of jackfruit.

Singh and Singh (2004) examined the effect of IBA and NAA treated with 2,500, 5,000, 7,500 or 10,000 ppm and their combination (1:1) on the air layering of jackfruit. The combination of IBA + NAA at 5,000 ppm each showed the best effect on the root initiation of air layers.

2.3 Effect of rooting media on rooting of air-layers of fruit crops

Sharfuddin and Hussain (1973) studied marcots of litchi cv. China treated with IAA and IBA at 500 ppm and wrapped with sawdust and plastic film, soil/dung mixture and plastic film and or soil/ dung mixture and gunny cloth. Sawdust and plastic film was the best wrap for untreated marcots, giving 83.33 per cent rooting. It also interacted with the growth compounds in the promotion of earlier rooting.

Malik and Maqbool (1977) used soil, soil/ sand and soil/ farm yard manure mixtures in litchi to study the effect of cutting or ringing the layers. A 1:1 ratio of soil/ sand mixture gave the best results. Also ringing gave better results than cutting.

Gowda (1983) used wet red soil, sand or saw dust as rooting media in ficus to the stripped portion and covered with polyethylene sheet. After 30 days the branches were cut and cutting were transferred to 23 x 30 cm polyethylene bags filled with 1:1:1 red earth : sand : manure. Out of 500 cuttings taken, 455 sprouted successfully.

Kuliev and Babaev (1983) observed propagation of feijoa by cuttings and layering. In 2 year trails cuttings rooted best in well rotted FYM or FYM: river sand 1:1 mixture under mist.

Veeraraghavan *et al.* (1983) examined five different rooting media, the percentage of rooted layers (40.0) was highest in wood shaving and lowest (18.7) in wood shavings enriched with rock phosphate in air-layering of cashew.

Grappelli *et al.* (1985) tested earthworm casting as a rooting media for air layering. Layers rooted better when casting mixture were used. The beneficial effect of earthworm casting was attributed to the presence of growth regulators namely GA_3, cytokinins and auxins.

Shetty and Melanta (1990) investigated rooted air layers of cashew were hardened in polyethylene bags containing eight different plant media. Highest survival (97.5%) was obtained in air layers hardened in sand + red earth + coir dust (1:1). This medium also gave the highest average number of healthy sprouts and leaves successful air layers on transfer to the field and field establishments (95%).

Durate and Freundt (1991) used coconut fibre, perlite, saw dust, synthetic foam, vermiculite, peat moss, sand + sawdust and no media (control) as an air layering media for *Ficus elastica*. The best rooting media for root quality was peat mass (>98% rooting) followed by coconut fibre and synthetic foam.

Pool *et al.* (1991) reported that the mixture of soil and leaf humus as a rooting media gave 64 per cent of marcots producing roots in air-layerings of clove.

Almeida *et al.* (1992) comprised the media saw dust, red sand and cattle manure alone or in combination by percentage rooting was highest in saw dust alone (90%) and lowest in cattle manure alone (0%).

Hore and Sen (1994) found that rooting media containing 2:1:1 ratio of garden soil : sand : rotted cowdung manure in air-layering of pomegranate rooted successfully.

Nath (1994) reported that air layers of carambola treated with 5000 ppm IBA and as media soil, leaf mould and compost (2:1:1) gave the highest percentage of rooting (72.4%), number of primary roots (11.0), root length (7.5 cm) and survival of rooted layers (75.6%).

Tomar *et al.* (1999) observed in kagzi lime that treated areas were wrapped in mixture of sand, farmyard manure and soil held in polythene film gives more success with an IBA concentration of 2400 ppm.

Alloli *et al.* (2001) investigate the influence of fly ash as a new media for induction of rooting of fig, pomegranate and guava in an air layering experiment. The efficiency of fly ash as a rooting induction media was compared with sawdust. The beneficial effects of fly ash were more pronounced in fig, which produced the highest fresh and dry weight of roots in this media. Fly ash was the most ideal media for fig, while sawdust was the most ideal for pomegranate.

Kumar *et al.* (2001) observed in three different rooting media viz. standard gootee mixture, sphagnum moss and saw dust alone and in combination with 500 pm IBA, on the propagation of custard apple by air layering that layers with combination of sawdust and IBA resulted in 53.76 per cent success whereas minimum (22.45%) was recorded in standard gootee mixture without IBA. Sawdust with combination of IBA produced the maximum number of roots (10.80) and the least number (7.00) was recorded in gootee mixture with IBA. The maximum survival percentage (31.00) was recorded in sawdust in combination with 500 ppm IBA.

CHAPTER-III

MATERIALS AND METHODS

This chapter deals with the description of the materials used and the methods or technique adopted during the course of investigation.

3.1 Experimental site

The present investigation was carried out during the year 2004-2005 at the Research Farm of Horticulture Department, College of Agriculture, Indira Gandhi Agricultural University Raipur, Chhattisgarh.

3.2 Geographical situation

Raipur is situated in mid-eastern part of Chhattisgarh state and lies at 21°16' N latitude and 81°36' E longitude with an attitude of 298.56 metre above the mean sea level.

3.3 Climate and weather condition

Raipur, the place of investigation comes under dry-moist, sub-humid region. It has an annual average rainfall of 1200-1400 mm, out of which 80-90 per cent is received during third week of June to mid September and very little during October to February. The rainfall pattern has great variation during rainy season from year to year. May is the hottest and December is the coolest month of the year. The maximum temperature during the summer months reaches as high as 46°C and the mercury drops to as low as 6°C during December to January. The atmospheric humidity is high from June to October.

The meteorological data, namely temperature, sunshine hours, relative humidity, wind velocity and evaporation during the crop period are depicted in fig. 3.1, during the course of investigation. The weekly maximum and minimum temperature were 33° and 9°C, respectively.

3.4 Experimental details

3.4.1 Design

The experiment was laid out in factorial completely randomized design.

There were two factors for the experiment

a. Plant growth regulators - Indole-3 butyric acid (IBA) five concentration (0, 3000, 4000, 5000 and 6000 ppm).

b. Rooting media – Three levels (soil : sand : poultry, soil : sand : vermi-compost and soil : sand : farm yard manure).

3.4.2 Treatment details

Treatments and their symbols

Treatment	Symbol
I. Plant growth regulators	I
II. Rooting media	M

The details of treatments are given below:

A. Plant growth regulator (I) – Concentration

(i)	Control	I_0
(ii)	Indole – 3 butyric acid (IBA) 3,000 ppm	I_1
(iii)	Indole – 3 butyric acid (IBA) 4,000 ppm	I_2
(iv)	Indole – 3 butyric acid (IBA) 5,000 ppm	I_3
(v)	Indole – 3 butyric acid (IBA) 6,000 ppm	I_4

B. Rooting media (M)

(i)	Soil	:	Sand	:	Poultry manure	M_1
(ii)	Soil	:	Sand	:	Vermi Compost	M_2
(iii)	Soil	:	Sand	:	Farmyard manure	M_3

C. Treatment combinations (Fifteen)

IBA and Rooting media I x M

T_1 : Control and poultry manure	I_0M_1
T_2 : IBA 3000 ppm and poultry manure	I_1M_1
T_3 : IBA 4000 ppm and poultry manure	I_2M_1
T_4 : IBA 5000 ppm and poultry manure	I_3M_1
T_5 : IBA 6000 ppm and poultry manure	I_4M_1
T_6 : Control and vermi compost	I_0M_2
T_7 : IBA 3000 ppm and vermi compost	I_1M_2
T_8 : IBA 4000 ppm and vermi compost	I_2M_2
T_9 : IBA 5000 ppm and vermi compost	I_3M_2
T_{10} : IBA 6000 ppm and vermi compost	I_4M_2
T_{11} : Control and Farmyard manure	I_0M_3
T_{12} : IBA 3000 ppm and Farmyard manure	I_1M_3
T_{13} : IBA 4000 ppm and Farmyard manure	I_2M_3
T_{14} : IBA 5000 ppm and Farmyard manure	I_3M_3
T_{15} : IBA 6000 ppm and Farmyard manure	I_4M_3

3.4.3 Randomization and replication

All fifteen treatments were replicated four times in factorial completely randomized design under each treatment 6 air-layers are taken. Thus, 15 x 4 = 60 branches (4 randomly branch in each as replication) were selected randomly over all the 15 trees of homogenous nature and than all the 15 x 4 = 60 treatment, combinations were applied randomly on these branches. Further, 6 samples of air layer were randomly taken on each branch for each treatment combination to get average performance over six air-layers.

3.5 Source, selection of plants and their branches

For this trial, 15 guava plants of uniform size and vigour were selected. The mother plant selected was grown under similar soil and environment conditions and approximately similar in growth vigour and maturity. On these plants well-matured and healthy branches of pencil thickness were selected. The average length of branches were 60 cm. For each replication fifteen plants were selected and six samples air –layers were randomly taken on each branch for each treatment combination. As such 24 shoots were layered in four replication and a total number of 360 air layered in all treatment combinations.

3.6 Preparation of paste of growth regulators

For preparation of 3,000 ppm paste of IBA, 300 mg of IBA was weighed on a chemical balance and was transferred in volumetric flask, after this, 5 ml of ethyl alcohol (95%) and small quantity of sugar was added and shaked thoroughly to dissolve properly. Then 95 ml of distilled water was added to make it 100 ml of solution of IBA.. In similar manner, the paste for other higher concentration of IBA was prepared as per treatment 4,000 ppm, 5,000 ppm and 6,000 ppm.

3.7 Tagging

Healthy branches of one year of age and about the thickness of a lead pencil were selected for air-layering, they were tagged for easy identification and records.

3.8 Ringing

A ring of bark about 5 cm in length was removed from selected shoot of guava just below the bud without injuring the underlying wood.

3.9 Method of application

Growth substances in different concentrations viz. 3,000 ppm, 4,000 ppm, 5,000 ppm and 6,000 ppm was applied in paste form on the ringed surface of selected shoots according to the treatments on 25th August 2004.

3.10 Covering

On the same day i.e. 25th August, 2004 the treated exposed portion of shoots were covered with three different rooting media according to the treatments. The three different rooting media used were -

1.	Soil	:	Sand	:	Poultry manure
	2	:	2	:	1
2.	Soil	:	Sand	:	Vermi Compost
	2	:	2	:	1
3.	Soil	:	Sand	:	Farmyard manure
	2	:	2	:	1

and wrapped with polythene of 300-gauge thickness and tied tightly at the two ends with *sutli*.

3.11 Separation of layers from mother plant

Before separation of layers from the mother plants, half cut were made on the shoots. After 8 days all layered shoots were detached from the mother plants and transplanted in pots and kept in shade for further observation.

3.12 Observation

3.12.1 Average success of air-layering (percentage)

Observation on success of air-layers were recorded at an interval of 30 and 45 days after air-layering.

3.12.2 Root study

The root study was undertaken in the air-layers after their detachment from the mother plants. In this process, before taking observation the rooting media's particles adhesing to the roots were washed out carefully with the fine spray of water without damaging the root system. The root study was made under the following heads:

3.12.2.1 Average number of primary and secondary roots per air layer

Average number of primary and secondary roots per layer were recorded after 60 days of air-layering by removing alkathene paper and rooting media.

3.12.2.2 Average length of primary and secondary root per air layer

On the same day the length of primary and secondary roots were measured and the average was calculated for study.

3.12.2.3 Average diameter of primary and secondary root per air layer

The diameter of primary and secondary roots of selected air layered for each treatments were measured separately by using vernier callipers and then average was worked out.

3.12.2.4 Average fresh weight of roots per air layer

The fresh weight of both primary and secondary roots were weighed by chemical balance and average fresh weight of roots per layer was calculated.

3.12.2.5 Average dry weight of roots per air layer

The dry weight of both primary and secondary roots weighed after drying roots in oven for 24 hours and average weight of roots per layer was calculated.

3.12.3 a Establishment of air-layers in nursery

After detachment of air-layered shoots (after 45 days of air-layering) the shoots were transplanted in pots and kept in the shade. In one pot only one layer was planted. All possible cares such as watering, foliar feeding, control of pest and disease were taken for the quick establishment of layers in the nursery.

3.12.3 b Growth and development of air-layers in the nursery

The air-layers detached from the mother plants were potted and kept in nursery to record their establishment growth and morphological development. Observations were recorded at an interval of 30 days. The process were made under following heads:

3.12.3.1 Number of green leaves per air layer

The number of new leaves emerged from the layers were recorded at monthly intervals and average number of leaves was calculated.

3.12.3.2 Average length of shoot per air layer

The length of shoot of air-layers was measured from base of sprout to the shoot tip at monthly interval and average length of shoot was calculated.

3.12.3.3 Average number of branches per air layer

Total number of branches emerged from the layers were recorded at monthly intervals and average branch number was calculated.

3.12.3.4 Fresh weight of shoots per air layer

All shoots were taken from the selected air-layers for weighing and fresh weight was recorded by chemical balance.

3.12.3.5 Dry weight of shoots per air layer

The dry weight of shoots weighed after drying of shoots in oven at 60^0C for 24 hours and average weight of shoots per layer was calculated.

3.12.4 Average survival percentage of air layers

The survival percentage of air-layers were recorded at 30 days intervals and final survival percentage were recorded after 3 month of transplanting and average survival percentage of air-layers was calculated.

3.13 Statistical analysis

The present experiment data was analyzed statistically by the techniques of analysis of variance as applicable to factorial completely randomized design. The significance of the treatment was tested by 'F' test value, critical difference (CD) at 5% level of significance was worked out for comparison and statistical interpretations of significant treatment means. The standard error of difference was given in each case for significant treatment effect. Critical difference (CD) of different concentration of IBA, rooting media and their interaction at 5% level of probability was calculated wherever 'F' test was significant. In statistical analysis of variance (ANOVA) table was prepared in the following ways for each character.

ANOVA

Source of variation	D.F.	S.S.	MSS	Fcal	F tab
Media (M)					
IBA (I)					
Media x IBA					
Error					
Total					

In order to compare the mean value of treatment, standard error and critical values were calculated as follows:

1. Standard Error of mean SEm + = $\sqrt{\mathbf{Ve/r}}$
2. Standard Error of difference SEm + = $\sqrt{\mathbf{2Ve/r}}$
3. Critical difference (CD) = SE (d) x t value at 5% level of significance error degree of freedom
4. Coefficient of variation (CV) = $\sqrt{\mathbf{Ve/Gm}}$ **x 100**

   where, Ve is error variance r is replication, Gm is general over all mean.

Table 3.1 : Physico-chemical composition of rooting media

S. No.	Composition	Soil : Sand : Poultry manure	Soil : Sand : Vermi Compost	Soil : Sand : Farm yard manure
A.	**Physical properties**			
1.	pH (Piper, 1967)	7.10	6.80	6.46
2.	Bulk density (mg/m^3) (Core method)	1.31	1.36	1.38
3.	Pore space (%) (Smith and Mullins, 1991)	37	34	31
4.	Maximum water holding capacity weight basis (Hillguard apparatus)	25.6	23.4	21.4
B.	**Chemical properties**			
1.	Available N ($kg\ ha^{-1}$) (Alkaline $KMNO_4$ method)	252.8	250.8	243.6
2.	Available P ($kg\ ha^{-1}$) (Olsen method)	20.24	19.8	18.38
3.	Available K ($kg\ ha^{-1}$) (Toth & Prince, 1949)	311.6	308.7	304.5

CHAPTER-IV

RESULTS AND DISCUSSION

This chapter deals with the effect of plant growth regulators and rooting media on rooting of guava air layers. These have been statistically analyzed by various characters during the course of investigation and their interpretation has been presented in this chapter along with appropriate table and figures.

Arc sine transformation is not used in analysis of rooting percentage and survival percentage characters because the percentage were lying between 30 to 70 per cent (Snedecor and Cochran, 1989).

Square root transformation is applied in analysis of number of primary roots, number of secondary roots, number of leaves and number of branches characters, because it can be used with counts in which it appears (Snedecor and Cochran, 1989).

The present investigation on "**Effect of plant growth regulator and rooting media on air layering in guava (*Psidium guajava* L.) cv. Lucknow-49 under Chhattisgarh region**" is discussed and the possibilities of using plant growth regulator and rooting media for raising the air-layers of guava is interpreted in the light of past work on similar studies by other workers.

Successful rooting of guava air layers has been measured in the form of percentage of rooting, number of primary and secondary root, length of primary and secondary root, diameter of primary and secondary root, fresh and dry weight of root, number of leaves, length of shoot, number of branches, fresh and dry weight of shoot and survival percentage of rooted air layers. In the present investigation the treatment of plant growth regulator and rooting media in general have given better performance as compared to control.

4.1 Percentage of rooting

The data for the percentage of rooting of air layers were recorded at an interval of 30 and 45 days after air layering. The treatment means in the table have been marked with different superscripts indicating their parity and disparity in view of CD (critical difference) values at 5 per cent level of significance.

A. Effect of growth regulator

The effect of different treatments on percentage of rooting is given in the table 4.1 and shown in fig. 4.1.

It is evident from the data that the growth regulator (IBA) at different concentrations showed significant effect on the rooting percentage of air layers. At 30 days after air layering as well as at 45 days after air layering (DAL) the highest percentage, 79.60 and 84.75 per cent, respectively, of rooting was recorded under (IBA 5000 ppm) followed by IBA (6000 ppm) which have at par effects on rooting but have significantly different effects on rooting when compared with the effects of IBA (4000 ppm) and IBA (3000 ppm). Percentage of rooting recorded under IBA (4000 ppm) and IBA (3000 ppm) were at par, but they had significantly different effect on rooting compared to that of control. The lowest rooting percentage was recorded in control, 44.75 and 54.08 per cent at 30 DAL and 45 DAL, respectively.

B. Effect of rooting media

The rooting media also significantly influenced the percentage of rooting at 30 and 45 days after air layering.

At 30 and 45 days after air layering the highest percentage 69.72 and 77.17 per cent of rooting were recorded respectively under the poultry media treatment. The poultry manure showed significantly different effect compared to those of both vermi compost and FYM media in respect of rooting percentage. The lowest rooting percentage, 61.90 and 68.25 per cent, were recorded under FYM at 30 and 45 days after air layering, respectively, which were significantly lower from those of both vermi compost and poultry manure media.

