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Assessment of different IBA concentration, rooting media and time for rooting behaviour of air layered Guava (*Psidium guajava* L.) cv. Shweta

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Abstract
An experiment was conducted at the Horticultural Research Centre and Department of Horticulture, Sardar Vallabhbhai Patel University of Agriculture and Technology, Modipuram, Meerut, Uttar Pradesh, India during the rainy season of the year 2019-20 to assessment of different IBA concentrations, rooting media and time for rooting behavior of air layered Guava (*Psidium guajava* L.) cv. Shweta. Experimental laid out in Factorial Randomized Block Design having fifty treatment combinations of IBA concentrations (control, 6000 ppm, 7000 ppm, 8000 ppm, and 9000 ppm), rooting media (Sphagnum moss, cocopeat, soil, Sphagnum moss + cocopeat and Sphagnum moss + cocopeat + soil) and time of layering (July and August). The treatments replicated thrice. The response of Shweta cultivar of guava to the treatments was evaluated on the basis of rooting attributes those are best under $C_4T_4T_2$ treatment i.e., minimum days taken root appearance (27.41 days), maximum rooting (100%), maximum number of primary (15.57) and secondary roots (25.87) per layers, maximum length of primary (11.18 cm) and secondary roots (6.43 cm), maximum diameter of primary (4.06 mm) and secondary roots (1.789 mm) per layers. On the basis of results obtained present investigations, it can be concluded that air layering treated with 9000 ppm IBA, use of Sphagnum moss+ cocopeat as a rooting media and time of performed air layering during August month have been found significantly superior on all other treatments.

Keywords: Air layering, IBA, Cocopeat, Sphagnum moss, ppm

Introduction
Guava (*Psidium guajava* L.), a native of Tropical America (from Mexico to Peru), is popular fruit crop in India due to its wide climatic adaptability and availability of fruits for long period during the year. In India, the total area under guava cultivation was approximately 255 Thousand Hectares with an estimated annual production of 4048 Lakh tons (Anonymous 2018) [2]. Its fruit is rich in vitamin-C (80 mg of vitamin C in 100g of fruit), Crude fiber (0.9-1.0 g) protein (0.1-0.5 g), carbohydrates (9.1-17 mg), minerals (Ca, P, Fe etc.) and pectin (Kamath *et al.* 2008) [14]. The guava plant comes up well even under the harsh conditions owing to its hardy nature. However, the main constraint in the popularization of guava is the preponderance of seedling progeny as seedling plants do not perpetuate the exact characters of particular superior selection in comparison to the vegetatively propagated fruit trees. Guava can be successfully propagated asexually by layering (Manna *et al.* 2004) [17]. Air layering is only reliable method for guava mass multiplication has an advantage over budding and grafting because, being on its own root the suckering problem is minimized and for stem cutting it require specialized environment conditions such as mist propagation beds (Nelson 1954) [21]. The success in air layering of guava is mainly depends upon mother plant, time of layering, rainfall, humidity, temperature, rooting media, growth media, plant growth regulators and care during removal of bark from shoots. Air-layering is practiced during the month of June-July with good success rates due to the relatively low temperature (23 ˚C to 31 ˚C), high relative humidity (80 to 90%) and rainfall which provides the conducive environment for the root initiation (Ahmed 1964) [1]. Layers prepared during these months get an additional advantage of longer duration of a favorable season for establishing the layer in the soil after preparation. The percentage of establishment and survival of rooted layers is reported to be poor, mainly due to hormonal imbalance and non-availability of standardized rooting media (Singh 2002). Air layering with the help of plant growth regulators and rooting media is reported to stimulate root primordial in the air layers (Tyagi and Patel 2004) [32].

Plenty of literature is available on these aspects for different fruit crops like pomegranate (Patel *et al*. 2012) [22], litchi (Chawla *et al.* 2012; Das and Prasad 2014) [9, 10] etc. However, there is a lack of standardization of PGR's doses and their interaction with different rooting media in the important fruit crops like guava. Bose *et al*. (1986) [7] showed that the time of layering and detachment of layers from the mother plants is the most important factor for rooting success because of presence of sufficient soil moisture, humidity and optimum temperature which are prerequisites of highest survival of the detached air- layers. So, propagation is also recommended in proper time for maximum survival of the detached air- layers in case of guava.

