RESEARCH ARTICLE

EFFECT OF TIME OF AIR LAYERING AND IBA CONCENTRATIONS ON THE ROOTING BEHAVIOUR OF PANT PRABHAT GUAVA (*PSIDIUM GUAJAVA* L.) UNDER SUB-TROPICAL CONDITION OF GARHWAL HIMALAYA

Dinesh Chandra Naithani[1]*, Anant Ram Nautiyal[2], Deepak Kumar Rana[1] and Deepak Mewar[1]

[1]Department of Horticulture, School of Agriculture and Allied Science, H.N.B. Garhwal University (A Central University), Srinagar Garhwal, Uttarakhand, India-246174
[2] High Altitude Plant Physiology Research Centre (HAPPRC), School of Agriculture and Allied Science, H.N.B. Garhwal University (A Central University), Srinagar Garhwal, Uttarakhand, India-246174
Email: naithani.dinesh@yahoo.com

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Abstract: The present study were undertaken at the Orchard Section, Horticultural Research Centre and Department of Horticulture, Chauras Campus, School of Agriculture and Allied Science, HNB Garhwal University (A Central University), Srinagar Garhwal, Uttarakhand, India during the rainy season of the year 2016 to study the effect of time of air layering and IBA concentrations on the rooting behaviour of Pant Prabhat Guava (*Psidium guajava* L.). The experimental findings showed that the minimum days taken to root appearance (28.40days), maximum rooting percentage (92.20%), maximum number of roots per layer (24.80), maximum length of longest root per layer (14.20cm), maximum diameter of thickest root per layer (1.86mm) and maximum percentage of layers showing secondary roots (70.00%) were significantly superior when layering was done on 15th July and treated with 4500 ppm concentration of IBA.

Keywords: IBA, Rooting, Layering, Secondary roots

INTRODUCTION

Guava (*Psidium guajava*), the apple of the tropics belongs to the family myrtaceae, and is one of the most common fruits in India. It claims to be the fifth most important fruit in area and production after banana, mango, citrus and papaya. Guava is quite hardy, prolific bearer and highly remunerative even without much care. The genus *Psidium* contains 150 species, most of which are fruit bearing trees. The basic chromosome number of guava is 11. Most of cultivars are diploid (2n=22), but some natural and artificial triploids (3n=33), that generally produce seedless fruits (Jaiswal, , 1992). In Uttarakhand, major guava producing areas are in Pithoragarh, Udham Singh Nagar, Haridwar, Dehradun, Pauri, Tehri and Uttarkashi districts. Guava is propagated by seeds and vegetative methods. Seed propagated plants start bearing fruits in 6-8 years, while those from vegetative method (air layering) start bearing in 2-3 years of age. Seedling trees exhibit lot of variations in quality of fruits and require more area for space in orchard due to the more vigorous growth habit. The propagation of guava through seeds is not encouraged because the seedlings have long juvenile phase, give lower yields and bear poor quality fruits. To maintain true-to-type cultivar, it is necessary to go through the vegetative method of propagation for guava (Bose *et al*., 1986). Propagation of guava by air-layering is done during summer of the year i.e. from February to August with varying success and survivability. Time of layering and detachment of layers from the mother plants are the important factors for rooting success because of presence of sufficient soil moisture, humidity and optimum temperature which are prerequisites of maximum survival of the detached air-layers. Kanwar and Khalon (1986) reported that layering was successful when carried out between mid July and early October in India. BARI (2002) reported that layers prepared in mid June showed the best performance of rooting percentage, survivability and growth of air-layers. There are many factors which affect the propagation of a particular plant species through layering. These factors include the physiological condition of the mother plant, nutrient and water supply, etiolation, age of mother plant, growing media, wrapping material, time/season of operation, external environmental conditions and application of root inducing substances. Among all these factors time of operation and application of different concentration of root inducing/promoting substances play an important role in the propagation of plants by air-layering. Hence, the present investigation was conducted to study the effect of time of air-layering and IBA concentration on the rooting behaviour of Pant Prabhat Guava (*Psidium guajava* L.)