C. Effect of interaction on growth regulators and rooting media

The effect of the interaction between growth regulators and rooting media was not found to be significant in respect of the rooting percentage at 5 per cent level of significance as per the F test during analysis of variance. Therefore, the results of this interaction have not been discussed further.

The percentage of rooting observed in this investigation was found to be significantly effective at both stages i.e. 30 and 45 days after air layering.

Percentage of rooting was maximum under IBA (5000 ppm) at 30 and 45 days after air layering. This may be due to the fact that (5000 ppm) IBA was the optimum concentration for the growth substances under use, for quick and better regeneration of roots.

The maximum rooting percentage may be due to the appropriate concentration of IBA which enhanced cell division, cell elongation and early differentiation of callus tissue.

A number of theories have been offered to explain why the application of growth substances to layers results in better root formation. Among these, this is the hypothesis which suggests the presence of an elaborate auxin balance within the stem. The theory suggests that there is an interaction between applied growth substances and rhizocaline, an intermediately auxin specifically directing root initiation. Borner and Wildaman (1946) suggested that rhizocaline is equally distributed through the length of twig and it is subsequently mobilized to the end of the layers and it helps in root formation.

The other theory is that any active substance absorbed by the cut portion was conducted to the base where it initiate roots, which develops at the expense of sugar and source of food (Andus, 1963).

These findings are in agreement with the findings of Patel *et al.* (1989), Sharma *et al.* (1991), Kamleshkar and Jain (1996) and Athani *et al.* (2001) in respect to rooting percentage in guava air layers and Duarte and Suchini (2002) in litchi air layers.

The percentage of rooting recorded in guava air layers rooted under poultry manure media studied in this investigation was found to be statistically effective at both stage of observation i.e. 30 and 45 days after air layering. This may be probably due to poultry manure media had low bulk density, which provide lower resistance for root initiation, higher porosity and maximum water holding capacity.

4.2 Number of primary roots per air layer

A. Effect of growth regulators

The number of primary roots per air layer were recorded at 45 days after air layering. The data on the number of primary roots per air layer is given in the table 4.2 and shown in fig. 4.2

It is evident from the table that growth regulator (IBA) influenced the number of primary roots per air layer.

The maximum number of primary roots per air layer were recorded under IBA (6000 ppm). This had significantly different effect on the number of primary roots per air layer compared to those of all growth regulator (IBA) treatments. Number of primary roots under IBA 4000 ppm and IBA 3000 ppm were at par with each other, but they had significantly different effect on number of primary roots compared to that of control. The minimum number of roots were observed in treatment I_0 i.e. control.

B. Effect of rooting media

The rooting media influenced the number of primary roots per air layer. The highest number of primary roots were found under poultry manure (15.60) media. The poultry manure media showed significantly different effect compared to those of vermi compost and FYM media in respect of number of primary roots. The lowest number of primary roots were found under FYM (12.39) media, which was significantly inferior to that of all other media included in this study.

C. Effect of interaction of growth regulator and rooting media

The effect of the interaction between growth regulator and rooting media was not found to be significant in respect of number of primary roots per air layer at 5 per cent level of significance as per the F test during analysis of variance. Therefore, the results of this interaction have not been discussed further.

4.3 Number of secondary roots per air layer

A. Effect of growth regulators

The number of secondary roots per air layer were recorded at 45 days after air layering. The data on the number of secondary roots per air layer is given in the table 4.3 and shown in fig. 4.3.

The data reveals that the number of secondary roots per air layer was highest (23.91) under IBA (6000 ppm) followed by IBA (5000 ppm) which was at par effect on number of secondary roots but showed significantly different effect on number of secondary roots compared to those of IBA (4000 ppm) and IBA (3000 ppm). The minimum number of roots was observed under treatment I_0 i.e. control which was significantly inferior to those of all other IBA treatments.

B. Effect of rooting media

The rooting media yielded significantly different number of roots per air layer. The maximum number of roots per air layer was recorded under poultry manure (22.9) media, which was followed by that of vermi compost (18.90) media. The minimum number of roots per air layer was recorded under FYM (15.52) media, which was significantly inferior to those of both vermi compost and poultry media.

C. Effect of interaction of growth regulator and rooting media

The effect of the interaction between growth regulator and rooting media was not found to be significant in respect of number of secondary root per air layer at 5 per cent level of significance as per the F test during analysis of variance. Therefore, the results of this interaction have not been discussed further.

The number of primary and secondary roots under different treatments varied from 8.06 to 18.57 and 11.28 to 23.91, respectively. The maximum number of primary and secondary roots were obtained under treatment IBA at 6000 ppm concentration. The increase in number of roots may be due to the accumulation of rooting co-factors above the ringed portion under the influence of IBA at 6000 ppm.

Khypal (1966) concluded that auxin induced growth phenomenon were dependent on RNA and protein synthesis and suggested that auxin stimulated of RNA. Among the auxin, IBA proved more effective probably due to its greater stability in air layers.

The beneficial effect of IBA on number of primary roots were also observed by Acharya and Dash (1972) in cashewnut and Chatterjee and Rao (1978) in ber. More number of secondary roots were also observed by Tomar (1979) in karaunda, Lavania *et al.* (1995) in jackfruit and Athani *et al.* (2001) in air layers of guava with application of growth substances.

Number of primary and secondary roots per air layer were maximum under poultry manure media as compared to vermi compost and FYM media this may be due to higher pore space and higher availability of nutrients which suited for good growth of roots.

4.4 Length of primary roots per air layer (cm)

A. Effect of growth regulators

Length of primary roots of air layers were recorded at 45 days after air layering which is presented in table 4.4. and fig. 4.4.

Length of primary root is a major indicator of root development of air layers.

The data clearly revealed that growth regulators (IBA) influenced the length of primary roots of air layers. The length of primary roots ranged from 4.34 to 6.96 cm. The maximum length (6.96 cm) of primary roots were recorded under treatment I_4 i.e. IBA (6000 ppm) followed by I_3 i.e. IBA (5000 ppm) which was at par effect on length of primary roots but significantly different effect on length of primary roots when compared with the effects of IBA (4000 ppm), IBA (3000 ppm) and control. The minimum length of primary root (4.34 cm) was observed under treatment I_0 i.e. control.

B. Effect of rooting media

A perusal of data clearly showed significant effect of rooting media on length of primary roots. All the rooting media treatment significantly differed from each other in respect to length of primary roots. The maximum length of primary roots were observed in poultry (6.48 cm) media, while minimum length of primary roots were observed in FYM (5.40 cm) media.

C. Effect of interaction of growth regulators and rooting media

The effect of the interaction between growth regulator and rooting media was not found to be significant in respect of the length of primary root per air layer at 5 per cent level of significance as per the F test during analysis of variance. Therefore, the results of this interaction have not been discussed further.

4.5 Length of secondary roots per air layer (cm)

A. Effect of growth regulators

The length of secondary roots of air layers were recorded at 45 days after air layering. The effect of different treatments on length of secondary root is presented in table 4.5 and shown in fig. 4.5.

It is evident from the table that growth regulators at different concentration significantly influenced the length of secondary roots. The length of secondary roots ranged from 1.81 to 3.70 cm. The maximum length (3.70 cm) of secondary roots were recorded under treatment I_4 i.e. IBA (6000 ppm) followed by I_3 i.e. (5000 ppm) which was at par with respect to effect on length of secondary roots. This had significantly different effect on length of secondary roots compared with IBA (4000 ppm), IBA (3000 pmm) and control. The minimum length (1.81 cm) of secondary root was observed in treatment I_0 i.e. control.

B. Effect of rooting media

The rooting media significantly influenced the length of secondary roots. The maximum length of secondary root per layer was recorded under poultry manure (3.06 cm) media which showed significantly different effect compared to those of both vermi compost and FYM media. The minimum length of secondary roots were recorded with FYM (2.49 cm) media.

C. Effect of interaction of growth regulators and rooting media

The effect of the interaction between growth regulators and rooting media was not found to be significant in respect to length of secondary root per air layers at 5% level of significance as per the F test during analysis of variance. Therefore, the results of this interaction have not been discussed further.

Length of primary and secondary roots per air layer was found to be higher with the application of (6000 ppm) IBA. This may be due to auxins effects leading to accumulation of other internal substances and their downward movement. The treatment (6000 ppm) IBA had found higher average length of primary and secondary roots. This might be due to highest rooting percentage and more number of primary roots observed in this treatment. This is in agreement with the finding of Bhagat *et al.* (1999) in guava, Brahmachari *et al.* (1997) in litchi. Better root growth was also reported by Hanamashetti *et al.* (1984) in cashewnut and Athani *et al.* (2001) in guava.

Length of primary and secondary root per air layer was maximum under poultry manure media. This was probably due to sufficient porosity, bulk density which allowed easy development of roots.

4.6 Diameter of primary root per air layer (cm)

A. Effect of growth regulators

The diameter of primary root per air layer was recorded at 45 days after air layering. The data on diameter of primary root is presented in table 4.6 and shown in fig.4.6.

It is clearly evident from data that growth regulators (IBA) influence the diameter of primary root per air layer. The maximum diameter (1.19 cm) of primary root was observed under treatment I_4 i.e. IBA (6000 ppm) followed by I_3 i.e. IBA (5000 ppm) which was at par effect on diameter of primary root but has significant different effect on diameter of primary root when compared with the effect of IBA (4000 ppm) and IBA (3000 ppm). Diameter of primary root recorded under IBA (4000 ppm) and IBA (3000 ppm) were at par with each other, but they had significantly different effect on diameter of primary root compared to that of control. The minimum diameter (0.87 cm) of primary root was observed in treatment I_0 i.e. control.

B. Effect of rooting media

The rooting media significantly influence the diameter of primary roots. The maximum diameter of primary root was found under poultry manure (1.12 cm) media followed by vermi compost (1.08 cm) media which was at par effect on diameter of primary root, but they had significantly different effect on diameter of primary root when compared with the effect of FYM media. The minimum diameter of primary root was recorded under FYM (1 cm) media.

C. Effect of interaction of growth regulators and rooting media

The effect of the interaction between growth regulator and rooting media was not found to be significant in respect of the diameter of primary root per air layer at 5% level of significance as per the F test during analysis of variance. Therefore, the results of this interaction have not been discussed further.

4.7 Diameter of secondary root per air layer (cm)

A. Effect of growth regulators

The diameter of secondary root per air layer was recorded at 60 days after air layering. The data on diameter of secondary root is presented in table 4.7 and shown in fig. 4.7.

It is noticed from data that growth regulators (IBA) influence the diameter of secondary root per air layer. The maximum diameter (0.35 cm) of secondary root was observed under treatment I_4 i.e. IBA (6000 ppm) followed by I_3 i.e. IBA (5000 ppm) which was at par effect on diameter of secondary roots. This had significantly different effect on diameter of secondary roots compared with IBA (4000 ppm), IBA (3000 ppm) and control. The minimum diameter (0.24 cm) of secondary root was observed in treatment I_0 i.e. control.

B. Effect of rooting media

The rooting media significantly influence the diameter of secondary roots. The maximum diameter of secondary root was found under poultry manure (0.32 cm) media followed by vermi compost (0.29) cm media, which was at par to each other, but they had significantly different effect on diameter of secondary root compared to that of FYM media. The minimum diameter of secondary root was recorded under FYM (0.25 cm) media which was significantly lower to those of both vermi compost and poultry manure media.

C. Effect of interaction of growth regulators and rooting media

The effect of the interaction between growth regulator and rooting media was not found to be significant in respect to the diameter of primary root per air layer at 5% level of significance as per the F test during analysis of variance. Therefore, the results of this interaction have not been discussed further.

Observation on diameter of primary and secondary root revealed that it varied from 0.87 cm to 1.19 cm and 0.24 to 0.35 cm, respectively. Maximum diameter was recorded under treatment IBA at 6000 ppm concentration. Increasing in diameter of primary and secondary roots with IBA at 4000 ppm treatment was also noted by Ram Chandra *et al.* (1991) in guava air layer. The diameter was increased due to higher accumulation of food material. These results are in conformity with the results of Sharma *et al.* (1991) in guava air layering.

Length of primary root per air layer was maximum under poultry manure media. This was probably due to sufficient porosity, bulk density which allowed easy development of roots.

4.8 Fresh weight of roots per air layers (g)

A. Effect of growth regulators

The data on fresh weight of roots per air layer is presented in table 4.8 and shown in fig. 4.8.

It is apparent from the data that the plant growth regulator (IBA) included in this study influenced the fresh weight of roots per air layers at

60 days after air layering. The maximum fresh weight (4.99 g) of roots per air layer was recorded under application of IBA (6000 ppm) which has at par effect on fresh weight of root with that of IBA (5000 ppm) but both had significantly different effect on fresh weight of root compared to that of IBA (4000 ppm) and IBA (3000 pmm). Fresh weight under IBA (4000 ppm) and IBA (3000 ppm) were at par to each other, but they had significantly different effect on fresh weight of root compared with control. The lowest fresh weight (2.87 g) of roots per air layer was recorded under control.

B. Effect of rooting media

The rooting media was found to have a significant effect on fresh weight of root per air layer. All the rooting media treatment differ significantly with each other in respect of fresh weight of root per air layers. The maximum fresh weight (4.59 g) of root per air layer was recorded under poultry manure media which was followed by that of vermi compost (4.15 g) media. The lowest fresh weight of root was recorded under FYM (3.41 g) media.

C. Effect of interaction of growth regulators and rooting media

The effect of the interaction between growth regulator and rooting media was not found to be significant in respect of the fresh weight of root at 5% level of significance as per the F test during analysis of variance. Therefore, the results of this interaction have not been discussed further.

4.9 Dry weight of roots per air layer (g)

A. Effect of growth regulators

The data on dry weight of roots per air layer is presented in table 4.9 and shown in fig.4.9.

It is noticed from data that the growth regulators (IBA) included in this study influence the dry weight of roots per air layer at 60 days after air layering. The maximum dry weight (1.67 g) of roots per air layer was recorded under treatment I_4 i.e. (6000 ppm) followed by IBA (5000 ppm) which has at par effect on dry weight of root but has significantly different effect on dry weight of shoot when compared with the effect of IBA (4000 ppm) and IBA (3000 ppm). Dry weight of shoot recorded under IBA (4000 ppm) and IBA (3000 ppm) were at par with each other, but it was significantly superior with that of treatment I_0 i.e. control. The lowest dry weight (1.01g) of root per air layer was recorded under control.

B. Effect of rooting media

It is evident from the data that rooting media significantly affected the dry weight of rots per air layers. The maximum dry weight (1.52g) of root per air layer was recorded under poultry manure media which showed significantly different effect compared to those of both vermi compost and FYM media. The minimum dry weight (1.24 g) was recorded under FYM media which was significantly inferior to those of both vermi compost and poultry manure media.

C. Effect of interaction of growth regulators and rooting media

The effect of the interaction between growth regulator and rooting media was not found to be significant in respect of the dry weight of roots per air layer at 5% level of significance. Therefore, the results of this interaction have not been discussed further.

The application of 6000 ppm IBA was found to be superior than all other treatments to increase the fresh weight and dry weight of roots per air layer.

Increase in number and length of roots was probably responsible for enhancement in fresh weight of root under 6000 ppm IBA. Maximum dry weight of root under 6000 ppm IBA may be due to maximum fresh weight of roots per air layers under 6000 ppm IBA. These results are in confirmation with findings of Sharma *et al.* (1991) who reported maximum weight of root under treatment IBA at 10000 ppm in air layers of guava.

Maximum fresh and dry weight of roots per air layer was observed under poultry manure media. It may be due to maximum pore space and highly nutrients contents under this media.

4.10 Number of green leaves per air layer

A. Effect of growth regulator

The data on number of leaves in table 4.10 and shown in fig. 4.10.

Data recorded on number of leaves per air layer at 30 days after transplanting indicate that the maximum value (12.60) for this attribute was noted with the treatment I_4 i.e. IBA (6000 ppm) which was found to have significantly different effect on number of leaves from those of all other treatments. The number of leaves recorded under treatment I_2 i.e. IBA (4000 ppm) followed by I_1 i.e. IBA (3000 ppm) which was at par effect on number of leaves but has significantly different effect on number of leaves when compared with control. The minimum number (7.39) of leaves was observed in control.

At 60 days after transplanting the number of leaves per air layer ranged from 7.78 to 14.36. The maximum number (14.36) of leaves per air layer was observed under (6000 ppm) IBA, which was found significantly different effect on number of leaves with those of all other IBA treatment. The number of leaves recorded under treatment I_3 i.e. IBA (5000 ppm) followed by I_2 i.e. IBA (4000 ppm) was at par effect on number of leaves but it was significantly different effect on number of leaves from that of IBA (3000 ppm). Number of leaves recoded under IBA (4000 ppm) and IBA (3000 ppm) were at par with each other, but they had significantly different effect on number of leaves compared with control. The minimum number (7.78) of leaves per air layer was recorded in control.

At 90 days after transplanting the number of leaves per air layer ranged from 8.23 to 15.44. The maximum number (15.44) of leaves per air layer was observed under IBA (6000 ppm) followed by IBA (5000 ppm) which has at par effects on number of leaves but has significantly different effects on number of leaves when compared with the effects of IBA (4000 ppm), IBA (3000 ppm) and control. The minimum number (8.23) of leaves per air layer was recorded in control which was significantly inferior to those of all other treatments.

B. Effect of rooting media

At 30, 60 and 90 days after transplanting the rooting media significantly influence the number of leaves per air layer.

At 30 days after transplanting the maximum number of leaves was found with poultry manure rooting (11.22) media which was followed by that of vermi compost (10.24) media. The minimum number of leaves recorded under FYM (8.82) media.

At 60 days after transplanting the maximum number (12.04) of leaves was found under poultry manure media which showed significantly different effect compared to those of both vermin compost and FYM media. The minimum number (10.11) of leaves per air layer were recorded under FYM media.