Materials and Methods

Details of experiments

The present experiment was conducted under the open field condition at Horticultural research centre and department of horticulture, college of agriculture, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India during the rainy season of the year 2019.

Meerut is located at 29˚ 40' N latitude and 77˚ 42' E longitude and 237 meters above mean sea level. The climate of Meerut is semi-arid and sub-tropical with hot summers, where maximum temperature exceeds 45 ˚C in May and June. The winters are cool and minimum temperature reaches as low as 4 ˚C in December and January; occurrence of frost is expected from the last week of December to the first week of February. Usually, the monsoon arrives in the second fortnight of June and lasts till September. Occasionally light rains are expected during winter. The mean annual rainfall of Meerut is about 840 mm of which nearly 85% is received in the monsoon period from end of June to end of September. The total of 683.1 mm rainfall was received during the experimental period.

Materials Used for the Experiment- Mother plants of guava cultivar Shweta of 8 years old were selected for air-layering operation. Transparent polythene sheet (size 20×20cm), sharp knife, thread, rooting media, IBA etc. were used.

Methods Followed to Perform Air Layering - On time July and August of the year 2019, air layering was done on the 1.5-2-year-old shoots by removing a strip of bark (phloem) 2.0-2.5cm wide cut below the bud by giving two circular cuts about 30cm below from shoot tip and then the exposed portion of shoot was rubbed without causing any injury to the xylem with the help of a knife. After that, the upper portion of exposed shoots was sprayed with different concentrations of IBA according to the treatments. The exposed wood with two centimeter above and below portions was then covered with different growing media i.e. sphagnum moss, coco peat and sphagnum moss + coco peat soaked overnight in water. The control shoots were treated with only respective media according to treatments soaked overnight in water. To wrap the rooting media completely a piece of transparent 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.

<table>
<tr><td rowspan="5">Factor 1 IBA Concentrati-ons</td><td>Control (C_0)</td><td rowspan="5">II) Factor 2 Rooting media</td><td>Sphagnum moss (M_1)</td><td rowspan="5">Factor 3 Time of layering</td><td rowspan="3">July (T_1)</td></tr>
<tr><td>6000 ppm (C_1)</td><td>Cocopeat (M_2)</td></tr>
<tr><td>7000 ppm (C_2)</td><td>Clay soil (M_3)</td></tr>
<tr><td>8000 ppm (C_3)</td><td>Sphagnum moss + cocopeat (M_4)</td><td rowspan="2">August (T_2)</td></tr>
<tr><td>9000 ppm (C_4)</td><td>Sphagnum moss + Cocopeat + Clay soil (M_5)</td></tr>
</table>

Total number of treatments: 5 × 5 × 2 = 50
Number of replications: 3
Number of layers/ replications: 08
Total number of layers/treatments: 3 × 8= 24
Total number of layers in the experiment: 50 × 24 = 1200
Cultivar: Shweta

Separation of air-layers form mother plants

All the air-layers were separated from the mother plants sixty days after air-layering operation with the help of secateurs by giving a horizontal cut just below the lower end of air-layers. After separation of the air-layers from mother plants, all the tying material (thread) and polythene sheet were removed carefully without damaging the roots.

Observations recorded

The following observations were recorded after 60 days of air-layering in respect to the rooting behaviour during the period of the experimentation-

1. Days taken root appearance (number of days)
2. Number of primary and secondary roots per layers
3. Rooting (%)
4. Length of primary and secondary roots(cm)
5. Diameter of primary and secondary roots (mm) per layers

Statistical analysis

All the data recorded during the period of experimentation were subjected to statistical analysis under the three-factor factorial randomized block design as described by Snedecar and Cochran. Valid conciliations were drawn after the determination of the significance of difference between the treatments at 5 percent level of probability. Critical difference was calculated in order to compare the treatment means.

Results and Discussions

The results obtained during the present experimentation clearly showed that the main and interaction Assessment of different IBA concentrations, rooting media and time of air-layering, have the significant effect on the survivability of air layered guava cv Shweta.

Main Effect of IBA concentrations

The variation in the callus formation was highly significant due to the main effect of IBA concentrations and rooting media but not time of layering.