MATERIAL AND METHOD

Detail of Experiment

The experiment was conducted under the open field condition at orchard section, Horticultural Research Centre and Department of Horticulture, Chauras Campus, School of Agriculture and Allied Science, HNB Garhwal University (A Central University)

*Corresponding Author

Srinagar Garhwal, Uttarakahnd, India during the rainy season of the year 2016. The experimental detail is follows-

Time of air-layering (T)		IBA Concentration(C)	
Notation	**Treatments**	**Notation**	**Treatments**
(T_1)	15th June	(C_1)	IBA @ 1500 ppm
(T_2)	30th June	(C_2)	IBA @ 3000 ppm
(T_3)	15th July	(C_3)	IBA @ 4500 ppm
(T_4)	30th July	(C_0)	Control

Treatment Combination

Notation	Treatments
T_1C_1	15th June+IBA @ 1500 ppm
T_1C_2	15th June+IBA @ 3000 ppm
T_1C_3	15th June+IBA@ 4500 ppm
T_1C_0	15th June+IBA @ 0 ppm
T_2C_1	30th June+IBA @ 1500 ppm
T_2C_2	30th June+IBA @ 3000 ppm
T_2C_3	30th June+IBA @ 4500 ppm
T_2C_0	30th June+IBA @ 0 ppm
T_3C_1	15th July+IBA @ 1500 ppm
T_3C_2	15th July+IBA @ 3000 ppm
T_3C_3	15th July+IBA @ 4500 ppm
T_3C_0	15th July+IBA @ 0 ppm
T_4C_1	30th July+IBA @1500 ppm
T_4C_2	30th July+IBA @ 3000 ppm
T_4C_3	30th July+IBA @ 4500 ppm
T_4C_0	30th July+IBA @ 0 ppm

Cultivar Pant Prabhat
Experimental design Randomized Block Design
Number of replications per treatment 3
Number of air layers per treatment 10
Number of treatments 16
Total number of air layers 3x10x16 = 480

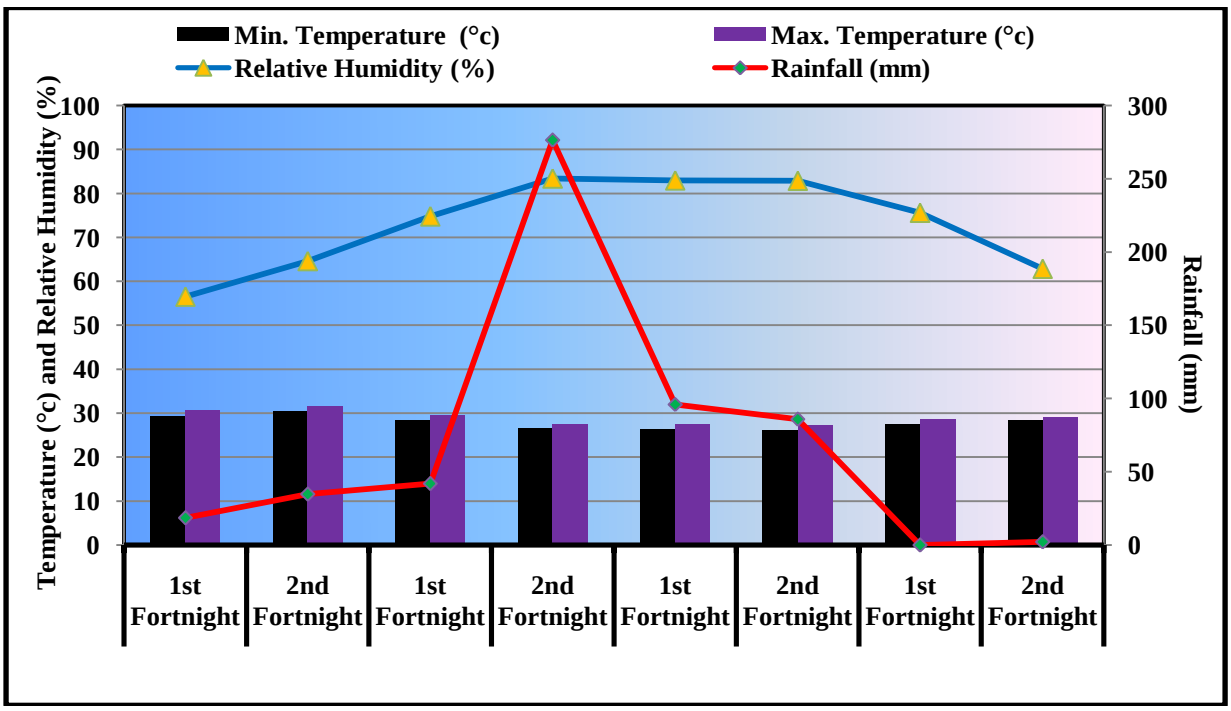

Fig. 1: Fortnightly meteorological data during the experimental period (June-September) 2016

Materials Used for the Experiment

Guava trees of the cultivar Pant Prabhat were selected for performing air layering. Clear polythene sheet (size: 20×20cm), sharp knife, thread (sutli), rooting media (Sphagnum moss), IBA, mother plant and sharpening stone were used.