At 90 days after transplanting the maximum number (13.69) of leaves was found under poultry manure media which showed significantly different effect compared to those of both vermi compost and FYM media in respect of number of leaves. The minimum number (10.69) of leaves per air layer were recorded under FYM media.

C. Effect of interaction of growth regulator and rooting media

At 30, 60 and 90 days after transplanting the effect of interaction between growth regulator and rooting media were not found to be significant in respect of number of leaves per air layer at 5% level of significance as per the F test during analysis of variance. Therefore, the results of this interaction have not been discussed further.

The maximum number of leaves were recorded under IBA at (6000 ppm). The more number of leaves noted in this treatment may be due to longest shoot noticed under this treatment. More number of leaves may be due to the fact that auxin were involved in regulation of protein synthesis.

Above results are supported by the findings of Bhagat *et al*. (1999). They recorded highest number of leaves per air layer with application of higher concentration (4500 ppm) of IBA in air layers of guava.

After 30, 60 and 90 days of transplanting the rooting media significantly increased the number of leaves per layer. The maximum number of leaves were recorded under poultry manure media. This may be due to good water holding capacity and sufficient nutrient supply as compared to that of vermi compost and FYM media.

4.11 Length of shoot per air layer (cm)

A. Effect of growth regulator

The length of shoot per layer was recoded at 30, 60 and 90 days after transplanting of air layers. The data on length of shoot in presented in table 4.11 and fig.4.11.

The treatment means in the table have been marked with different superscripts indicating their parity or disparity in view of CD values at 5% level of significance.

Shoot length is one of the main character representing vegetative growth of the plant. It is apparent from table length of shoots per layer recorded at 30 days after transplanting ranged from 1.94 to 4.33 cm. The maximum length (4.33) of shoot per air layer was noted under treatment IBA (6000 ppm). Which was found remarkably significant from those of all other IBA treatment included in this study. The minimum length (1.94 cm) of shoot per air layer was noted under control which was significantly inferior to those of all other growth regulator treatments.

Data recorded 60 days after transplanting of air layer showed that the maximum length of shoot (5.31) per layer was recoded with the treatment of IBA at (6000 ppm) which was found to be significantly better than those of all other growth regulator treatment. Length of shoot per air layer was recorded under treatment IBA (4000 ppm) was followed by treatment IBA (3000 ppm) which has at par effect on length of shoot but showed significantly different effect on length of shoot when compared by that of control. The minimum length (3.28 cm) of shoot per layer was recorded in control.

At 90 days after transplanting, the length of shoot per air layer ranged from 3.40 to 5.83 cm. The maximum length (5.83 cm) of shoot per layer was observed under IBA (6000 ppm). This had significantly different effect on the length of shoot compared to those of all other growth regulator treatments. The length of shoots recorded under treatment IBA (4000 ppm) and IBA (3000 ppm) was at par with each other, but they had significantly different effect on length of shoot compared to that of control. The minimum length (3.40 cm) of shoot per air layer was recorded in control.

B. Effect of rooting media

At 30 days after transplanting the rooting media significantly influenced the length of shoot per air layers. The maximum length (3.79) was recorded under poultry manure media which showed significantly different effect compared to those of both vermi compost and FYM media. The minimum length of (2.72 cm) was observed under FYM media.

At 60 days after transplanting the rooting media significantly influenced the length of shoot per air layers. The maximum length of 4.97 cm was recorded under poultry manure media, which was followed by that of vermi compost (4.48 cm) media. The minimum length of shoots per air layer was recorded under FYM (3.98) media.

At 90 days after transplanting it is evident that maximum length of shoot (5.05 cm) per air layer was recorded under poultry manure media, while minimum length of shoot (4.05) were recorded under FYM media.

C. Effect of interaction of growth regulator and rooting media

At 30, 60 and 90 days after transplanting the effect of the interaction between regulator and rooting media were not found to be significant in respect of length of shoot per air layers at 5% level of significance as per the F test during analysis of variance. Therefore, the results of this interaction have not been discussed further.

After 30, 60 and 90 days of transplanting of air layers length of shoot per air layer was found to be significantly highest under IBA at (6000 ppm). The longest shoot was observed in this treatment, which may be due to more number of leaves.

Jain *et al*. (2003) reported longest shoot length for air layer of litchi treated with (2500 ppm) of IBA.

Rooting media gave the significant difference on the length of shoot per air layers. The maximum length of shoot was observed under poultry manure media. This was probably due to more nutrient content in poultry media as compare to remaining media.

4.12 Number of branches per air layer

A. Effect of growth regulator

The data on the number of branches is given in table 4.12 and shown in fig. 4.12.

It is evident from the data that growth regulators (IBA) significantly influence the number of branches per air layer at 30, 60 and 90 days after transplanting.

The number of branches per air layer at 30 days after transplanting ranged from 1.90 to 5.42. The maximum number (5.42) of branches per air layer was recorded under treatment IBA (6000 ppm) followed by IBA (5000 ppm) which has at par effect on number of branches when compared with the effect of IBA (4000 ppm) and IBA (3000 ppm). The number of branches recorded under IBA (4000 ppm) and IBA (3000 ppm) were at par with each other, but they had significantly different effect on number of branches compared to that of control. The minimum number of branches (1.90) per air layer was found under treatment I_0 i.e. control.

At 60 days after transplanting the maximum number (5.80) of branches per layer was recorded under treatment IBA (6000 ppm) followed by IBA (5000 ppm) which had at par effect on number of branches. This had significantly different effect on number of branches compared with IBA (4000 ppm) and IBA (3000 ppm). The number of branches recorded under IBA (4000 ppm) and IBA (3000 ppm) were at par with each other but it was significantly different from that of control. The minimum number (2.25) of branches per air layer was recorded under control.

At 90 days after transplanting the number of branches per air layer ranged from 2.99 to 6.10. The maximum number (6.10) of branches per air layer was observed under (6000 ppm) IBA followed by (5000 ppm) IBA which was at par with respect to number of branches but showed significantly different effect on number branches compared to those of IBA (4000 ppm) and IBA (3000 ppm). The minimum number (2.89) of branches per air layer was recorded in control which was significantly inferior to those of all other treatments.

B. Effect of rooting media

At 30, 60 and 90 days after transplanting the rooting media significantly influenced the number of branches per air layer.

At 30 days after transplanting the maximum number of branches was recorded under poultry manure (4.84) media which was followed by that of vermi compost (4.24). The minimum number of branches recorded under FYM (3.34) media which was inferior to those of both vermi compost and poultry media.

At 60 days after transplanting the maximum number (5.10) of branches was observed under poultry manure media which showed significantly better than those of both vermi compost and FYM media. The minimum number (3.64) of branches was recorded under FYM media.

At 90 days after transplanting the maximum number (6.00) of branches was recorded under poultry manure media, while minimum number (4.08) of branches was recorded under FYM media.

C. Effect of interaction of growth regulator and rooting media

At 30, 60 and 90 days after transplanting the effect of interaction between growth regulator and rooting media were not found to be significant in respect of number of branches per air layer at 5% level of significance as per the F test during analysis of variance. Therefore, the results of this interaction have not been discussed further.

The number of branches per air layer was maximum number (6000 ppm) IBA. This may be due to higher number of leaves and longer shoots recorded under this treatment.

Rooting media also showed significant difference between treatments for number of branches per air layer. The maximum number of branches per air layer was recorded under poultry manure media. This was may be probably due to sufficient nutrition supply by poultry manure media.

4.13 Fresh weight of shoots per air layer

A. Effect of growth regulator

The data on fresh weight of shoots per air layer is depicted in table 4.13 and shown in fig. 4.13. The treatment means in the table have been marked with different superscripts indicating their parity or disparity in view of CD (critical difference) value at 5% level of significance.

It is evident from the table that the fresh weight of shoots per layer recorded at 90 days after transplanting ranged from 3 to 5.85 g. The maximum fresh weight (5.85) of shoots per air layer were treated with (6000 ppm) IBA. This had significantly different effect on fresh weight of shoots per air layer compared to those of all other growth regulator. Fresh weight recorded under treatment I_2 i.e. IBA (4000 ppm) was at par effect on fresh weight of shoot with that of treatment I_1 i.e.IBA (3000 ppm) but they had significantly different effect on fresh weight of shoot compared with control. The minimum value for this attribute was observed in control (3.00 g) which was significantly inferior to those of all other treatments.

B. Effect of rooting media

The rooting media had significantly different effect on the fresh weight of shoots per air layer. The maximum fresh weight (5.12 g) of shoots per air layer was recoded under poultry manure which was found remarkably significant from those of all other media included in the study.

The minimum fresh weight of shoot per air layer was observed in FYM (4.03 g) media which was significantly different from those of both vermi compost and poultry manure media.

C. Effect of interaction of growth regulator and rooting media

The effect of the interaction between growth regulator and rooting media was not found to be significant in respect of fresh weight of shoot per air layer at 5 per cent level of significance as per the F test during analysis of variance. Therefore, the results of this interaction have not been discussed further.

Fresh weight of shoots per air layer was maximum under (6000 ppm) IBA. Increase in fresh weight of shoot per layer may be due to higher number of leaves, longer shoots and more number of branches recorded under this treatment. IBA promote luxurious growth of roots as well as shoots which may have been resulted in the maximum fresh weight of shoots.

Fresh weight of shoot per layer was maximum under poultry manure media. This may be due to higher number of leaves, length of shoots and number of branches.

4.14 Dry weight of shoots per air layer (g)

A. Effect of growth regulators

The dry weight of shoots per air layer were recorded at 90 days after transplanting. The data on dry weight of shoot is presented in table 4.14 and fig. 4.14.

It is revealed from the table that dry weight of shoots per air layers recorded at 90 days after transplanting raged from 1.02 to 1.96 g. The maximum dry weight (1.96 g) of shoots per air layer were recorded under the treatment (6000 ppm) IBA followed by (5000 ppm) IBA which has at par effect on dry weight of shoot but has significantly different effect on dry weight of shoot when compared with the effects of IBA (4000 ppm) and IBA (3000 pmm). The lowest dry weight (1.02 g) of shoots per air layer were noted in control.

B. Effect of rooting media

Data recorded on the effect of rooting media at 90 days after transplanting of air layer showed that the dry weight of shoots per air layers in this study ranged from 1.50 to 1.76 g. The maximum dry weight (1.76 g) of shoots per air layers was recorded under poultry manure media which was found to be significantly better than those of both vermi compost and FYM media. The lowest dry weight of shoot was recorded under FYM (1.50 g) media.

C. Effect of interaction of growth regulator and rooting media

The effect of the interaction between growth regulator and rooting media was not found to be significant in respect of dry weight of shoot per air layer at 5% level of significance as per the F test during analysis of variance. Therefore, the results of this interaction have not been discussed further.

A higher dry weight of shoots per air layer was recorded under 6000 ppm IBA than those of all other treatments. This may be due to maximum fresh weight of shoot per air layer found under this treatment.

As for the rooting media, maximum dry weight of shoots per air layer was observed under poultry manure media. This might be due to higher fresh weight of shoot per air layer obtained under poultry manure media.

4.15 Percentage of survival

A. Effect of growth regulator

The percentage of survival of layers were recorded at an interval of 30, 60 and 90 days after transplanting. The effect of different treatments on percentage of survival is presented in table 4.15 and shown in fig. 4.15. The treatment means in the table have been marked with different superscripts indicating their parity or disparity in view of CD (critical difference) value at 5% level of significance.

Percentage of survival is the character which shows the final success of air layering.

It is evident from the table that the growth regulator at different concentration significantly influenced the percentage of survival at 30, 60 and 90 days after transplanting. The highest percentage of survival were recorded (75.26%, 72.10% and 60.13%) under IBA (6000 ppm) after 30, 60 and 90 days after transplanting of air layers, respectively. The treatment I_4 i.e. IBA (6000 ppm) had significantly different effect on the percentage of survival compared to those of all growth regulator (IBA) treatments. Similarly all other treatments were having significantly different effect in respect of percentage of a survival in comparison with each other. The minimum percentage (45.25, 43.45 and 40.27 per cent) of survival was recorded under control i.e. I_0 after 30, 60 and 90 days after transplanting of air layers which was inferior to those of all other treatments.

B. Effect of rooting media

The rooting media significantly influenced the percentage of survival at 30, 60 and 90 days after transplanting. The highest percentage of survival (67.42, 64.60 and 56.78%) was recorded under poultry manure media at 30, 60 and 90 days after transplanting of air layer respectively. This had showed significantly different effect compared to those of both vermi compost and FYM media in respect of survival percentage. The minimum percentage of survival (60.52, 57.67 and 49.13%) was recorded under FYM at 30, 60 and 90 days after transplanting, respectively, which was significantly different from those of both vermi compost and poultry manure media.

c. Effect of interaction of growth regulator and rooting media

At 30, 60 and 90 days after transplanting of air layers the effect of interaction between growth regulator and rooting media were not found to be significant in respect of the survival percentage of air layers at 5 per cent level of significance as per the F test during analysis of variance. Therefore, the results of this interaction have not been discussed further.

Observations on survival (after three months of transplanting) of rooted layers revealed that with the application of growth regulators survival percentage varies from 40.27 to 60.13 per cent. Maximum survival was obtained with IBA (6000 ppm) (60.13%). However, minimum survival percentage was observed under control.

Kamleshkar and Jain (1996) and Bhagat *et al*. (1999) also reported beneficial effect of IBA in air layers of guava in respect of survival percentage.

The survival of air layers is directly dependent on number, length and diameter of primary and secondary roots.

IBA proved significantly superior in respect of survival percentage of air layers in the nursery because of their greater stability and low mortality in plants. It was observed that when air layers with better root development were planted in the nursery exhibited better establishment. Maximum root number was closely associated with more root length and diameter. Thus, the fibrous nature of primary roots helped in their quick establishment in the soil. A uniform spread of root system, absorbed sufficient nutrients and water from soil, which helped in quick growth of shoots and subsequently more development of roots.

The beneficial effect of IBA on better survival of layers was also confirmed by Ram and Majumdar (1983) in litchi, Chatterjee *et al*. (1990) in sapota, Misra and Singh (1990) in karaunda, Bisen and Barholia (1995) in jackfruit and Chovatia and Singh (2000) in custard apple.

After 30, 60 and 90 days of transplanting of air layers the rooting media did significantly influence the percentage of survival. The maximum survival percentage was observed under poultry manure as compared to vermi compost and FYM media. This may be probably due to maximum root number and more root length under poultry manure compared to vermi compost and FYM media.

CHAPTER V

SUMMARY, CONCLUSION AND SUGGESTIONS FOR FUTURE RESEARCH WORK

An experiment on "**Effect of plant growth regulator and rooting media on air layering in Guava (*Psidium guajava* L.) cv. Lucknow-49 under Chhattisgarh region**" was conducted from 25th August, 2004 to 25th January 2005 at Research Farm of Horticulture Department, Indira Gandhi Agricultural University, Raipur (C.G.). The experiment was laid out in two factors Factorial experiment in completely randomized design with four replication and two factor. Plant growth regulator, IBA, is first factor and it consisted of five IBA concentration i.e. 0 ppm or control, 3000 ppm, 4000 ppm, 5000 ppm and 6000 ppm. Second factor consisted of three rooting media i.e. soil:sand:poultry manure, soil:sand:vermi compost, soil:sand:farmyard manure in 2:2:1 combination.

The experimental findings based on the observations made on rooting behaviour and vegetative growth of rooted air layer of guava are summarized below:

- Growth substances promoted the rootability of guava air layering significantly in comparison to untreated shoots. Maximum percentage (84.75%) of rooted air layers were obtained with the IBA at 5000 ppm concentration followed by IBA 6000 ppm. The poultry media had significantly highest (77.17%) performance on rooting compared to both vermi compost and FYM media.

- Number of primary and secondary roots were increased by the application of different growth substances at various concentration. The application of IBA 6000 ppm proved remarkably better than other treatments for number of primary roots (18.57) and secondary roots (23.91).

  Poultry manure media was found superior than vermi compost and farm yard manure in producing higher number of primary roots (15.60) and secondary roots (23.13).

- Guava air layers when treated with growth substances increased the length of primary and secondary root. IBA 6000 ppm showed maximum length of primary root (6.96 cm) and secondary root (3.70 cm). Poultry manure media was found effective in increasing the length of primary and secondary root with maximum length of (6.48 cm) and (3.06 cm), respectively.

- Maximum diameter of primary root (1.19 cm) and secondary root (0.35cm) was obtained in IBA at 6000 ppm concentration as well as poultry manure media also gave maximum diameter of primary root (1.12 cm) and secondary root (0.32 cm).

- Fresh and dry weight of roots were increased by the application of IBA at various concentration. However, maximum fresh weight (4.99g) and maximum dry weight (1.67g) of root were obtained under treatment IBA 6000 ppm.

Maximum fresh (4.59g) and dry weight (1.52 g) of roots were obtained on poultry manure media as compared to other tested media.

- Number of leaves per air layers were obtained highest with the treatment IBA 6000 ppm. Similarly, more number of leaves were obtained with poultry manure media after 30, 60 and 90 days of transplanting.
- The length of shoots per air layer was maximum (5.83 cm) under treatment IBA at 6000 ppm as well as poultry manure media also gave maximum length (5.05 cm) of shoot per air layer.
- The application of IBA 6000 ppm proved remarkably better than other treatments for number of branches with maximum number of branches (6.10). Number of branches per air layer were significantly higher in poultry manure media compared to vermi compost and FYM media.
- Fresh and dry weight of shoots were increased by the application of IBA at various concentration. However, maximum fresh weight (5.85g) and maximum dry weight (1.96g) of shoots were obtained with application of IBA at 6000 ppm.

Maximum fresh weight (5.12 g) and dry weight (1.76g) of shoots per air layer were notice under poultry manure media.

- As regard to survival percentage of guava air layers in nursery after 90 days of transplanting all the treated air layers were found significantly superior to untreated air layers. The best treatment in this respect was IBA at 6000 ppm which showed maximum survival (60.13%). Survival percentage (56.78%) was significantly superior under poultry manure media.