Results indicated that among the various concentrations of IBA treatments on the minimum mean days taken to root appearance (38.90 days) was noticed under the treatment C_4 (9000ppm) while, maximum mean days taken to root

appearance (49.84 days) was observed under the treatment C_0 (Control). Status of soil and plant nutrients and the positive impact of growth regulator may be the possible reason for early rooting. The response of IBA at higher concentration might be due to the activity of auxin at cambial may be adequate for callus formation and initiation of root primordia. In addition, exogenous application of auxin could have converted starch into simple sugars, which is required to a greater extent for the production of new cells and for the increased respiratory activity in the regenerating tissues at the time of initiation of new root primordial. Results obtained from the present investigation have more or less conformity with the findings of Chawala in Litchi, Chauhan in Fig (*Ficus carica* L.) cv. Poona under middle Gujarat conditions, and Udavrao in pomegranate cv. Bhagwa.

Among all the concentration of IBA on the maximum rooting percentage (72.50%) was recorded under the treatment C_4 (9000 ppm) treatment. Whereas, the minimum rooting percentage (36.25%) under C_0 (Control) treatment. IBA at higher concentration (9000 ppm) gave better result than at lower concentrations or under control and there appeared to be an increasing tendency of rooting with an increasing concentration, this might be at higher concentration of IBA the quantity of auxin reaching the cambial activity may be adequate for initiating root primordia, so the highest performance was seen at higher concentrations of IBA. Indicating the possibility of better success with employing higher concentrations of IBA (Bhagat *et al*. 1999) [4]. The results obtained in the present investigation are found to be more or less conformity with studies of Athani *et al.* in guava, Haque *et al.* in guava, Kumar in guava, Patil *et al.* in guava.

Among various IBA concentration C_4 (9000ppm) treatment gave the maximum mean number of primary (16.36) and secondary roots (24.07) per layer, while the minimum mean number of primary (5.80) and secondary roots (11.89) per layers was observed under by C_0 (Control) treatment. Increased number of roots in the air-layering with the higher concentration of IBA might be due to increased cell wall elasticity which further may have increased cell division and in turn, increased number of roots. IBA at higher

concentration increased root length by affecting the synthesis of enzymes which are related to cell enlargement. These results are more or less similar to the results obtained by Athani *et al.* in guava, Haque *et al.* in guava, Kumar in guava, and Das *et al.* in Litchi cv. Purbi.

Among the different concentrations of IBA C_4 (9000ppm) treatment was better to produce maximum mean length of the primary (6.98 cm) and secondary root(4.97cm) per layers, while the minimum mean length of the primary (3.40 cm) and secondary root (1.67cm) per layer was found in the C_0 (Control) treatment. The maximum number of primary and secondary roots might be due to hormonal effect leading to accumulation of internal substances and their downward movement. Regarding the number of secondary roots might be due to more cell division. These findings are more or less close to the results obtained by Athani *et al.* in guava, Haque *et al.* in guava and Kumar in guava**.**

In case of IBA concentrations, the maximum mean diameter of the primary (1.84 mm) and secondary root (0.943mm) per layer was observed under C_4 (9000 ppm) treatment, whereas C_0 (Control) treatment gave the minimum mean diameter of the primary (0.88 mm) and secondary root (0.53 mm) per layer during the experiment. These findings are more or less match with the findings of Chawla in Litchi under middle Gujarat conditions, Birla in Guava cv. Gwalior-27, Kumar in guava, Yadav in Acid Lime cv. Vikram, Yadav in Guava cv. Gwalior-27**.**

Main effect of rooting media

In respect to the various rooting media evaluated, the minimum mean days taken to root appearance (42.62days) was observed under the M_4 (Sphagnum moss + Cocopeat) treatment. The maximum mean days taken to root appearance (48.44days) was recorded under M_3 (Clay Soil) treatment. This might be due to proper aeration and good water holding capacity of sphagnum moss and cocopeat which causes early root initiation. Similar results were reported by Bhosale *et al.*4 in Pomegranate (*Punica granatum* L.) cv. Sindhuri, Maurya *et al*.22 in Guava cv. Allahbad Safeda, Patel *et al*.26 in Pomegranate cv. Ganesh.