Preparation of IBA Solution

For the preparation of one liter stock solution of 4500 ppm concentration of IBA, 4500 mg IBA (4.5gm) was weighted and it was then dissolved in small amount of alcohol and few drops of ammonium hydroxide were also added to stop precipitation. Further, it was diluted to one liter with distilled water and stored in cool and dark place. The working solutions of required concentrations, viz; 1500 ppm, 3000 ppm and 4500 ppm were prepared from this stock solution.

Selection of Branches

For guava air-layering healthy, well matured, uniform, disease free, vigorously growing lateral shoots having green and brown portion at the apical and basal portion respectively of past season growth with approximate diameter of 1.0cm and length of 30cm were selected. Careful observations were also made to ensure that the selected branches had sufficient leaves on them.

Technique Followed to Perform Air Layering

On dated 15th June, 30th June, 15th July and 30th July, of 2016 air layering was done on the selected shoots by removing a strip of bark (phloem) 2.0 to 2.5 cm wide just below the bud by giving two circular cuts about 30-35cm below from shoot tip and then the exposed portion was rubbed without causing any injury to the xylem with the help of a knife. Then the upper portion of exposed shoots was sprayed with different concentrations of IBA according to the treatments. The exposed wood with two centimeters above and below portions was then covered with sphagnum moss soaked overnight in water. The control shoots were treated with only sphagnum moss soaked overnight in water. To cover the rooting medium completely a piece of clear polythene sheet (size: 20×20cm) was wrapped. The two ends of the wrapping material were carefully tied up thoroughly with thread and left for rooting.

Detachment of Air Layers

The layers were separated from the mother plants 60 days after layering operation with the help of secateurs when the outer surface of rooting medium within the wrapped polythene sheet was full of newly formed roots.

Observations Recorded

The following observations on rooting behaviour were recorded during the period of experimentation.

Days taken to root appearance

Air-layers were visited regularly and days taken to first root appearance were counted under each treatment within each replication from the date of air-layering operation. Then mean days required for root appearance were calculated.

Rooting percentage

The number of successful layers was counted after 60 days from the date of operation and the result was calculated in percentage by using the following formula-

$$\frac{\text{Number of successful rooted layers in a treatment}}{\text{Number of layers done in a treatment}} \times 100$$

Number of roots per layer

Three randomly selected rooted layers from each replication were taken for recording the data on the number of roots per layer. Mean number of roots per layer was calculated by dividing the total number of roots, with the number of layers.

Length of the longest root per layer (cm)

This observation was recorded after the detachment of air-layers (60 days after operation). Three randomly selected rooted layers from each replication were taken for recording the data on the length of the longest root. Length of longest root in each layer was measured with the help of measuring scale and mean was calculated.

Diameter of the thickest root per layer (mm)

This observation was recorded after the detachment of air-layers (60 days after operation). Three randomly selected rooted layers from each replication were taken for recording the data on the diameter of the thickest root.

Percentage of layers showing secondary roots (%)

The percentage of layers showing secondary roots was recorded in each treatment 60 days after detachment of air-layers from mother plant. It was calculated with the help of following formula:

$$\frac{\text{Number of layers showing secondary roots in a treatment}}{\text{Number of layers done in a treatment}} \times 100$$

Statistical analysis

Data recorded during the course of investigations were subjected to statistical analysis under randomized block design as described by Snedecar and Cochran (1987). Valid conciliations were drawn after the determination of significance of difference between the treatments, at 5 per cent level of probability. Critical difference was calculated in order to compare the treatment means.

RESULT AND DISCUSSION

The results obtained on days taken to root appearance, rooting percentage, number of roots per layer, length of the longest root per layer, diameter of the thickest root per layer and percentage of layers showing secondary roots are shown in table 1.