Conclusion

Thus from the above findings it may be concluded that guava can be commercially propagated by air layering by the application of growth regulators IBA at 6000 ppm concentration.

Among the rooting media, Soil:Sand:Poultry manure in combination of 2:2:1 was found significantly superior than those of Soil:Sand:Vermi compost and Soil: Sand:Farmyard manure media for performing air layering in guava. For the maximum regeneration, length and number of roots and their establishment in the nursery, application of growth regulators, IBA at 6000 ppm concentration with soil:sand:poultry manure media was judged to be the best.

Suggestions for future work

Since the results of present investigation belongs to only one year of experimentation, for reaching to any definite conclusion and recommendation, it needs further confirmation for atleast two successive years. However, following studies are also suggested to be undertaken in future.

- Other rooting media may be included to study their effect on rooting of guava air layers.
- Optimum concentration of IBA with other growth regulators may be included in future studies.
- Other combination of rooting media may be included to study their effect on rooting of guava air layers.

“EFFECT OF PLANT GROWTH REGULATOR AND ROOTING MEDIA ON AIR LAYERING IN GUAVA (*Psidium guajava* L.) CV. LUCKNOW-49 UNDER CHHATTISGARH REGION”

by

Jitendra Chandraker

ABSTRACT

The present investigation entitled **“Effect of plant growth regulator and rooting media on air layering in guava (*Psidium guajava* L.) cv. Lucknow-49 under Chhattisgarh region”** was carried out at Research Farm, Department of Horticulture, College of Agriculture, Raipur (C.G.) from 25th August, 2004.

The experiment design was factorial experiment in completely randomized design (CRD). One year old shoots of “Lucknow-49” cultivar about 60 cm length having diameter of pencil thickness, were selected for the experiment. Removing barks of the branches of 5 cm width and air layering was done in four replicates treating with a combination of media, viz. poultry manure, vermi compost and farmyard manure and growth regulators viz. the IBA in concentration of 0 ppm, 3000 ppm, 4000 ppm, 5000 ppm and 6000 ppm.

Plant growth regulator (IBA) as well as rooting media promoted rooting of air layers.

IBA concentration of 6000 ppm stimulated maximum root growth and development. This treatment also increased the number of leaves, length of shoot, diameter of shoot, fresh and dry weight of root and shoot and also increased survival percentage of guava air layers. IBA concentration of 5000 ppm was found to be best for rooting of air layering.

Soil:Sand:Poultry manure media produced maximum percentage of rooting, root growth, root development and vegetative growth.

It can be inferred from the study that an application of 6000 ppm IBA with soil:sand:poultry manure media would be helped to produce better root-shoot growth, survival and better establishment for air layers of guava.

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Table 4.1 : Effect of plant growth regulator and rooting media on percentage of rooting

Treatment		Percentage of rooting	
		30 DAL	45 DAL
IBA concentration			
Control	I_0	44.75[a]	54.08[a]
IBA 3000 ppm	I_1	62.83[b]	71.08[b]
IBA 4000 ppm	I_2	62.33[b]	70.79[b]
IBA 5000 ppm	I_3	79.16[c]	84.75[c]
IBA 6000 ppm	I_4	78.20[c]	84.25[c]
SEm±		0.51	0.56
CD at 5% level		1.46	1.59
Rooting media			
Poultry manure	M_1	69.72[c]	77.17[c]
Vermi compost	M_2	64.75[b]	72.50[b]
Farmyard manure	M_3	61.90[a]	68.25[a]
SEm±		0.40	0.43
CD at 5% level		1.13	1.23
Interaction (Growth regulator x Rooting media)			NS

Table 4.2 : Effect of plant growth regulator and rooting media on number of primary roots per air layer

Treatment		Number of primary roots / air layer
IBA concentration		
Control	I_0	8.06
		(2.84)[a]
IBA 3000 ppm	I_1	12.96
		(3.60)[b]
IBA 4000 ppm	I_2	13.69
		(3.70)[b]
IBA 5000 ppm	I_3	17.47
		(4.18)[c]
IBA 6000 ppm	I_4	18.57
		(4.31)[c]
SEm±		0.06
CD at 5% level		0.16
Rooting media		
Poultry manure	M_1	15.60
		(3.95)[c]
Vermi compost	M_2	13.76
		(3.71)[b]
Farmyard manure	M_3	12.39
		(3.52)[a]
SEm±		0.04
CD at 5% level		0.13
Interaction (Growth regulator x Rooting media)		**NS**

(Data in parenthesis indicates square root transformed value)

Table 4.3 : Effect of plant growth regulator and rooting media on number of secondary roots per air layer

Treatment		Number of secondary roots / air layer
IBA concentration		
Control	I_0	11.28
		(3.36)[a]
IBA 3000 ppm	I_1	17.97
		(4.24)[b]
IBA 4000 ppm	I_2	19.71
		(4.44)[c]
IBA 5000 ppm	I_3	23.81
		(4.88)[d]
IBA 6000 ppm	I_4	23.91
		(4.89)[d]
SEm±		0.04
CD at 5% level		0.12
Rooting media		
Poultry manure	M_1	22.9
		(4.79)[c]
Vermi compost	M_2	18.9
		(4.35)[b]
Farmyard manure	M_3	15.52
		(3.94)[a]
SEm±		0.03
CD at 5% level		0.09
Interaction (Growth regulator x Rooting media)		**NS**

(Data in parenthesis indicates square root transformed value)

Table 4.4 : Effect of plant growth regulator and rooting media on length of primary root (cm) per air layer

Treatment		Length of primary root (cm) / air layer
IBA concentration		
Control	I_0	4.34^a
IBA 3000 ppm	I_1	5.95^b
IBA 4000 ppm	I_2	6.24^c
IBA 5000 ppm	I_3	6.69^d
IBA 6000 ppm	I_4	6.96^d
SEm±		0.10
CD at 5% level		0.28
Rooting media		
Poultry manure	M_1	6.48^c
Vermi compost	M_2	6.19^b
Farmyard manure	M_3	5.40^a
SEm±		0.08
CD at 5% level		0.21
Interaction (Growth regulator x Rooting media)		**NS**

Table 4.5 : Effect of plant growth regulator and rooting media on length of secondary root (cm) per air layer

Treatment		Length of secondary root (cm) / air layer
IBA concentration		
Control	I_0	1.81^{a}
IBA 3000 ppm	I_1	2.55^{b}
IBA 4000 ppm	I_2	2.38^{c}
IBA 5000 ppm	I_3	3.59^{d}
IBA 6000 ppm	I_4	3.70^{d}
SEm±		0.06
CD at 5% level		0.16
Rooting media		
Poultry manure	M_1	3.06^{c}
Vermi compost	M_2	2.87^{b}
Farmyard manure	M_3	2.49^{a}
SEm±		0.04
CD at 5% level		0.13
Interaction (Growth regulator x Rooting media)		**NS**

Table 4.6 : Effect of plant growth regulator and rooting media on diameter of primary root (cm) per air layer

Treatment		Diameter of primary root (cm) / air layer
IBA concentration		
Control	I_0	0.87[a]
IBA 3000 ppm	I_1	1.04[b]
IBA 4000 ppm	I_2	1.06[b]
IBA 5000 ppm	I_3	1.17[c]
IBA 6000 ppm	I_4	1.19[c]
SEm±		0.03
CD at 5% level		0.07
Rooting media		
Poultry manure	M_1	1.12[b]
Vermi compost	M_2	1.08[b]
Farmyard manure	M_3	1.00[a]
SEm±		0.02
CD at 5% level		0.06
Interaction (Growth regulator x Rooting media)		**NS**

Table 4.7 : Effect of plant growth regulator and rooting media on diameter of secondary root (cm) per air layer

Treatment		Diameter of secondary root (cm) / air layer
IBA concentration		
Control	I_0	0.24[a]
IBA 3000 ppm	I_1	0.26[b]
IBA 4000 ppm	I_2	0.28[b]
IBA 5000 ppm	I_3	0.32[c]
IBA 6000 ppm	I_4	0.35[c]
SEm±		0.01
CD at 5% level		0.03
Rooting media		
Poultry manure	M_1	0.32[b]
Vermi compost	M_2	0.29[b]
Farmyard manure	M_3	0.25[a]
SEm±		0.01
CD at 5% level		0.03
Interaction (Growth regulator x Rooting media)		**NS**

Table 4.8 : Effect of plant growth regulator and rooting media on fresh weight of roots (g) per air layer

Treatment		Fresh weight of root (g) / air layer
IBA concentration		
Control	I_0	2.87[a]
IBA 3000 ppm	I_1	3.80[b]
IBA 4000 ppm	I_2	3.82[b]
IBA 5000 ppm	I_3	4.79[c]
IBA 6000 ppm	I_4	4.99[c]
SEm±		0.09
CD at 5% level		0.27
Rooting media		
Poultry manure	M_1	4.59[c]
Vermi compost	M_2	4.15[b]
Farmyard manure	M_3	3.41[a]
SEm±		0.07
CD at 5% level		0.21
Interaction (Growth regulator x Rooting media)		**NS**

Table 4.9 : Effect of plant growth regulator and rooting media on dry weight of roots (g) per air layer

Treatment		Dry weight of root (g) / air layer
IBA concentration		
Control	I_0	1.01[a]
IBA 3000 ppm	I_1	1.27[b]
IBA 4000 ppm	I_2	1.31[b]
IBA 5000 ppm	I_3	1.62[c]
IBA 6000 ppm	I_4	1.67[c]
SEm±		0.05
CD at 5% level		0.14
Rooting media		
Poultry manure	M_1	1.52[c]
Vermi compost	M_2	1.37[b]
Farmyard manure	M_3	1.24[a]
SEm±		0.04
CD at 5% level		0.11
Interaction (Growth regulator x Rooting media)		**NS**

Table 4.10 : Effect of plant growth regulator and rooting media on number of green leaves per air layer

Treatment		No. of green leaves / air layer		
		30 DAT	60 DAT	90 DAT
IBA concentration				
Control	I_0	7.39	7.78	8.23
		$(2.72)^{a}$	$(2.79)^{a}$	$(2.87)^{a}$
IBA 3000 ppm	I_1	9.48	11.02	11.49
		$(3.08)^{b}$	$(3.32)^{b}$	$(3.39)^{b}$
IBA 4000 ppm	I_2	9.79	11.35	12.32
		$(3.13)^{b}$	$(3.37)^{bc}$	$(3.51)^{c}$
IBA 5000 ppm	I_3	11.49	11.62	14.51
		$(3.39)^{c}$	$(3.41)^{c}$	$(3.81)^{d}$
IBA 6000 ppm	I_4	12.60	14.36	15.44
		$(3.55)^{d}$	$(3.79)^{d}$	$(3.93)^{d}$
SEm±		0.04	0.04	0.05
CD at 5% level		0.10	0.11	0.14
Rooting media				
Poultry manure	M_1	11.22	12.04	13.69
		$(3.35)^{c}$	$(3.47)^{c}$	$(3.70)^{c}$
Vermi compost	M_2	10.24	11.22	12.11
		$(3.20)^{b}$	$(3.35)^{b}$	$(3.48)^{b}$
Farmyard manure	M_3	8.82	10.11	10.69
		$(2.97)^{a}$	$(3.18)^{a}$	$(3.27)^{a}$
SEm±		0.03	0.03	0.04
CD at 5% level		0.08	0.09	0.11
Interaction (Growth regulator x Rooting media)			**NS**	

(Data in parenthesis indicates square root transformed value)

Table 4.11 : Effect of plant growth regulator and rooting media on length of shoot (cm) per air layer

Treatment		Length of shoot (cm) / air layer		
		30 DAT	60 DAT	90 DAT
IBA concentration				
Control	I_0	1.94[a]	3.28[a]	3.40[a]
IBA 3000 ppm	I_1	3.09[b]	4.37[b]	4.43[b]
IBA 4000 ppm	I_2	3.28[c]	4.39[b]	4.54[b]
IBA 5000 ppm	I_3	3.70[d]	5.03[c]	5.15[c]
IBA 6000 ppm	I_4	4.33[e]	5.31[d]	5.83[d]
SEm±		0.06	0.09	0.11
CD at 5% level		0.16	0.26	0.30
Rooting media				
Poultry manure	M_1	3.79[c]	4.97[c]	5.05[c]
Vermi compost	M_2	3.29[b]	4.48[b]	4.67[b]
Farmyard manure	M_3	2.72[a]	3.98[a]	4.05[a]
SEm±		0.04	0.07	0.08
CD at 5% level		0.13	0.20	0.23
Interaction (Growth regulator x Rooting media)			**NS**	

Table 4.12 : Effect of plant growth regulator and rooting media on number of branches per air layer

Treatment		No. of branches / air layer		
		30 DAT	60 DAT	90 DAT
IBA concentration				
Control	I_0	1.90	2.25	2.89
		(1.38)[a]	(1.50)[a]	(1.70)[a]
IBA 3000 ppm	I_1	4.41	4.53	5.19
		(2.10)[b]	(2.13)[b]	(2.28)[b]
IBA 4000 ppm	I_2	4.20	4.36	4.84
		(2.05)[b]	(2.09)[b]	(2.20)[c]
IBA 5000 ppm	I_3	5.24	5.56	5.95
		(2.29)[c]	(2.36)[c]	(2.44)[d]
IBA 6000 ppm	I_4	5.42	5.80	6.10
		(2.33)[c]	(2.41)[c]	(2.47)[d]
SEm±		0.03	0.03	0.02
CD at 5% level		0.09	0.08	0.06
Rooting media				
Poultry manure	M_1	4.84	5.10	6.00
		(2.20)[c]	(2.26)[c]	(2.45)[c]
Vermi compost	M_2	4.24	4.53	4.79
		(2.06)[b]	(2.13)[b]	(2.19)[b]
Farmyard manure	M_3	3.34	3.64	4.08
		(1.83)[a]	(1.91)[a]	(2.02)[a]
SEm±		0.03	0.02	0.02
CD at 5% level		0.07	0.06	0.04
Interaction (Growth regulator x Rooting media)			**NS**	

(Data in parenthesis indicates square root transformed value)

Table 4.13 : Effect of plant growth regulator and rooting media on fresh weight of shoots (g) per air layer

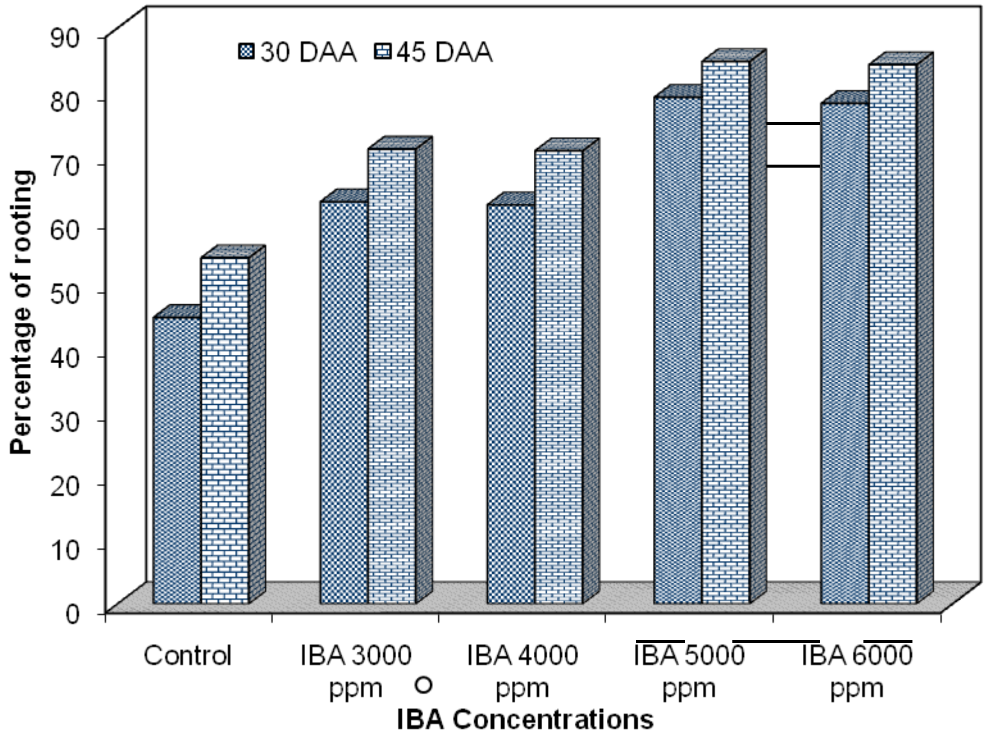
Treatment		Fresh weight of shoot (g) / air layer
IBA concentration		
Control	I_0	3.00[a]
IBA 3000 ppm	I_1	4.43[b]
IBA 4000 ppm	I_2	4.47[b]
IBA 5000 ppm	I_3	5.28[c]
IBA 6000 ppm	I_4	5.85[d]
SEm±		0.10
CD at 5% level		0.28
Rooting media		
Poultry manure	M_1	5.12[c]
Vermi compost	M_2	4.67[b]
Farmyard manure	M_3	4.03[a]
SEm±		0.08
CD at 5% level		0.21
Interaction (Growth regulator x Rooting media)		**NS**

Table 4.14 : Effect of plant growth regulator and rooting media on dry weight of shoots (g) per air layer

Treatment		Dry weight of shoot (g) / air layer
IBA concentration		
Control	I_0	1.02[a]
IBA 3000 ppm	I_1	1.51[b]
IBA 4000 ppm	I_2	1.67[c]
IBA 5000 ppm	I_3	1.90[d]
IBA 6000 ppm	I_4	1.96[d]
SEm±		0.03
CD at 5% level		0.08
Rooting media		
Poultry manure	M_1	1.76[c]
Vermi compost	M_2	1.60[b]
Farmyard manure	M_3	1.50[a]
SEm±		0.02
CD at 5% level		0.06
Interaction (Growth regulator x Rooting media)		**NS**

Table 4.15 : Effect of plant growth regulator and rooting media on survival percentage of air layers