In case of rooting media, the maximum rooting percentage (63.75%) was found under M_4 (Sphagnum moss + cocopeat) treatment. While, the minimum mean rooting percentage (45.00%) was observed under M_3 (Clay soil) treatment. The increased rooting percentage in sphagnum moss + cocopeat might have been due to better initiation of roots and increased number of rooting co-factors at the time of callus formation and root initiation. The similar results were also recorded by Rymbai and Reddy in Guava cv. L-49, Yeboah *et al.* in Shea (*Vitellaria paradoxa*).

In case of rooting media used in the air-layering operation, M_4 (Sphagnum moss + cocopeat) treatment gave the maximum mean number of primary (13.21) and secondary roots (22.18) per layers, whereas, M_3 (Clay soil) treatment gave the minimum mean number of primary (9.63) and secondary roots (14.74) per layer. The similar results were also recorded by Rymbai and Reddy in Guava cv. L-49. Bhosale *et al.* in Pomegranate (*Punica granatum* L.) cv. Sindhuri, Maurya *et al*. in Guava cv. Allahbad Safeda, Patel *et al.* in Pomegranate cv. Ganesh,

In relation to the rooting media, maximum mean length of the primary (5.62cm) and secondary root(3.70cm) per layer was noticed under M_4 (Sphagnum moss + Cocopeat) treatment, whereas M_3 (Clay soil) treatment has the minimum mean length of the primary (4.73cm) and secondary root (2.88mm) per layer. The similar results were also recorded by Rymbai and Reddy in Guava cv. L-49. Bhosale *et al.* in Pomegranate (*Punica granatum* L.) cv. Sindhuri, Maurya *et al*. in Guava cv. Allahbad Safeda, Patel *et al.* in Pomegranate cv. Ganesh.

In respect to the rooting media, the maximum mean diameter of the primary (1.63mm) and secondary root (0.82 mm) per layer was recorded with M_4 (Sphagnum moss + cocopeat) treatment. The minimum mean diameter of the primary (1.24mm) and secondary root (0.63 mm) per layer was noticed under M_3 (Clay soil) treatment during the experimentation. The superiority of sphagnum moss over other rooting media might be owing to its unique ability like-proper aeration and increased water holding capacity which in later stage help in thicker roots formation.

Main effect of time

The main effect of IBA concentrations rooting media and time of air-layering, have non significantly affected the days taken to root appearance in Shweta variety of guava as presented in Table 1. Among all the time of air-layering, the minimum mean days taken to root appearance (44.18days) was recorded under the T_2 (August) treatment whereas maximum mean days taken to root appearance (46.22days)

was noticed under the T_1 (July) treatment. It might be due to the favourable environmental conditions *viz.*, temperature, relative humidity and rainfall, which results in the lesser days taken to root appearance in August month. The results obtained from the present investigation are in agreement with the findings of Rehman *et al.* in Olive, Mozumder *et al.* in Plum, Tayade *et al.* observed the minimum days taken to root initiation (21.85days) in air-layers of pomegranate cv. Bhagwa when layering was performed in July month.

The data pertaining to the rooting percentage (Table 1) clearly shows that the main effect of IBA concentrations, rooting media and time of air-layering were found significant in relation to the rooting percentage. In respect to all the time of air-layering, the maximum rooting percentage (54.00%) was found under T_2 (August) treatment. The minimum rooting percentage (53.66%) was observed when air-layering was performed during July (T_1). It may be due to a particular correlation of temperature, humidity and rainfall. The similar findings have also been reported by Shrivastava in *Punica granatum*, Ahmad in Guava, Mishra and Agarwal in Kagzi Kalan, Kunwar and Kahlon in Litchi, Sharma and Grewal in Litchi, Sarker and Ghose in Guava, Hossain *et al.* in Litchi and Tayade *et al.* in Pomegranate cv. Bhagwa.