Days taken to root appearance: Time of air layering and IBA concentrations significantly affected the days taken to root appearance in Pant

Prabhat guava as shown in Table 1. Among all treatments, minimum days taken to root appearance (28.40days) on air layering of guava was recorded under T_3C_3 (15th July+IBA @ 4500 ppm) treatment while maximum days taken to root appearance (54.50days) was observed under T_1C_0 (15th June+IBA @ 0 ppm) treatment. The decreased number of days taken to root initiation could be due to the appropriate environmental conditions viz. temperature, rainfall and humidity (Fig. 1) with increased concentration of IBA. Tayade *et al.* (2017) also reported minimum days taken to root appearance in layers of pomegranate when layering operation performed in July month. These findings are more or less similar to the observations reported by Reang *et al.* (2016) in jackfruit, Baghel *et al.* (2016) in guava cv. L-49, Manga *et al.* (2017) in guava cv. Sardar.

Rooting percentage: Results shown in Table 1 revealed that T_3C_3 (15th July+IBA @ 4500 ppm) treatment found best in relation to rooting percentage (92.20%), whereas least rooting percentage (40.00%)) was found under the treatment T_2C_0 (30th June+IBA @ 0 ppm). Increased concentration of IBA may have caused mobilization and utilization of carbohydrates and nitrogen fraction with the presence of co-factors at wound (griddled) site which may have helped in better root initiation coupled with appropriate layering time (Singh and Mahato, 2016). Hence, IBA at highest concentration (4500 ppm) resulted in highest rooting percentage of the guava air layers. Rooting percentage also depends on the physiological condition of plant. Tayade *et al.* (2017) also reported maximum rooting percentage of air layers of pomegranate when layering was done in July month. These findings are more or less in conformity with the results reported by Bhagat *et al.* (1998, 1999a, 1999b) in guava, Baghel *et al.* (2016) in guava cv. L-49, Manga *et al.* (2017) in guava cv. Sardar, Singh and Mahato in guava (2016) in guava, Tomar (2011) in jackfruit and Tomar (2016) in *Spondias pinnata*.

Number of roots per layer: The data pertaining to number of roots per layer (Table 1) shows that 15th July air layering time and higher IBA concentration have significant effect on number of roots per layer. Maximum number of roots per layer (24.80) was recorded in layers of T_3C_3 (15th July+IBA @ 4500 ppm) treatment whereas minimum number of roots (3.74) was recorded under T_1C_0 (15th June+IBA @ 0 ppm) treatment. IBA has been found to be most effective in producing maximum number of roots with better vigour. Similar trend was observed by Bhagat *et al.* (1998, 1999a, 1999b) in guava, Baghel *et al.* (2016) in guava cv. L-49, Reang *et al.* (2016) in jackfruit, Manga *et al.* (2017) in guava cv. Sardar, Singh and Mahato (2016) in guava, Tomar (2011) in jackfruit and Tomar (2016) in *Spondias pinnata*.

Length of the longest root per layer: The data on length of the longest root per layer presented in Table 1 revealed that length of the longest root was found significant in respect to time of air layering and IBA concentrations. The treatment T_3C_3 (15th July+IBA @ 4500 ppm) was found to have maximum length of longest root per layer (14.20cm) whereas minimum length of the longest root per layer (3.40cm) was observed under the treatment T_1C_0 (15th June+IBA @ 0 ppm). Tayade *et al.* (2017) also found increased length of primary roots in air layers of pomegranate performed in the month of July. Many workers have reported successful results by the use of plant growth regulators in stimulating the root length in air layering of guava crop (Bhagat *et al*., 1999b; Singh and Bhuj, 2000; Tyagi and Patel, 2004 and Singh *et al*., 2007). Similar trends were also found by Bhagat *et al.* (1998, 1999a) in guava, Baghel *et al.* (2016) in guava cv. L-49, Manga *et al.* (2017) in guava cv. Sardar, Singh and Mahato (2016) in guava, Tomar (2011) in jackfruit and Tomar (2016) in *Spondias pinnata*.

Diameter of the thickest root per layer: The data presented in Table 1 indicate that all the treatments of time of air layering and IBA concentrations were found to vary significantly in terms of diameter of roots. The maximum diameter of the thickest root per layer (1.86mm) was recorded in layers of T_3C_3 (15th July+IBA @ 4500 ppm) treatment, whereas minimum diameter of the thickest root per layer (1.11mm) was noticed in layers of T_1C_0 (15th June+IBA @ 0 ppm) treatment. This result is in more or less conformity with the findings of Chauhan (2012) in fig, Chawla *et al.* (2012) in litchi, Tomar (2011) in jackfruit and Udhavrao *et al.* (2017) in pomegranate.