Treatment		Survival percentage of air layer		
		30 DAT	60 DAT	90 DAT
IBA concentration				
Control	I_0	45.25[a]	43.45[a]	40.27[a]
IBA 3000 ppm	I_1	60.30[b]	57.30[b]	51.95[b]
IBA 4000 ppm	I_2	64.67[c]	61.67[c]	53.83[c]
IBA 5000 ppm	I_3	73.00[d]	70.00[d]	56.13[d]
IBA 6000 ppm	I_4	75.26[e]	72.10[e]	60.13[e]
SEm±		0.46	0.47	0.59
CD at 5% level		1.31	1.33	1.69
Rooting media				
Poultry manure	M_1	67.42[c]	64.60[c]	56.78[c]
Vermi compost	M_2	63.14[b]	60.44[b]	51.49[b]
Farmyard manure	M_3	60.52[a]	57.67[a]	49.13[a]
SEm±		0.36	0.36	0.46
CD at 5% level		1.02	1.03	1.31
Interaction (Growth regulator x Rooting media)			**NS**	



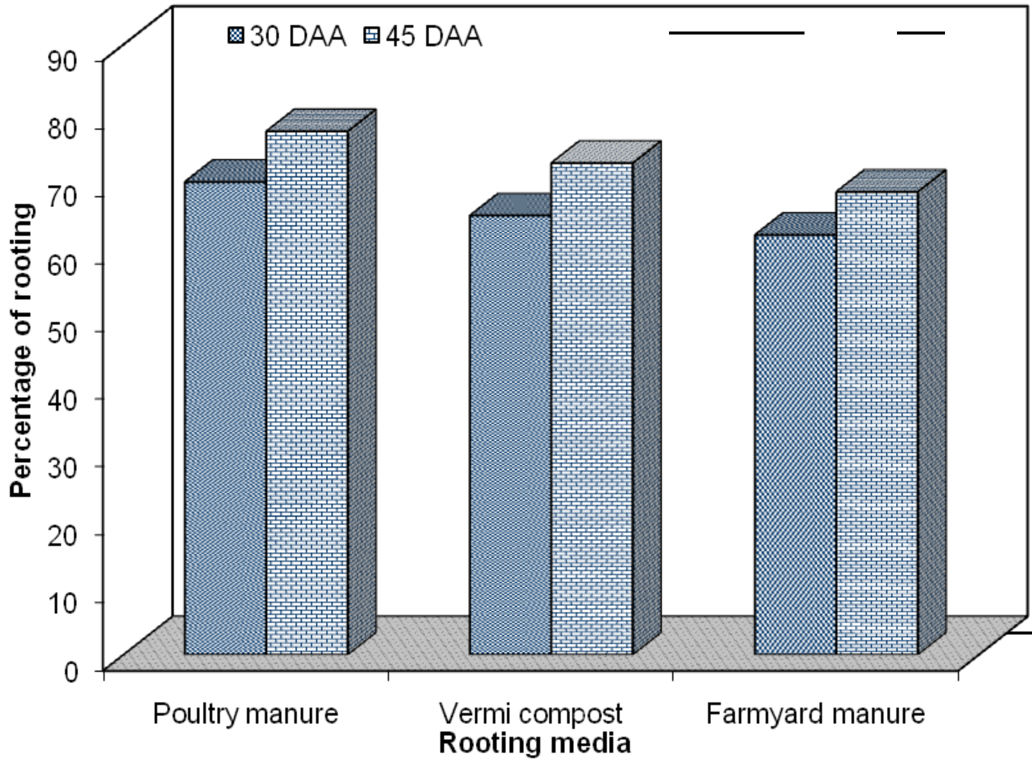
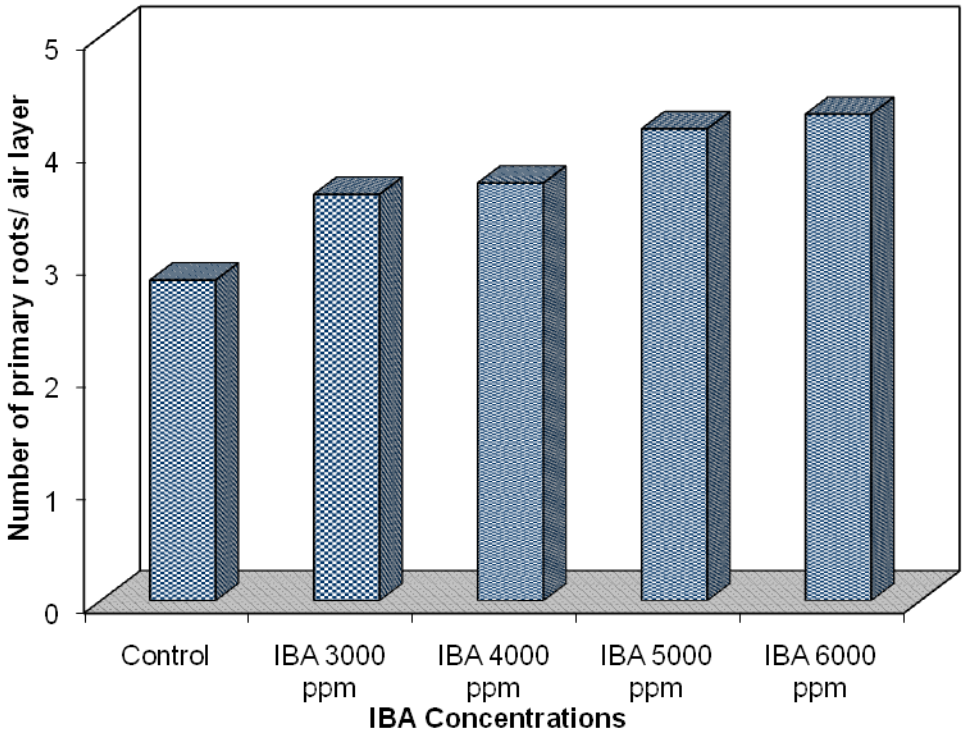
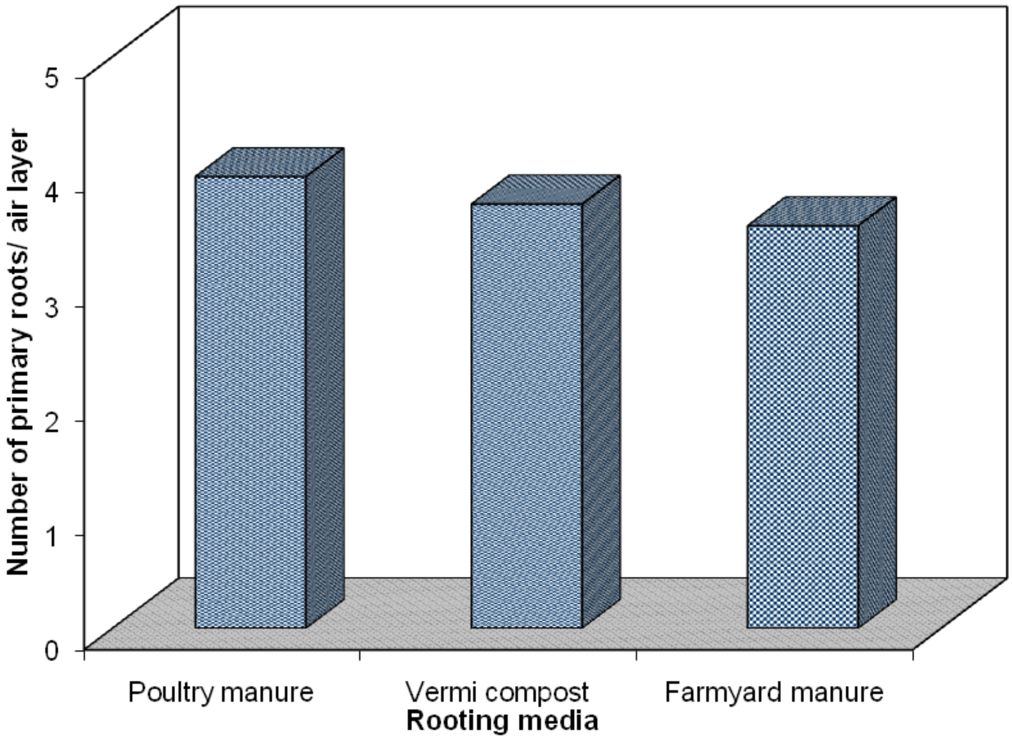
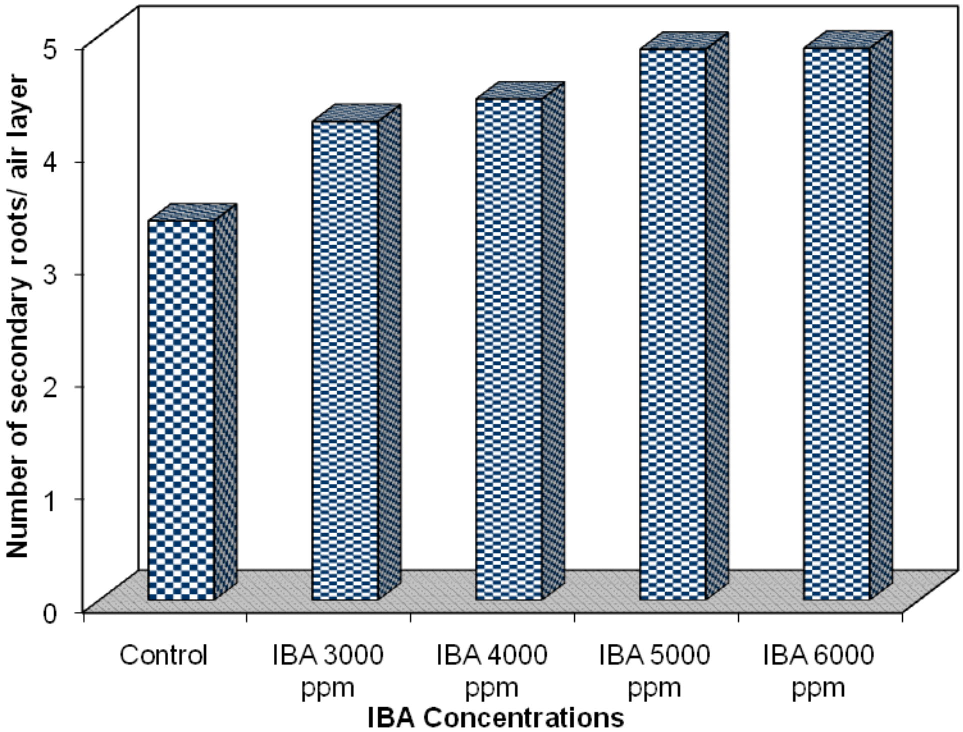


Fig. 4.1 : Effect of plant growth regulator and rooting media on rooting percentage


Number of primary roots/ air layer
0
1
2
3
4
5
Control
IBA 3000 ppm
IBA 4000 ppm
IBA 5000 ppm
IBA 6000 ppm
IBA Concentrations


Number of primary roots/ air layer
0
1
2
3
4
5
Poultry manure
Vermi compost
Farmyard manure
Rooting media



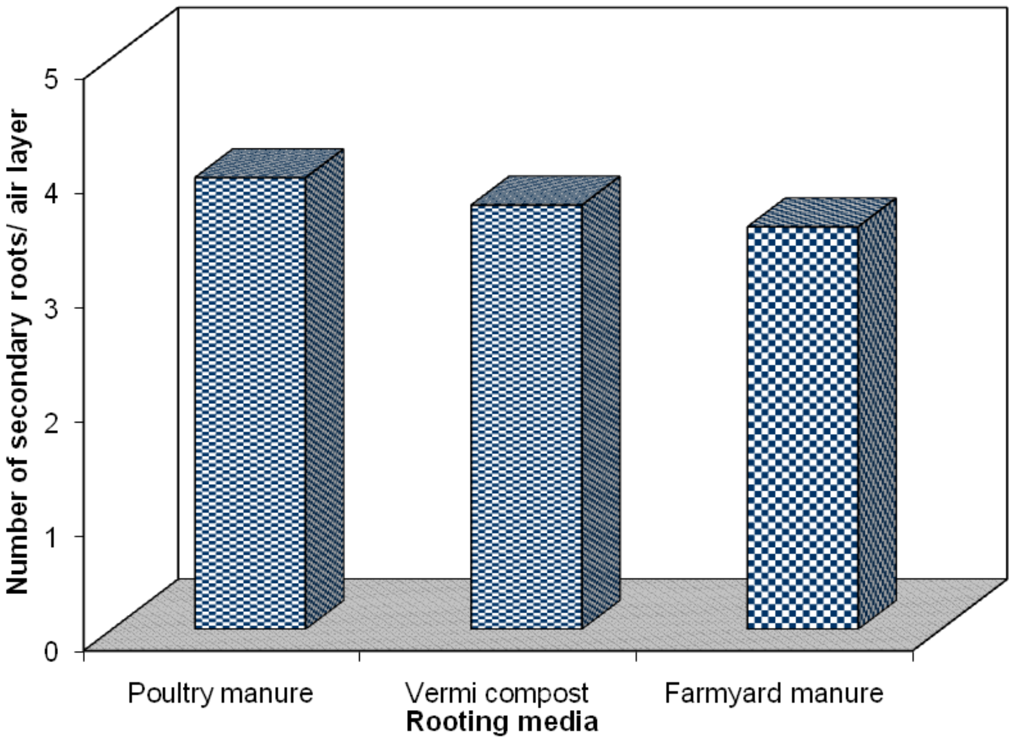
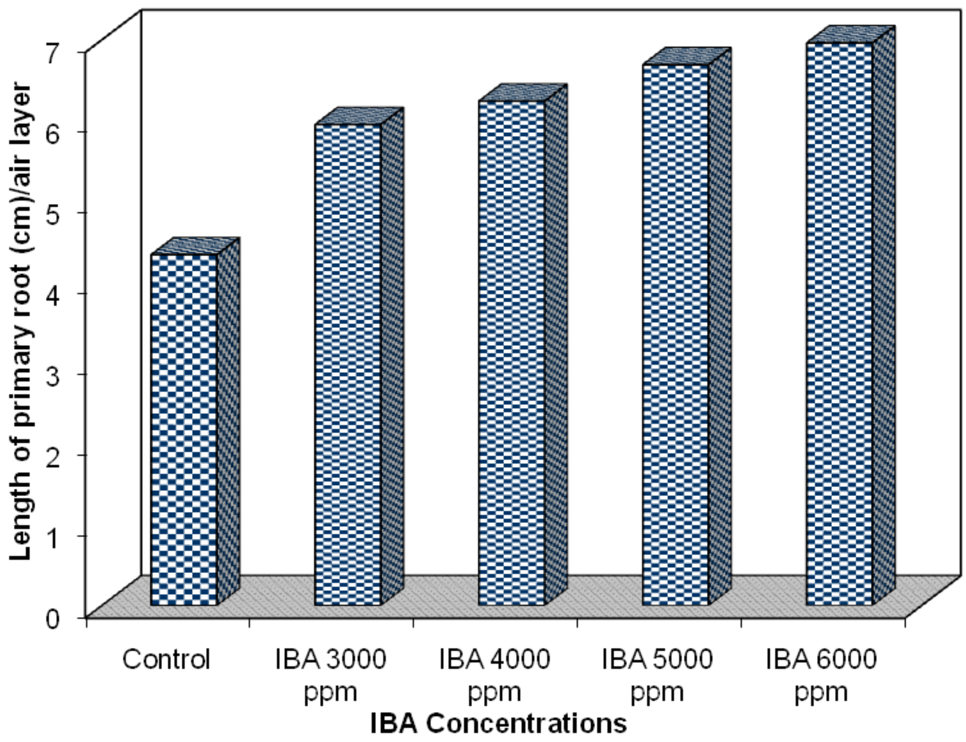


Fig. 4.3 : Effect of plant growth regulator and rooting media on number of secondary roots/ air layer