Table 1: Main effect of different IBA concentration, rooting media and time on rooting behaviour of air layered guava (*Psidium guajava* L.) cv. Shweta

Treatments	Days taken to root appearance (Days)	Rooting percentage (%)	Number of roots per layer		Length of the root per layer (cm)		Diameter of root per layer (mm)	
			Primary	Secondary	Primary	Secondary	Primary	Secondary
IBA concentrations (C)								
C_0 (Control)	49.84	36.25	5.80	11.89	3.40	1.67	0.88	0.535
C_1 (60000 ppm)	44.60	52.50	10.65	17.22	4.60	2.90	1.37	0.707
C_2 (7000 ppm)	43.87	52.91	11.10	17.89	5.26	3.32	1.45	0.729
C_3 (8000 ppm)	43.79	55.00	11.21	20.00	5.54	3.44	1.61	0.768
C_4 (9000 ppm)	38.90	72.50	16.36	24.07	6.98	4.97	1.84	0.943
S.E.(m)±	0.14	1.16	0.14	0.13	0.09	0.01	0.03	0.001
C.D. $_{0.05}$	0.41	3.25	0.41	0.37	0.27	0.04	0.09	0.004
Rooting media (M)								
M_1 (Sphagnum moss)	43.97	53.83	10.38	17.32	5.12	3.29	1.42	0.737
M_2 (Coco peat)	45.11	51.25	9.87	16.66	4.87	3.20	1.31	0.670
M_3 (Soil)	48.44	45.00	9.63	14.74	4.73	2.88	1.24	0.635
M_4 (Sphagnum moss + Coco peat)	42.62	63.75	13.21	22.18	5.62	3.70	1.63	0.822
M_5 (Sphagnum moss + Coco peat+ Soil)	42.85	55.83	12.02	20.16	5.30	3.42	1.54	0.817
S.E.(m)±	0.14	1.16	0.14	0.13	0.09	0.01	0.03	0.001
C.D. $_{0.05}$	0.41	3.25	0.41	0.37	0.27	0.04	0.09	0.004
Time of air-layering (T)								
T_1 (July)	46.22	53.66	10.56	18.11	5.07	3.24	1.39	0.731
T_2 (August)	44.18	54.00	11.86	18.31	5.76	3.28	1.46	0.742
S.E.(m)±	0.09	0.73	0.09	0.08	0.06	0.01	0.02	0.001
C.D. $_{0.05}$	NS	NS	NS	NS	NS	0.03	0.06	0.003

It is clear from Table 1 that the main effect of IBA concentrations, rooting media and time of air-layering were found non-significant in respect to the number of primary and secondary roots per layer. In case of various time of air-layering, the maximum mean number of primary (11.86) and secondary roots (18.31) per layer was observed under the treatment T_2 (August), whereas the minimum mean number of primary (10.56) and secondary roots (18.11) per layer was found in the T_1 (July) treatment. The similar results were reported by, Sarker and Ghose in Guava and Mozumber *et al.* in Plum.

The perusal of Table 1 shows that the non-significant main effect of IBA concentrations, rooting media and time or air-layering on mean length of the primary root but significant effect on mean length of secondary root per layer during the experimentation. In relation to the time of air-layering, the maximum mean length of the primary (5.76 cm) and secondary root (3.28cm) per layer was obtain under the treatment T_2 (August). The minimum mean length of the primary (5.07cm) and secondary root (3.24 cm) per layer was recorded under the T_1 (July) treatment. These findings are similar to the results obtained Litchi (*Litchi sinensis* Sonn.), Hossain *et al.* in Litchi.

It is clear from the Table 1 that the main effect of IBA concentrations, rooting media and time of air-layering, were found significant in mean diameter of the primary and secondary root per layer. Among the different time of air-layering, T_2 (August) treatment recorded the maximum mean diameter of the thickest (1.46 mm) and secondary root (0.742 mm) per layer, while the minimum mean diameter of the thickest (1.39 mm) and secondary root (0.731 mm) per layer was noticed under the treatment T_1 (July). Clear finding from Ghosh in Water Apple, Mozumder *et al.* in Plum and Tayade *et al.* in Pomegranate cv. Bhagwa.

Interaction effect of IBA concentrations, rooting media and time of air-layering

The interaction effect among IBA concentrations, rooting media and time of air-layering showed the significant effect on days taken to root appearance (Table 2). The minimum mean days taken to root appearance (27.41days) was noted under the C4M4T2 (9000ppm IBA + (Sphagnum moss + Cocopeat) + August) treatment combination. Whereas, maximum mean days taken to root appearance (57.00 days) was recorded under the C0M3T1 (Control + Clay soil + July) treatment combination.