Percentage of layers showing secondary roots: Among all the treatments, percentage of layers showing secondary roots was recorded maximum (70.00%)) under the treatment T_3C_3 (15th July+IBA @ 4500 ppm), whereas the air layers in [T_1C_0 (15th June+IBA @ 0 ppm) and T_2C_0 (30th June+IBA @ 0 ppm) treatments] failed to produce secondary roots. The minimum percentage of layers showing secondary roots (3.33) were recorded under treatments (T_4C_0 (30th July+IBA @ 0 ppm)). Tomar (2011) in jackfruit also reported maximum percentage of layers showing secondary roots when layering was performed during 25-26th July and treated with 10000 ppm IBA. These findings shows that time of air layering operation and increased concentration of growth regulator is beneficial for secondary roots development in air layering of guava.

Table 1. Effect of Time of Air Layering and IBA Concentrations on the Rooting Behaviour of Pant Prabhat Guava (*Psidium guajava* L.)

Treatments	Days taken to root appearance	Rooting percentage (%)	Number of roots per layers	Length of longest root per layer (cm)	Diameter of thickest root per layers (mm)	Percentage of layers showing secondary roots (%)
T_1C_1 (15th June+IBA @ 1500 ppm)	47.00	56.67	7.74	6.50	1.34	7.78
T_1C_2 (15th June+IBA @ 3000 ppm)	39.00	64.44	13.00	8.34	1.48	31.10
T_1C_3 (15th June+IBA@ 4500 ppm)	34.30	75.56	15.30	10.50	1.58	46.70
T_1C_0 (15th June+IBA @ 0 ppm)	54.50	41.11	3.74	3.40	1.11	0.00
T_2C_1 (30th June+IBA @ 1500 ppm)	44.20	42.22	8.52	7.84	1.30	20.00
T_2C_2 (30th June+IBA @ 3000 ppm)	39.00	53.30	13.90	10.10	1.41	27.80
T_2C_3 (30th June+IBA @ 4500 ppm)	31.80	71.10	17.30	12.60	1.54	52.20
T_2C_0 (30th June+IBA @ 0 ppm)	50.60	40.00	5.00	3.73	1.14	0.00
T_3C_1 (15th July+IBA @ 1500 ppm)	38.10	65.56	11.10	7.85	1.42	22.20
T_3C_2 (15th July+IBA @ 3000 ppm)	32.60	84.44	18.20	11.90	1.61	44.40
T_3C_3 (15th July+IBA @ 4500 ppm)	28.40	92.20	24.80	14.20	1.86	70.00
T_3C_0 (15th July+IBA @ 0 ppm)	43.50	54.44	6.96	7.01	1.22	8.89
T_4C_1 (30th July+IBA @1500 ppm)	41.40	62.20	7.52	6.90	1.32	11.10
T_4C_2 (30th July+IBA @ 3000 ppm)	37.70	72.20	11.30	9.07	1.46	33.30
T_4C_3 (30th July+IBA @ 4500 ppm)	30.80	86.70	18.60	12.30	1.59	46.70
T_4C_0 (30th July+IBA @ 0 ppm)	48.40	46.67	4.48	4.01	1.16	3.33
Mean	**40.07**	**63.06**	**11.72**	**8.51**	**1.41**	**26.60**
SE(m)	0.64	1.84	0.48	0.47	0.015	1.85
SE(d)	0.90	2.61	0.68	0.66	0.021	2.61
C.D. at 5%	1.79	5.17	1.35	1.31	0.041	5.18
Significance	*	*	*	*	*	*

CONCLUSION

As per the findings of this experiment, time of air layering and IBA concentrations had a positive significant effect on the rooting behaviour and success of rooting of air layers in Pant Prabhat guava. Air layering performed during 15th July gave best rooting performance and significant results in rooting characteristics. In respect to IBA concentrations, 4500 ppm showed best results for all the rooting parameters comparison to control. Therefore, on the basis of above conclusion, it is recommended that air layering time 15th July with 4500 ppm IBA is suitable for best rooting performance of air layers of Pant Prabhat guava under sub-tropical condition of Garhwal Himalaya.

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