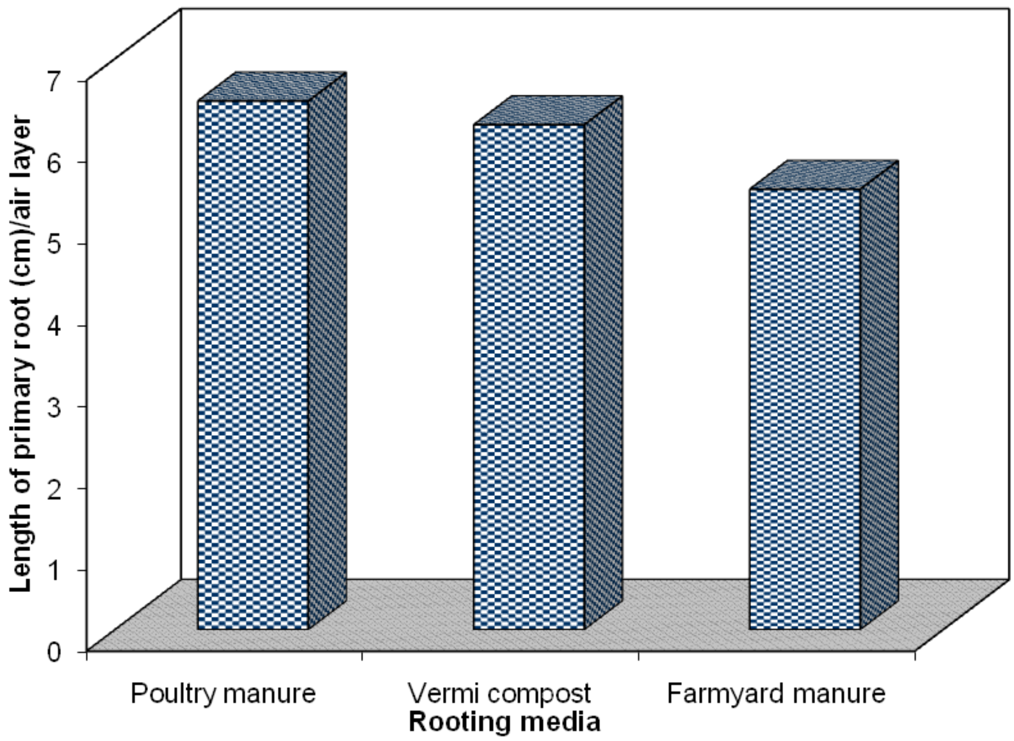
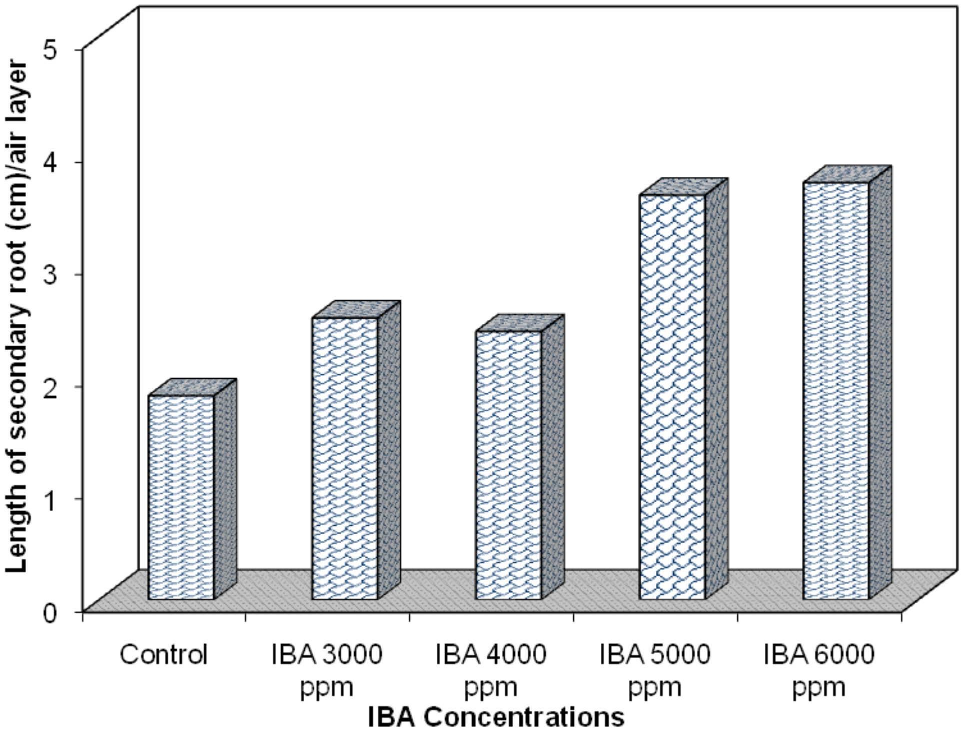


Fig. 4.4 : Effect of plant growth regulator and rooting media on length of primary root (cm)/ air layer



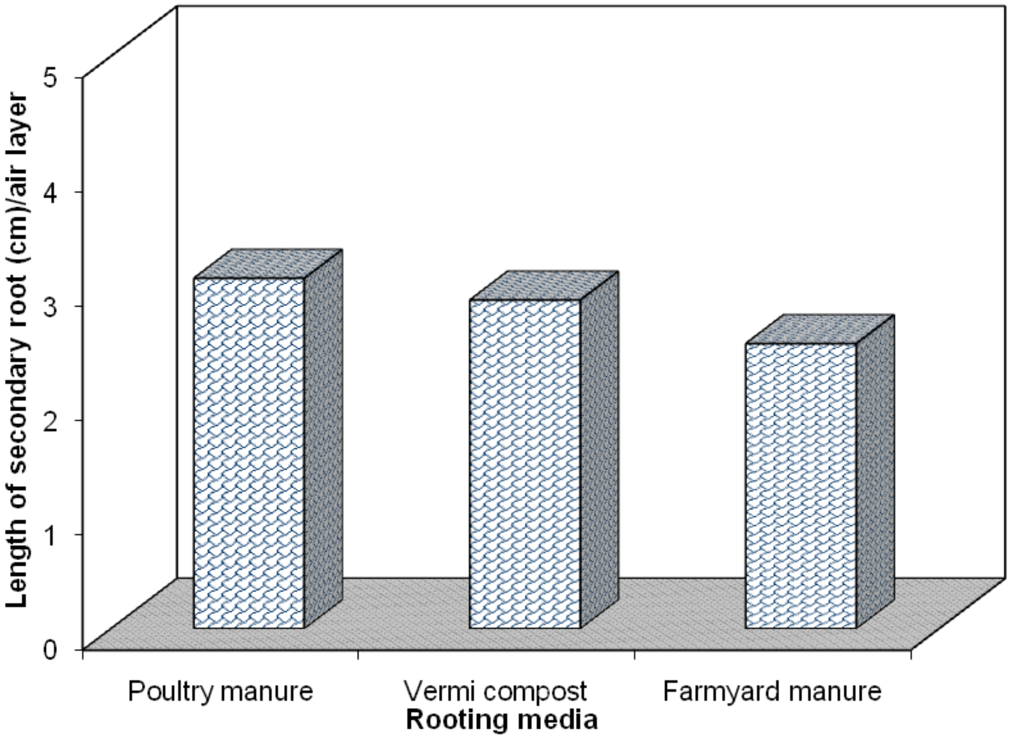
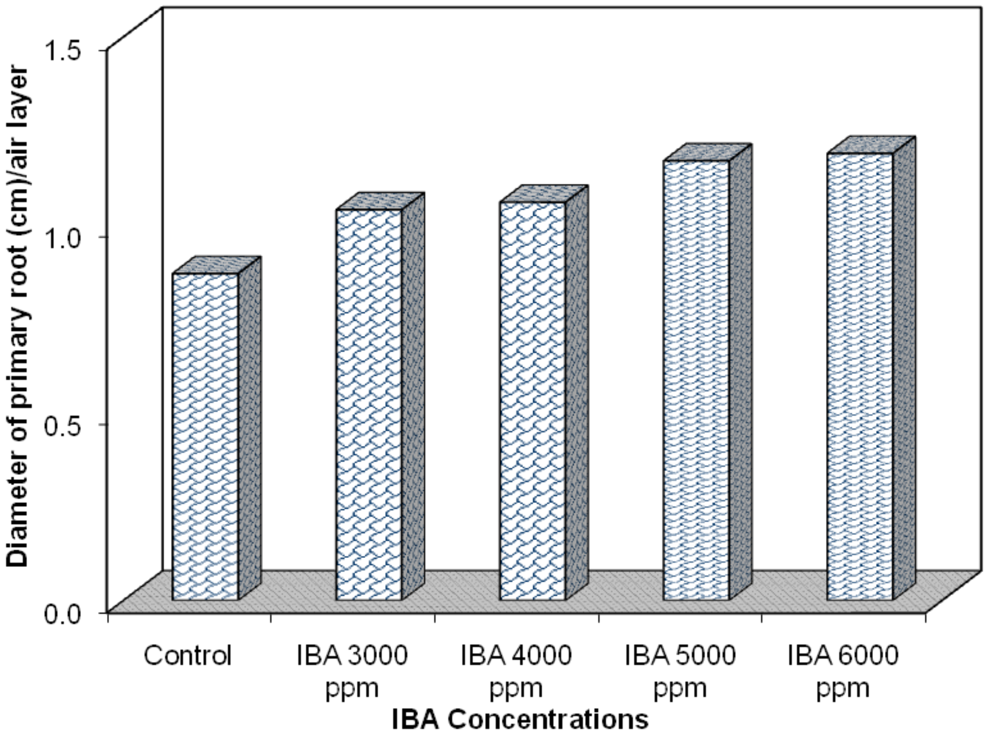


Fig. 4.5 : Effect of plant growth regulator and rooting media on length of secondary root (cm)/air layer



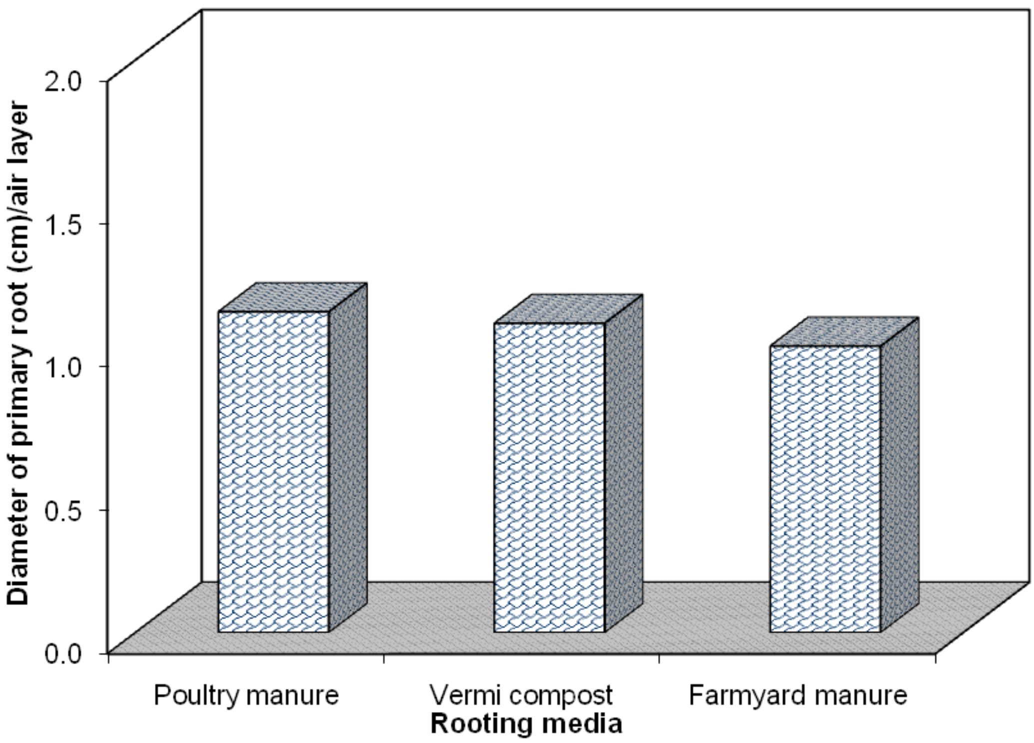
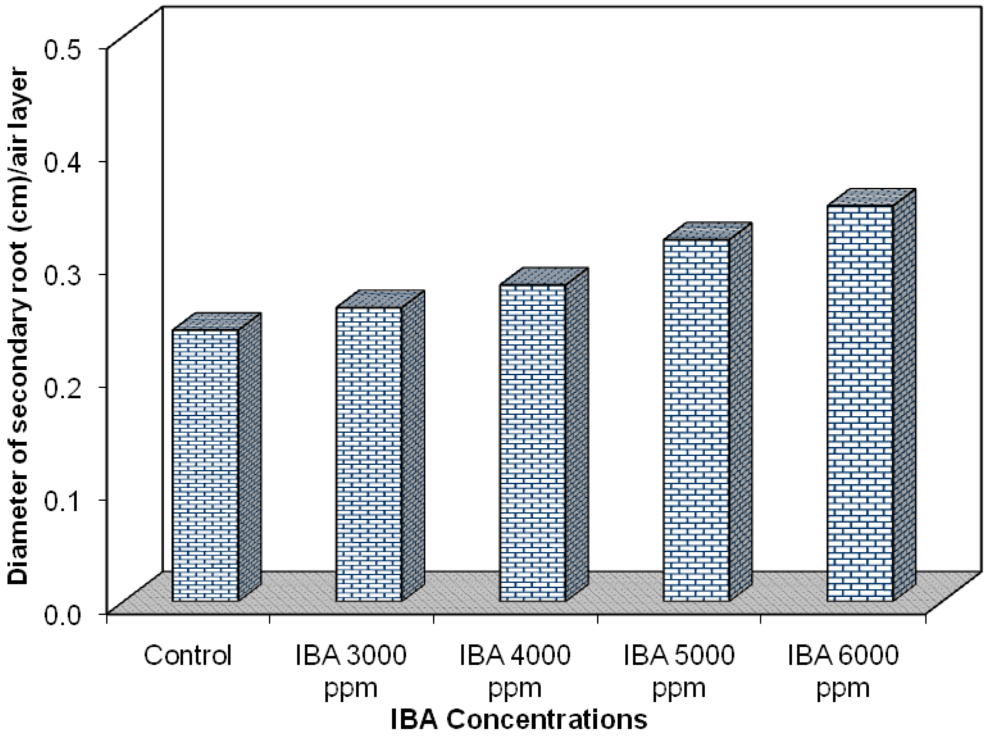


Fig. 4.6 : Effect of plant growth regulator and rooting media on diameter of primary root (cm)/air layer



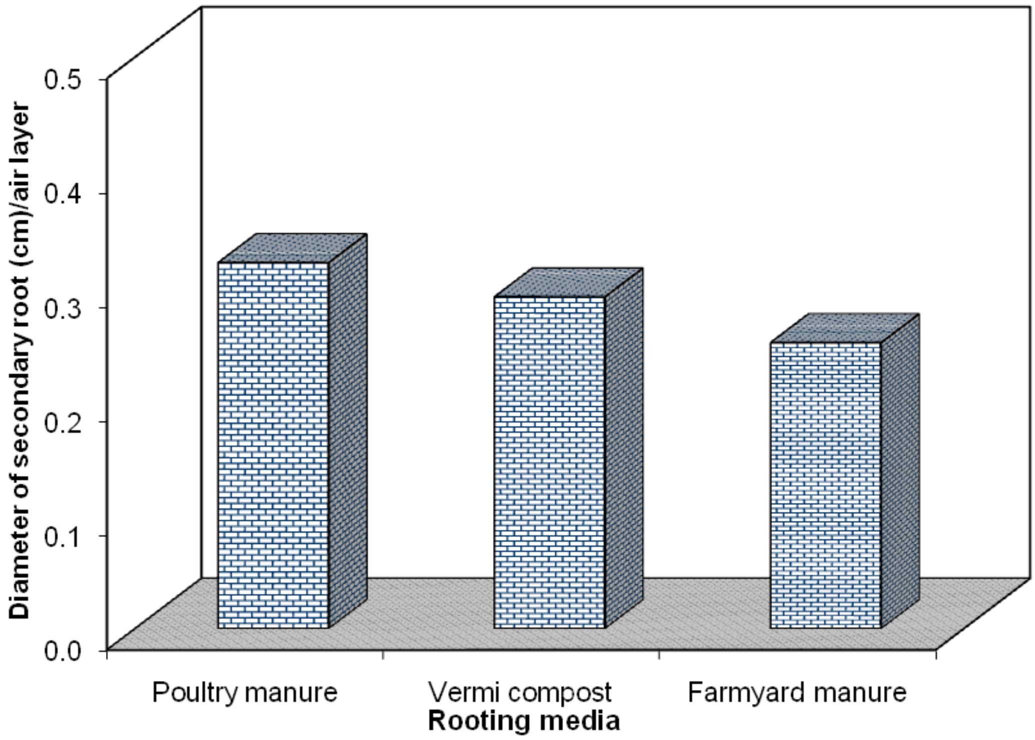
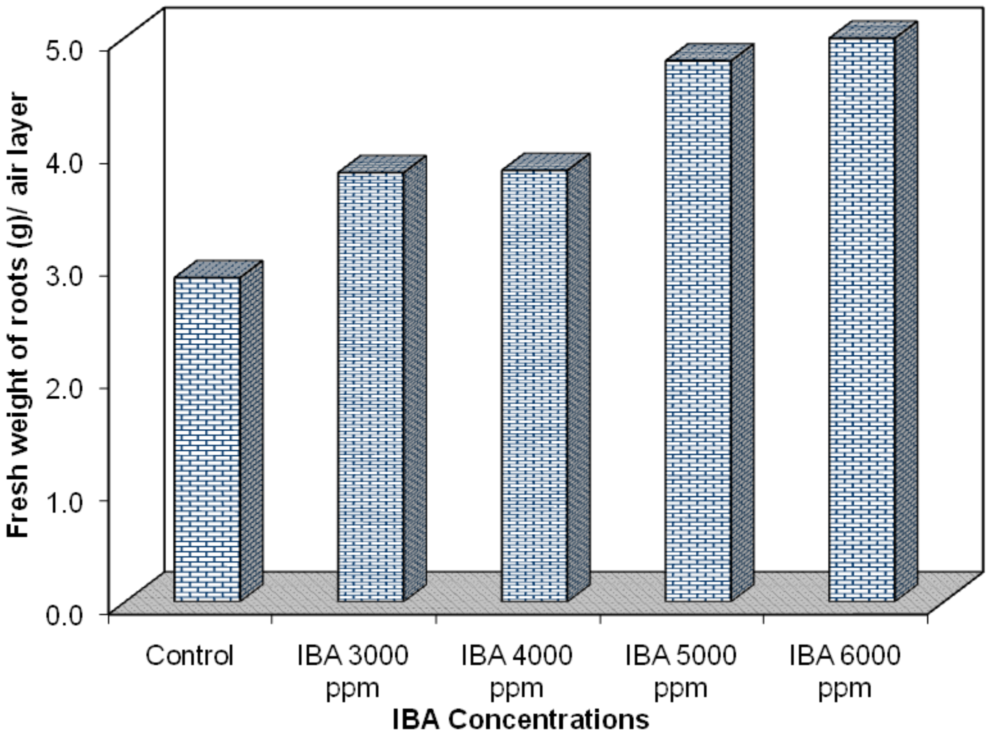


Fig. 4.7 : Effect of plant growth regulator and rooting media on diameter of secondary root (cm)/air layer