Table 3 shows that the interaction effect among IBA concentrations, rooting media and time of air-layering was

also found significant in rooting percentage. The maximum rooting percentage (100%) was found under C4M4T2 (9000ppm IBA + Sphagnum moss + Cocopeat) + August) treatment combination. While, the treatment combination C0M3T1 (Control + Clay soil + July), treatments combination gave the minimum rooting percentage (20.83%). Kumar *et al.* also found a significant difference while working on Guava cv. Allahabad Safeda air-layering. Rymbai and Reddy observed that the interaction effect of different treatment combination has shown significant differences regarding rooting percentage. They found the treatment combination IBA@4000ppm+ Sphagnum moss+15th August was best in relation to the rooting percentage (86%) in Guava cv. L-49 air-layering under Andhra Pradesh.

Table 4 and table 5 shows that the interaction effect among IBA concentrations, rooting media and time of air-layering was also found significant in the mean number of primary and secondary roots per layer. The maximum mean number of primary (15.57) and secondary roots (25.87) per layer was recorded under the C4M4T2 (9000ppm IBA+ (Sphagnum moss + Cocopeat) +August) treatment combination. The minimum mean number of primary (4.19) and secondary roots (7.37) per layer was noticed under the treatment combination C0M3T1 (Control + Sphagnum moss+ Clay soil). Kumar *et al.* also found a significant difference while working on Guava cv. Allahabad Safeda air-layering. Rymbai and Reddy also found the maximum number of roots (10.80) in Guava cv. L-49 air-layers with the treatment combination IBA@4000ppm+ Sphagnum moss+15th August under Andhra Pradesh conditions.

Data in Table 6 and table 7 pertaining to the mean length of the primary and secondary root per layer indicate that the interaction effect of IBA concentrations, rooting media and time of air- layering, were found significant during the period of experimentation. Maximum mean length of the primary (11.18cm) and secondary root(6.43cm) per layer was recorded in the treatment combination C4M4T2 (9000ppm IBA+ (Sphagnum moss+Cocopeat) +August). The minimum mean length of the primary (1.91 cm) and secondary root (0.78 cm) per layer was obtained under C0M3T1 (Control + Clay soil + July) treatment combination. Kumar *et al.* also found a significant difference while working on Guava cv. Allahabad Safeda air-layering. Rymbai and Reddy found that the treatment combination IBA@4000ppm+Sphagnum moss+ 15th August is the best combination with respect to the maximum length of the longest root (10.32cm) in Guava cv. L-49 air-layering under Andhra Pradesh condition.

Table 8 and table 9 shows that the interaction effect among IBA concentrations, rooting media and time of air-layering was also found significant in respect to the mean diameter of the primary and secondary root per layer. The maximum mean diameter of the primary (4.06 mm) and secondary root (1.78) per layer was found under the treatment combination C4M4T2 (9000ppm IBA+ (Sphagnum moss+ Cocopeat) +August). The minimum mean diameter of the primary (0.56mm) and secondary root (0.33mm) per layer was obtained under C0M3T1 (Control + Clay soil + July) treatment combination. increased concentration of IBA, sphagnum moss and favourable climatic conditions, all in combination might be responsible for increased diameter of the roots.

Table 2: Interaction effect among IBA concentrations, rooting media and time of air-layering on days taken for root appearance

IBA concentrations	Rooting media									
	M_1		M_2		M_3		M_4		M_5	
	Time of air-layering		Time of air-layering		Time of air-layering		Time of air-layering		Time of air-layering	
	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2
C_0 (Control)	49.27	48.22	53.47	47.81	**57.00**	51.36	46.96	52.28	46.65	45.40
C_1 (6000 ppm)	47.30	44.98	45.62	43.39	53.35	42.77	40.83	45.40	43.11	41.00
C_2 (7000 ppm)	39.11	36.40	44.65	40.20	48.54	47.34	38.29	36.98	39.43	38.71
C_3 (8000 ppm)	36.03	34.77	38.30	36.11	46.52	43.74	34.32	32.58	35.28	33.31
C_4 (9000 ppm)	33.75	31.91	35.49	33.70	42.78	41.72	29.71	27.41	32.82	30.70
S.E.(m)±	0.47									
C.D. $_{0.05}$	1.32									

Table 3: Interaction effect among IBA concentrations, rooting media and time of air-layering on rooting %