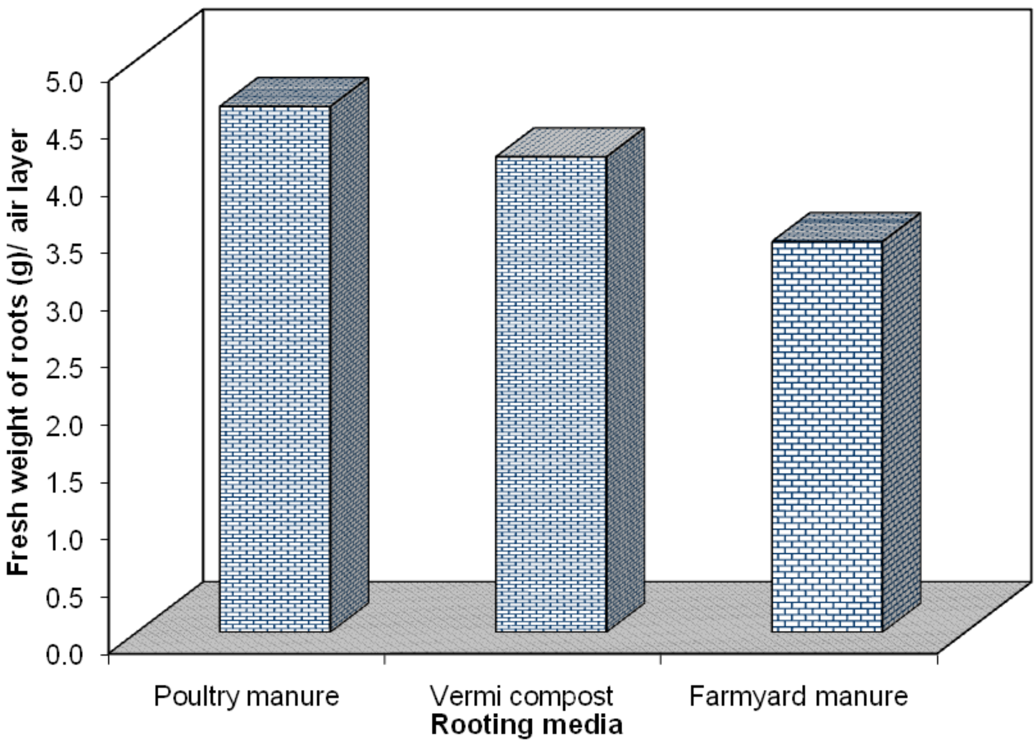
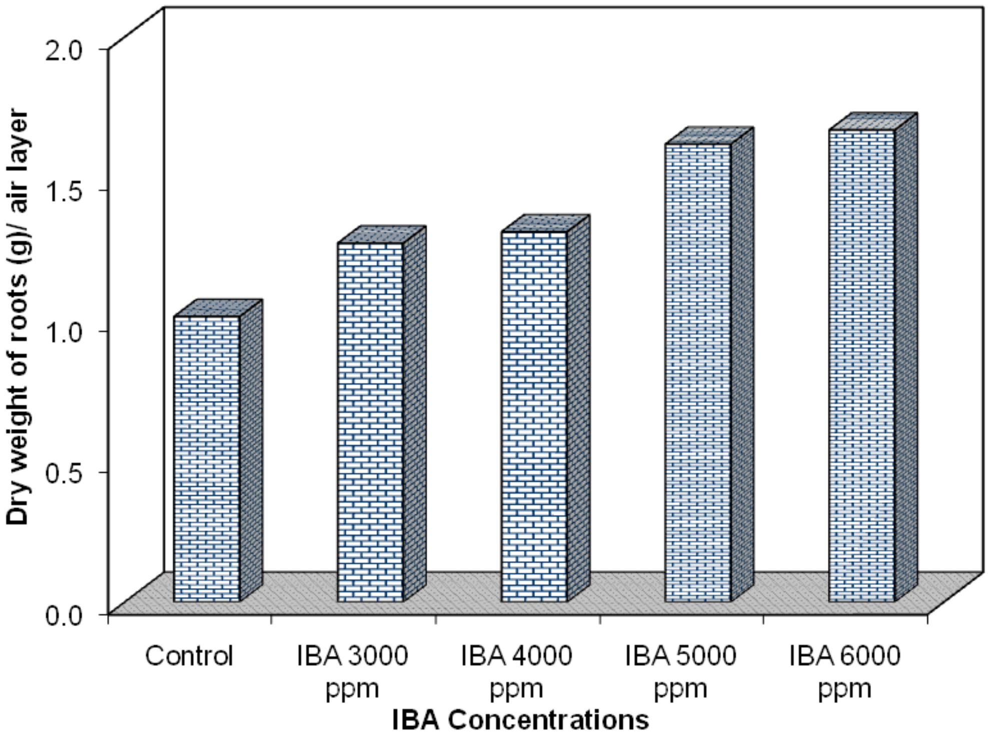


Fig. 4.8 : Effect of plant growth regulator and rooting media on fresh weight of roots (g)/ air layer



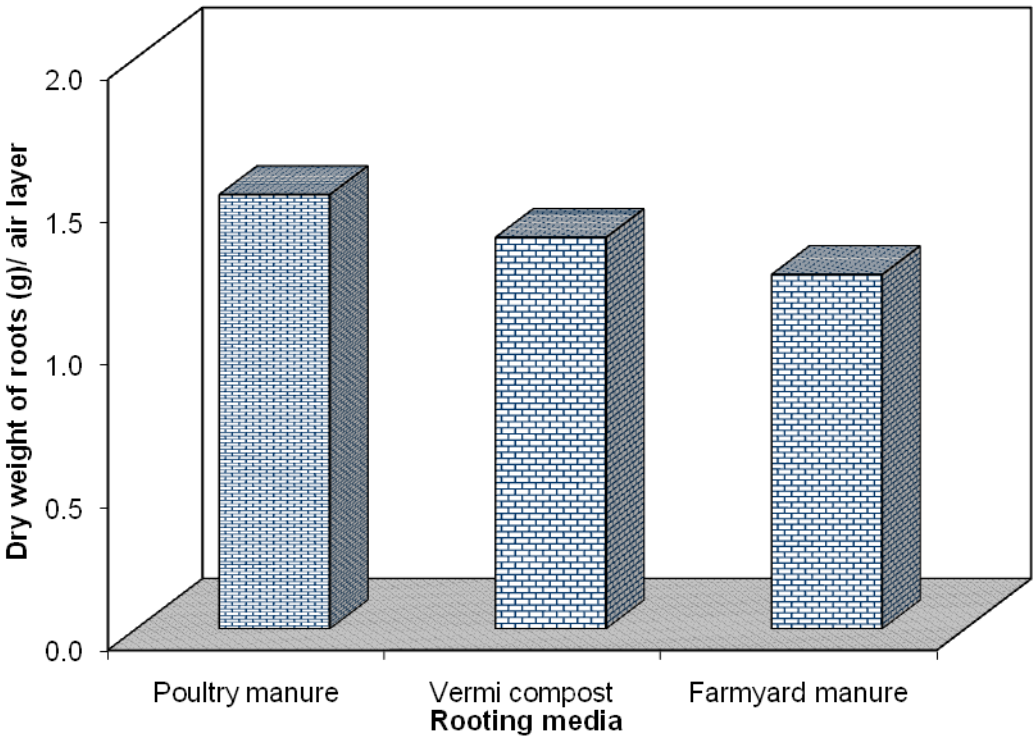
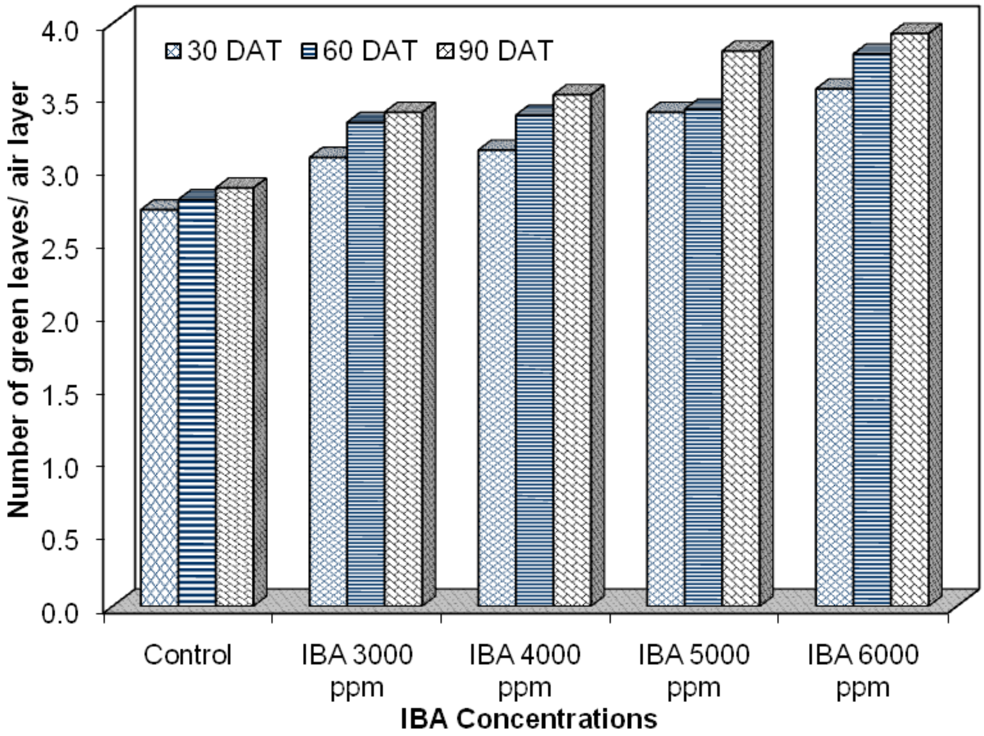


Fig. 4.9 : Effect of plant growth regulator and rooting media on dry weight of roots(g) / air layer



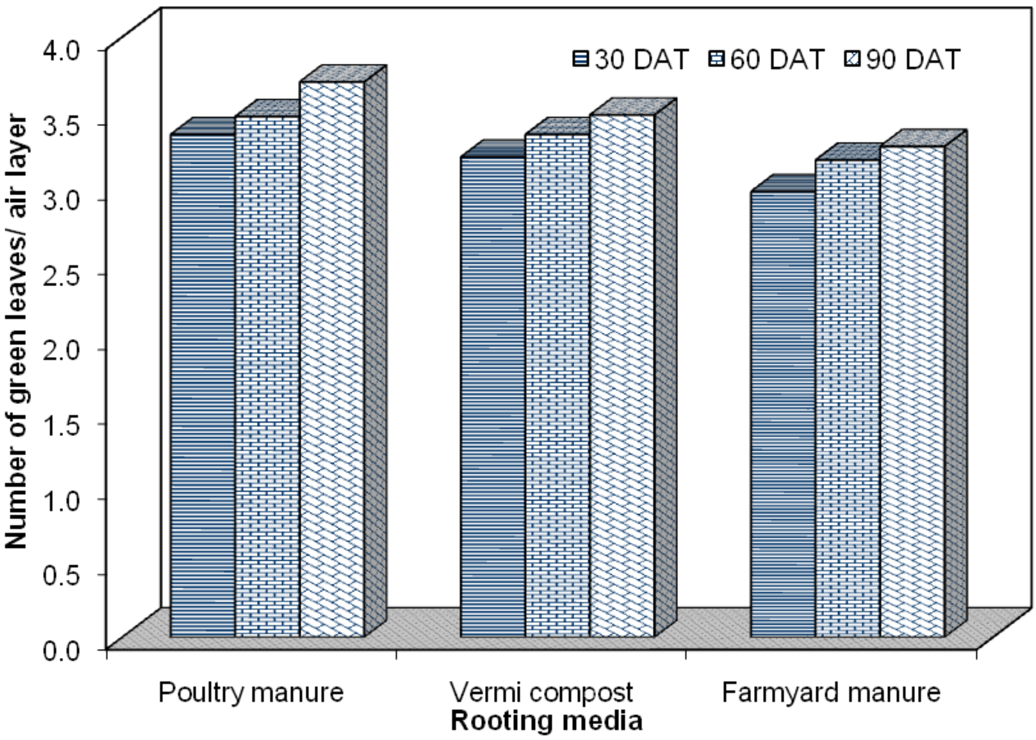
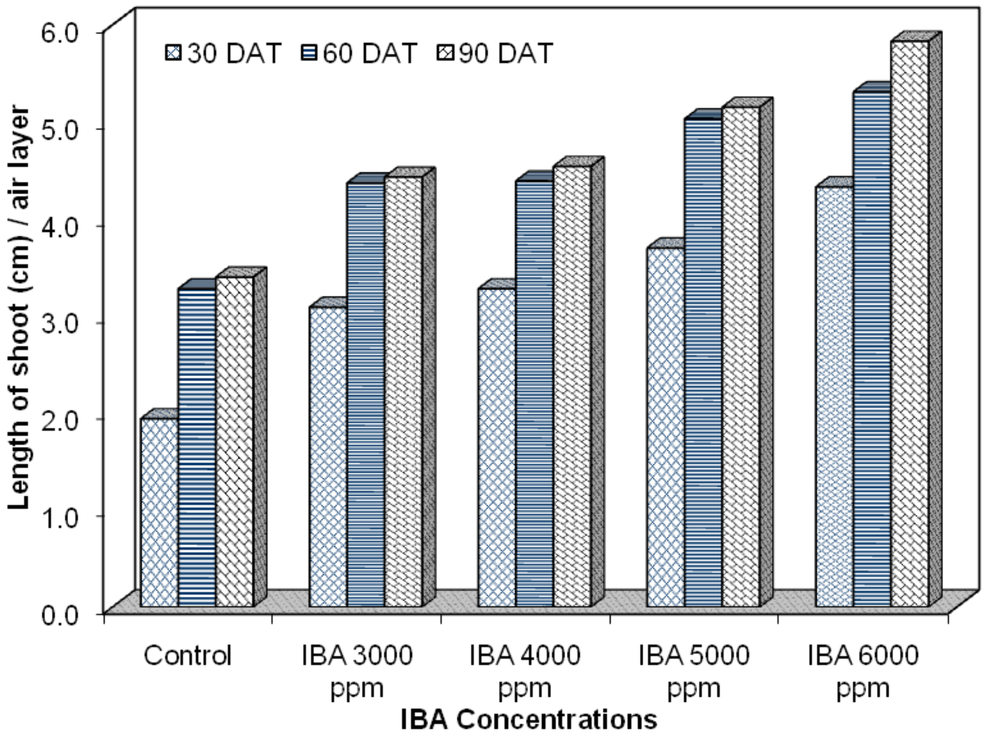


Fig. 4.10 : Effect of plant growth regulator and rooting media on number of green leaves/ air layer



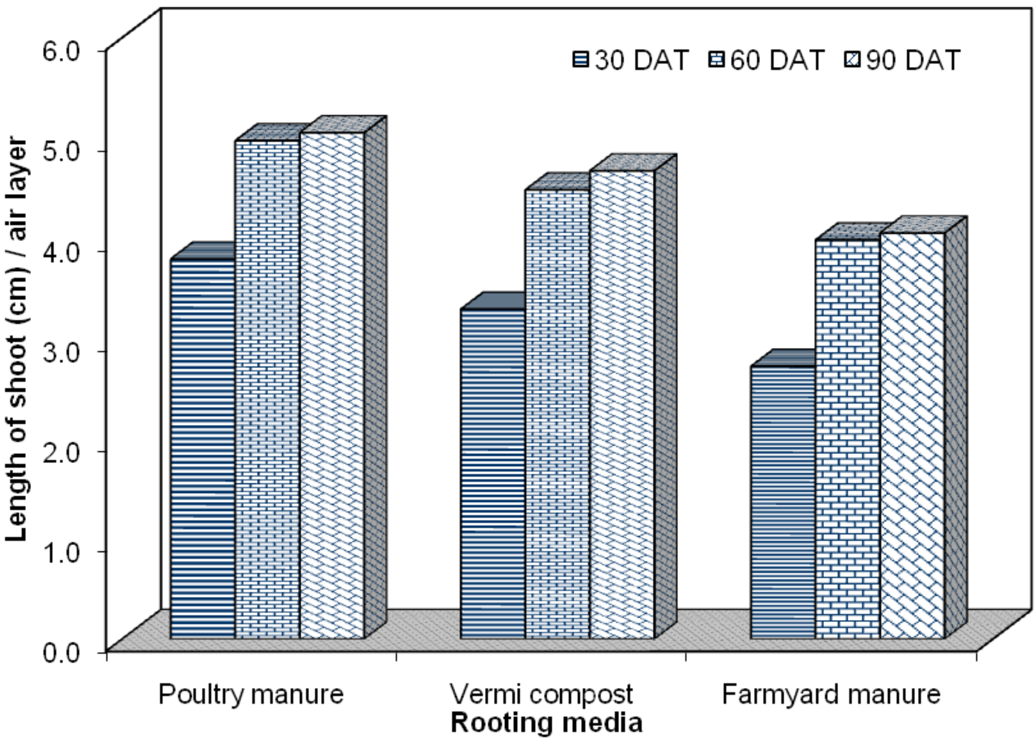
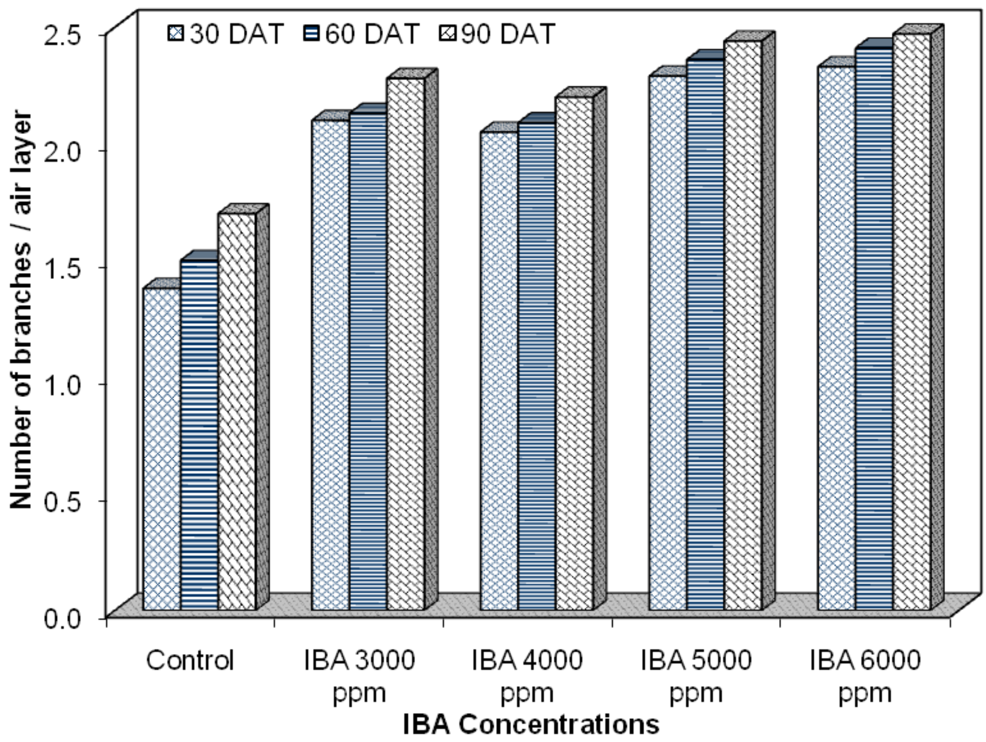