IBA concentrations	Rooting media									
	M_1		M_2		M_3		M_4		M_5	
	Time of air-layering		Time of air-layering		Time of air-layering		Time of air-layering		Time of air-layering	
	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2
C_0 (Control)	37.50	41.66	33.33	41.66	20.83	25.00	41.66	58.33	37.50	50.00
C_1 (6000 ppm)	54.16	58.33	50.00	54.16	37.50	45.83	75.00	79.16	50.00	62.50
C_2 (7000 ppm)	66.66	70.83	62.50	66.66	50.00	54.16	79.16	87.50	54.16	62.50
C_3 (8000 ppm)	79.16	83.33	66.66	75.00	54.16	58.33	87.50	95.83	66.66	75.00
C_4 (9000 ppm)	83.33	95.83	79.16	83.33	66.66	75.00	95.83	100.00	87.5	83.33
S.E.(m)± 3.66										
C.D. $_{0.05}$ 10.29										

Table 4: Interaction effect among IBA concentrations, rooting media and time of air-layering on number of primary roots

IBA concentrations	Rooting media									
	M_1		M_2		M_3		M_4		M_5	
	Time of air-layering		Time of air-layering		Time of air-layering		Time of air-layering		Time of air-layering	
	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2
C_0 (Control)	5.46	6.70	5.06	5.56	4.19	4.74	8.11	9.00	6.54	8.17
C_1 (6000 ppm)	7.15	8.50	6.31	8.39	5.97	7.66	10.57	12.77	8.31	10.02

C_2 (7000 ppm)	9.32	10.72	7.17	9.74	7.28	8.98	11.77	13.56	10.02	12.52
C_3 (8000 ppm)	10.96	12.56	9.09	11.02	8.68	9.49	12.32	14.21	11.28	13.02
C_4 (9000 ppm)	11.68	13.53	10.78	12.12	9.94	11.30	14.28	15.57	12.08	13.32
S.E.(m)±	0.37									
C.D. $_{0.05}$	1.03									

Table 5: Interaction effect among IBA concentrations, rooting media and time of air-layering on number of secondary roots

IBA concentrations	**Rooting media**									
	M_1		**M_2**		**M_3**		**M_4**		**M_5**	
	Time of air-layering		**Time of air-layering**		**Time of air-layering**		**Time of air-layering**		**Time of air-layering**	
	T_1	**T_2**	**T_1**	**T_2**	**T_1**	**T_2**	**T_1**	**T_2**	**T_1**	**T_2**
C_0 (Control)	9.24	11.34	8.12	9.09	7.37	8.05	10.80	11.80	10.09	11.16
C_1 (6000 ppm)	11.80	13.44	10.81	12.77	9.62	10.43	13.48	15.30	12.28	14.05
C_2 (7000 ppm)	13.35	15.91	12.76	14.21	11.67	12.21	16.39	18.83	15.14	17.92
C_3 (8000 ppm)	15.12	17.64	13.54	16.32	13.14	15.40	19.02	21.35	18.24	19.17
C_4 (9000 ppm)	18.48	20.00	17.22	19.59	16.97	18.58	23.28	25.87	21.36	23.38
S.E.(m)±	0.42									
C.D. $_{0.05}$	1.17									

Table 6: Interaction effect among IBA concentrations, rooting media and time of air-layering on length of primary root (cm)

IBA concentrations	**Rooting media**									
	M_1		**M_2**		**M_3**		**M_4**		**M_5**	
	Time of air-layering		**Time of air-layering**		**Time of air-layering**		**Time of air-layering**		**Time of air-layering**	
	T_1	**T_2**	**T_1**	**T_2**	**T_1**	**T_2**	**T_1**	**T_2**	**T_1**	**T_2**
C_0 (Control)	3.66	4.26	3.11	3.77	1.91	3.09	4.73	4.89	4.17	4.40
C_1 (6000 ppm)	4.53	4.60	4.15	4.55	2.60	3.60	6.89	8.66	6.06	6.56
C_2 (7000 ppm)	6.85	6.90	5.49	6.83	3.22	3.80	8.10	9.17	7.99	8.45
C_3 (8000 ppm)	7.44	6.46	6.96	5.19	4.22	5.68	9.60	10.48	8.39	9.54
C_4 (9000 ppm)	8.05	9.18	7.03	8.00	5.17	5.37	10.21	11.18	9.10	10.04
S.E.(m)±	0.31									
C.D. $_{0.05}$	0.87									