Fig. 4.11 : Effect of plant growth regulator and rooting media on length of shoot (cm)/ air layer



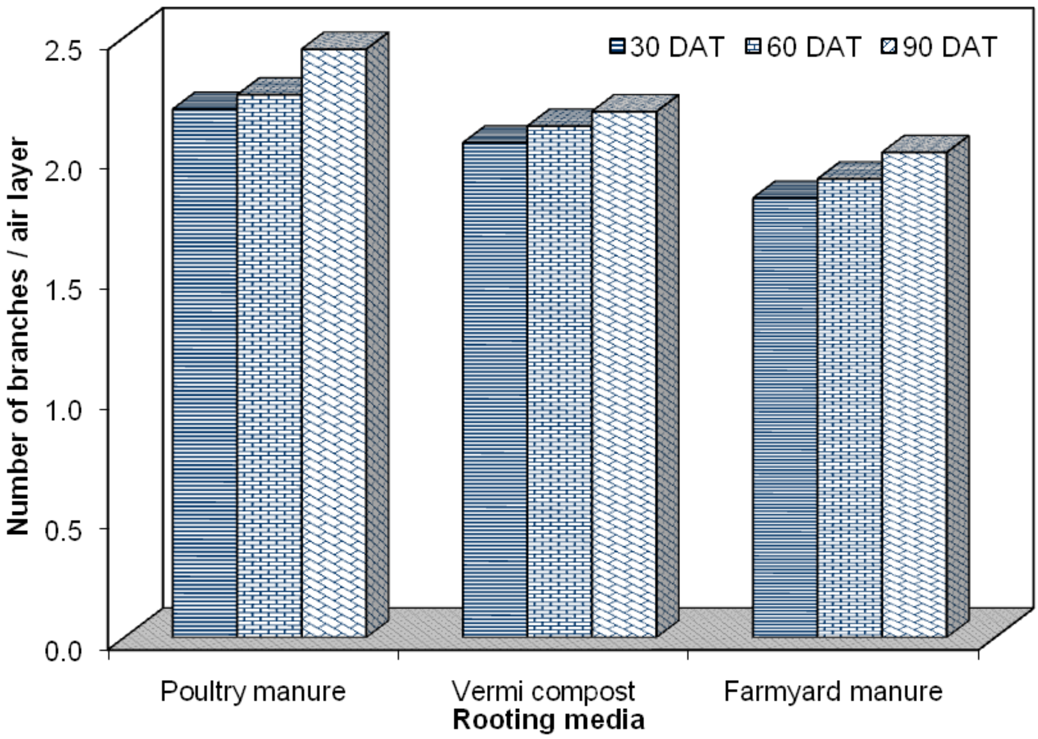
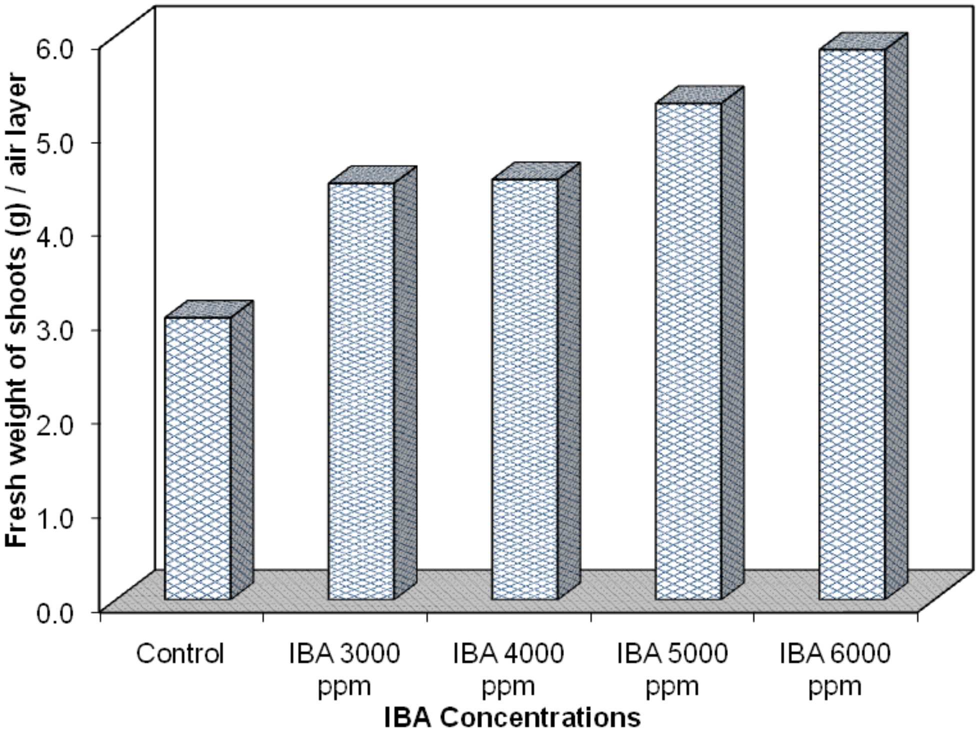


Fig. 4.12 : Effect of plant growth regulator and rooting media on number of branches / air layer



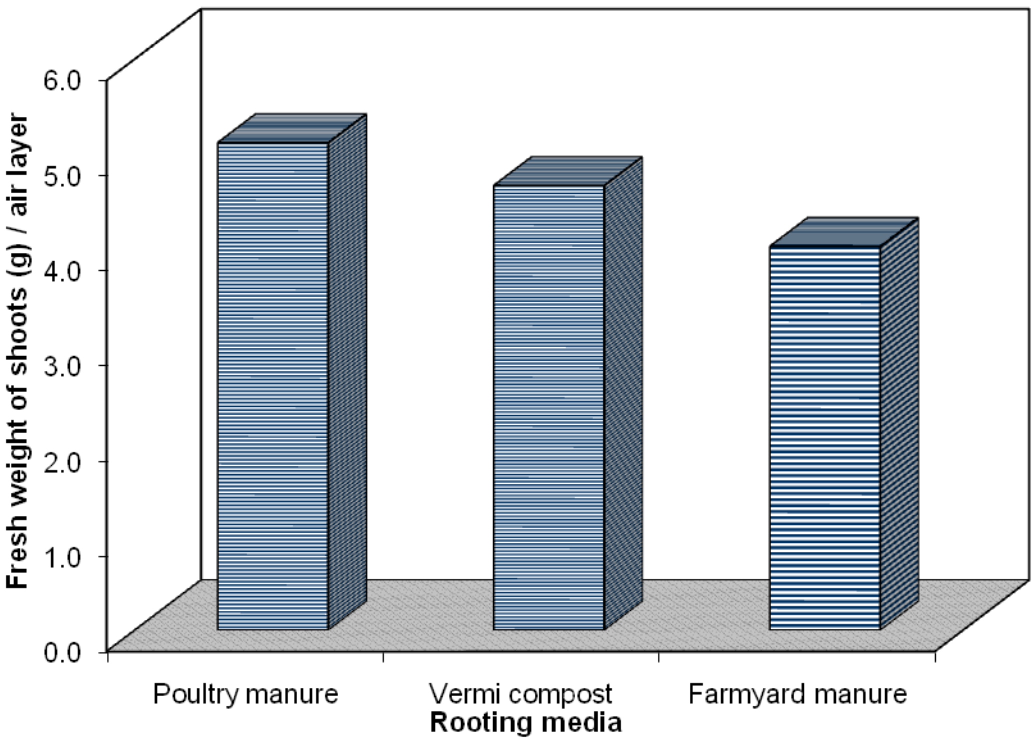
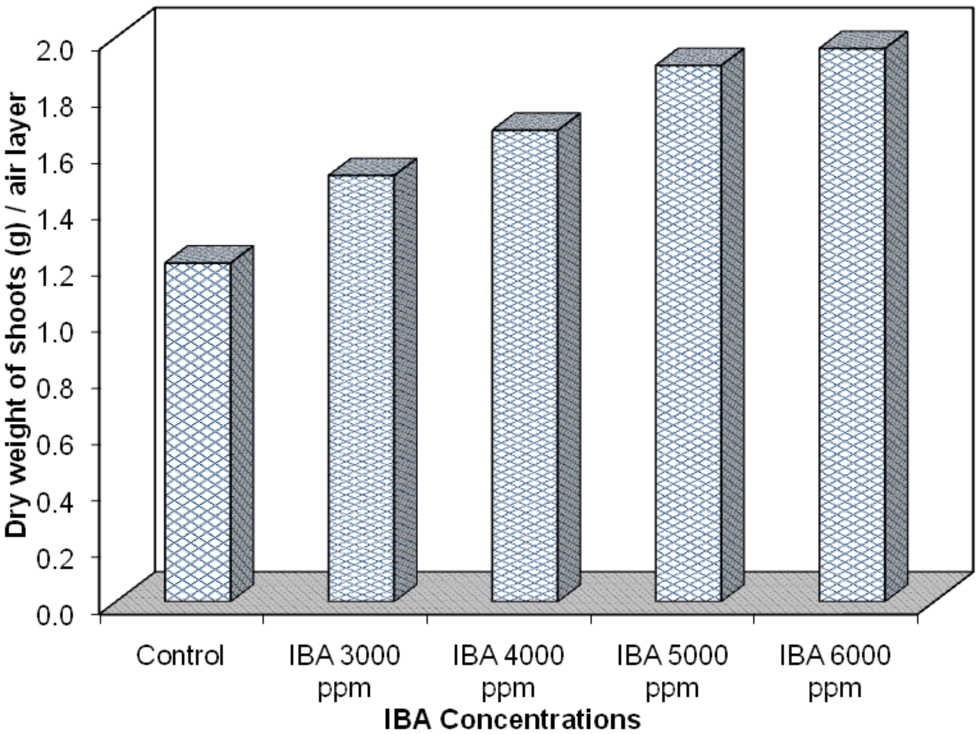


Fig. 4.13 : Effect of plant growth regulator and rooting media on fresh weight of shoots (g)/ air layer



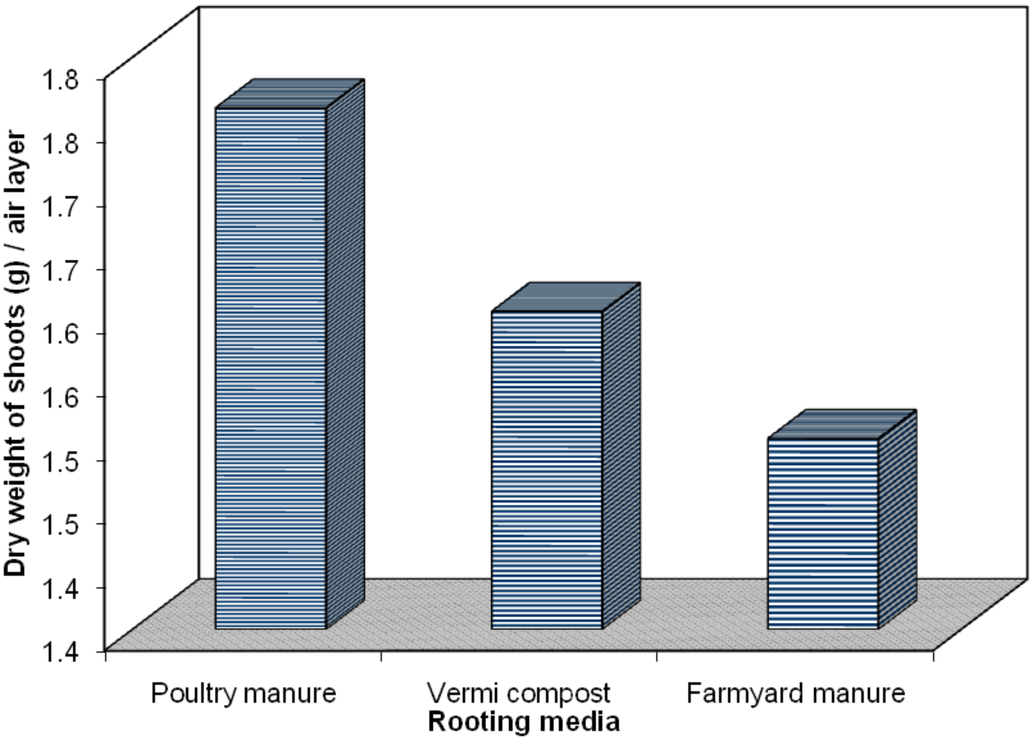
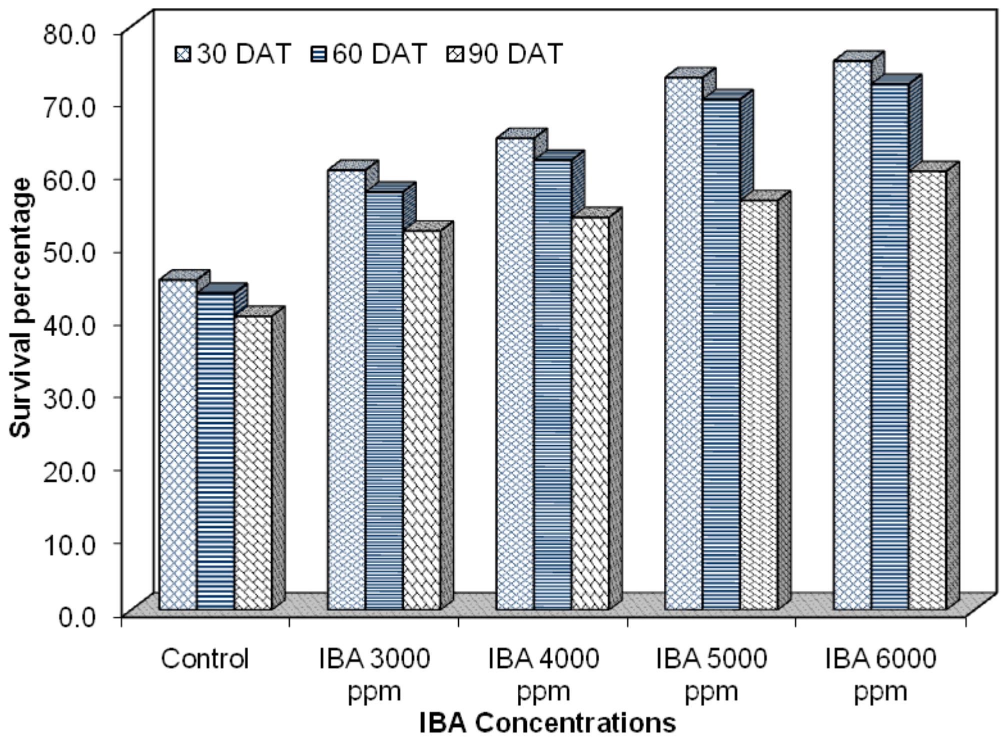


Fig. 4.14 : Effect of plant growth regulator and rooting media on dry weight of shoots (g)/ air layer



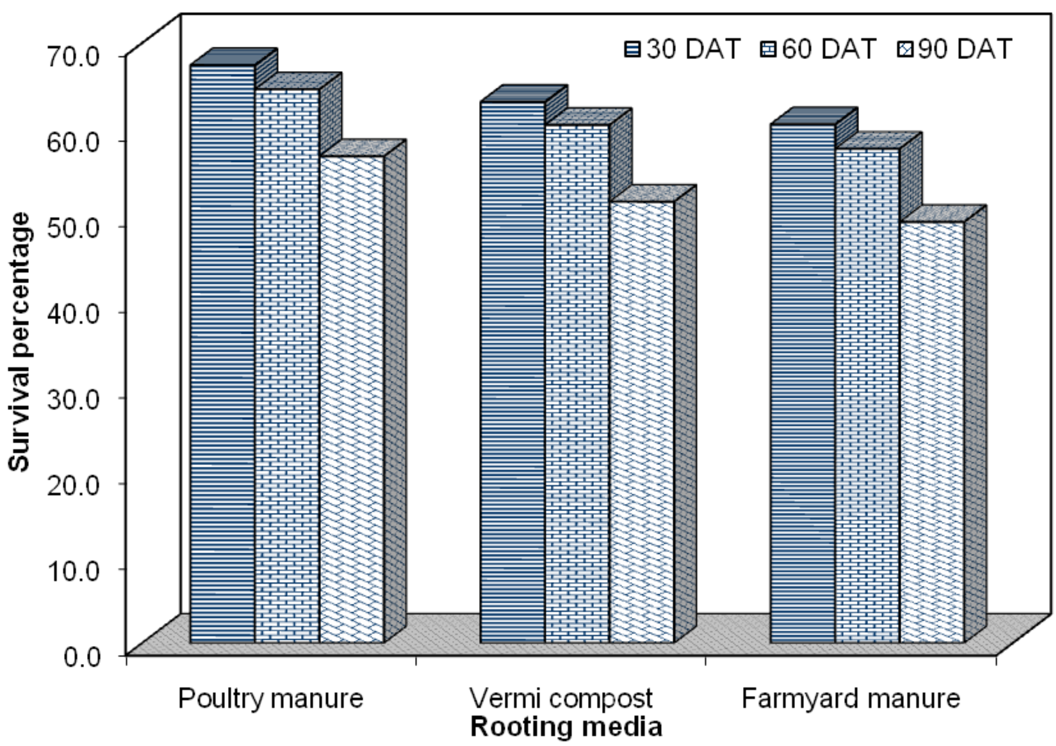


Fig. 4.15 : Effect of plant growth regulator and rooting media on survival percentage of air layers