Table 7: Interaction effect among IBA concentrations, rooting media and time of air-layering on length of secondary root (cm)

IBA concentrations	**Rooting media**									
	M_1		**M_2**		**M_3**		**M_4**		**M_5**	
	Time of air-layering		**Time of air-layering**		**Time of air-layering**		**Time of air-layering**		**Time of air-layering**	
	T_1	**T_2**	**T_1**	**T_2**	**T_1**	**T_2**	**T_1**	**T_2**	**T_1**	**T_2**
C_0 (Control)	1.07	1.93	0.89	1.46	0.78	1.05	1.28	2.43	1.67	2.26
C_1 (6000 ppm)	1.58	2.16	1.08	1.96	1.07	1.47	1.44	2.76	1.69	2.17
C_2 (7000 ppm)	2.42	3.21	2.22	3.07	2.17	2.47	2.79	3.86	2.56	3.27
C_3 (8000 ppm)	2.89	3.57	2.66	2.95	2.26	2.75	3.78	4.58	3.54	3.33
C_4 (9000 ppm)	4.66	5.12	3.95	5.03	3.32	3.97	4.91	6.43	4.65	5.56
S.E.(m)±	0.05									
C.D. $_{0.05}$	0.14									

Table 8: Interaction effect among IBA concentrations, rooting media and time of air-layering on diameter of primary root (mm)

IBA concentrations	**Rooting media**									
	M_1		**M_2**		**M_3**		**M_4**		**M_5**	
	Time of air-layering		**Time of air-layering**		**Time of air-layering**		**Time of air-layering**		**Time of air-layering**	
	T_1	**T_2**	**T_1**	**T_2**	**T_1**	**T_2**	**T_1**	**T_2**	**T_1**	**T_2**
C_0 (Control)	0.94	0.97	0.79	0.90	0.56	0.67	1.03	1.14	0.98	1.04
C_1 (6000 ppm)	1.28	1.71	0.97	1.27	0.76	1.07	1.45	1.81	1.34	1.60
C_2 (7000 ppm)	1.88	2.36	1.55	2.07	0.96	1.55	2.07	2.78	1.92	2.14
C_3 (8000 ppm)	2.78	3.44	2.35	2.87	1.54	1.88	2.65	3.85	1.88	3.44
C_4 (9000 ppm)	3.35	3.78	2.76	3.39	1.90	2.38	3.84	4.06	2.98	3.29
S.E.(m)±	0.11									
C.D. $_{0.05}$	0.31									

Table 9: Interaction effect among IBA concentrations, rooting media and time of air-layering on diameter of secondary root (mm)

IBA concentrations	**Rooting media**									
	M_1		**M_2**		**M_3**		**M_4**		**M_5**	
	Time of air-layering		**Time of air-layering**		**Time of air-layering**		**Time of air-layering**		**Time of air-layering**	
	T_1	**T_2**	**T_1**	**T_2**	**T_1**	**T_2**	**T_1**	**T_2**	**T_1**	**T_2**
C_0 (Control)	0.540	0.670	0.430	0.460	0.330	0.457	0.630	0.670	0.600	0.654
C_1 (6000 ppm)	0.690	0.710	0.530	0.610	0.370	0.445	0.720	0.837	0.710	0.812

C_2 (7000 ppm)	0.739	0.950	0.634	0.850	0.436	0.613	0.921	1.130	0.833	0.989
C_3 (8000 ppm)	0.829	0.980	0.710	0.890	0.587	0.740	1.035	1.600	0.943	1.320
C_4 (9000 ppm)	0.970	1.023	0.850	0.950	0.677	0.790	1.380	1.789	1.170	1.254
S.E.(m)±	0.004									
C.D. $_{0.05}$	0.013									

Conclusion

On the basis of the experimental findings, it can be concluded that the IBA @ 9000ppm concentration and sphagnum moss + Cocopeat as a rooting medium and August month, is the time of air-layering individually and in combination is the best and can be used for mass multiplication of true-to-type plants of Guava cv. Shweta through air-layering.

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