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Effect of rooting media and IBA treatments on shoot and leaf production of terminal cuttings in guava (*Psidium guajava* L.) cv. Taiwan Pink

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ABSTRACT

The purpose of this study was to evaluate the effect different *concentrations of Indole-3-butyric acid i.e., 250 ppm, 500 ppm, 750 ppm in solution form and 1500 ppm, 3000 ppm and 6000 ppm in powdered form planted in different rooting media i.e., coco peat, vermiculite and saw dust on terminal cuttings on guava cv. Taiwan Pink. Among the three different rooting media, coco peat showed the best response and among the six different Indole-3-butyric acid concentrations, 3000 ppm gave the highest values in all the intervals of parameters viz., number of shoots per cutting, number of leaves per cutting, leaf area per cutting and total leaf chlorophyll content.*

Keywords **:** Guava, IBA, rooting media and terminal cuttings

Guava (*Psidium guajava* L.), the "poor man's fruit" or "apple of the tropics" belongs to tropical and subtropical climate. It is native to the Tropical America stretching from Mexico to Peru. Guava belongs to Family: Myrtaceae. The genus *Psidium* contains 150 species, most of which are fruit bearing trees. The basic chromosomal number of guava is 11. Most of the cultivars are diploid (2n=22), but some are natural and artificial triploids (2n=33), these are generally produce seedless fruits (Jaiswal and Nasim, 1992). In terms of production, guava ranked fifth after banana, mango, citrus and papaya in India (NHB, 2015). It has attained popularity in the dietary list of common people of our country owing to nutritious, deliciousness, pleasing flavour and availability for a longer period of time in a year at moderate price. It has great demand as a raw material in the processing industries and leads to earn good foreign exchange (Purseglove, 1977).

The main reasons for its popularity are prolific bearing nature and remunerative yields even without much care justifying its name as Poor man's apple. Guava fruits are used for both fresh consumption and processing. Guava is one of the richest sources of vitamin C containing 2 to 5 times more than that in oranges.

Guava is propagated commercially by means of both vegetative and direct seedling methods, but the fruits of commercial grade can be obtained only when plants are propagated through vegetative progeny. Vegetative propagation of guava can be done by budding (Kaundal *et al*., 1987), air layering (Manna *et al*., 2004), stooling (Pathak and Saroj, 1988) and inarching (Mukherjee and Majumdar, 1983). In direct seedling method, progeny are not uniform due to segregation and recombination of different characters. Moreover, the plants propagated through seeds come to bearing much later than the plants propagated through cuttings. Clonal propagation of guava is the possible approach to ascertain uniformity among the progeny and to maintain good quality fruits (Giri *et al.*, 2004). Initially, true-to-type planting material is a basic need in guava orchards to ensure both quality and quantity of guava fruits (Singh *et al.*, 2005).

Propagation through air layering in guava is a time consuming and hence necessitated a search for alternate but effective means of vegetative propagation. Of late, several woody perennials are successfully and rapidly propagated through use of terminal cuttings. In this context, rapid methods of propagation become very important when planting material is limited due to scarcity of a clone or varieties or due to sudden expansion in acreage. Thus it leads to an idea about the utilization of terminal cuttings, rapid propagation method in guava.

MATERIALS AND METHODS

An experiment was conducted on the effect of rooting media and IBA treatments on the root and shoot parameters of guava cv. Taiwan Pink at Kadiyaddha village, under the supervision of College of Horticulture, Dr. Y.S.R. Horticultural University, Venkataramannagudem, West Godavari District, Andhra Pradesh. The experiment was laid out in Factorial Completely Randomized Design with two factors *viz.,* Rooting media (3 levels) and IBA treatments (6 levels), making eighteen treatment combinations which were replicated twice. Terminal cuttings were planted in protrays consisting of rooting media *viz.,* coco peat, vermiculite and saw dust after treating with IBA at 250, 500, 750 ppm in solution form for 5 minutes and 1500, 3000, 6000 ppm in powder form. The terminal cuttings were kept under mist chamber for 35 days, under shade net for 10 days and after that, the rooted terminal cuttings were planted in 8 x10 inches poly bag with potting mixture consisting of Red soil and FYM in 2:1 proportion

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and kept under open conditions, the observations on various parameters at 45, 90 and 135 DAP were recorded as presented below.

RESULTS AND DISCUSSION

Number of shoots per cutting

The differences observed in the number of shoots per cutting at 45, 90 and 135 DAP were found significant by the influence of different rooting media, IBA treatments and their interactions. The mean number of shoots per cutting increased from 1.43 at 45 DAP to 4.07 at 135 DAP (Table 1).

At 135 DAP, among the three different rooting media, coco peat exhibited significantly higher number of shoots per cutting (4.41) followed by vermiculite (4.17) and the lowest number of shoots per cutting (3.63) was recorded by the saw dust.

The number of shoots per cutting was highest (4.60) with the terminal cuttings treated with powder dip of IBA at 3000 ppm followed by (4.39) those treated with IBA powder dip @ 6000 ppm, while the minimum (3.54) number of shoots per cutting was observed with solution dip of IBA @ 750 ppm.

There existed a significant interaction between rooting media and IBA treatments for number of shoots per cutting. Significantly maximum number of shoots per cutting (4.82) was found in the terminal cuttings planted in coco peat + dipping in IBA powder at 3000 ppm concentration (M_1G_5).

Terminal cuttings planted in coco peat showed maximum number of shoots which might be due to decomposition of lignins present in coco peat resulting in the formation of humic fractions (Kadalli *et al.,* 2001). Coco peat had a property of retaining more nutrients and also helpful in increasing the number of shoots per cutting as reflected in the present study. The cuttings treated with IBA 3000 ppm recorded greater number of shoots per cutting which could be attributed to the enhancement of physiological functions in the cuttings favourably (Iqbal *et al*., 1999) at this concentration.

Earliness to sprouting, increase in the number of sprouts and sprout length might be due to better utilization of stored carbohydrates, nitrogen and other factors with the aid of growth regulators (Chandramouli, 2001). Such observations were also made by Ismail and Asghar (2007) in *Ficushawaii*.

Number of leaves per cutting

The average number of leaves per cutting increased from 5.55 at 45 DAP to 20.57 at 135 DAP which was presented in table 2.

At 135 DAP, terminal cuttings planted in coco peat medium showed significantly maximum number of leaves (24.21) followed by the terminal cuttings planted in vermiculite (20.95), while the minimum number of leaves (16.56) was observed in the terminal cuttings planted in saw dust.

The maximum number of leaves per cutting was found in the terminal cuttings treated with IBA powder @ 3000 ppm (25.40) which was followed by terminal cuttings treated with 6000 ppm of IBA concentration (23.51), while the lowest number of leaves (16.33) was observed in terminal cuttings treated with solution dip with IBA @ 750 ppm.

There existed a significant interaction between rooting media and IBA treatments for the number of leaves per cutting. Significantly maximum number of leaves per cutting (30.14) was found in terminal cuttings planted in coco peat medium + treatment with IBA powder @ 3000 ppm (M_1G_5).

The maximum number of leaves per cutting was produced in terminal cuttings planted in coco peat, which might be due to superior root development in this medium. It could be in turn attributed to the higher moisture retention capacity, porosity and nutrient status of coir pith (Nagarajan *et al.,* 1985) as proven in coco peat medium. Maximum number of leaves was produced in cuttings treated with IBA 3000 ppm which might be due to activation of shoot growth leading to an increased number of nodes that leads to development of more number of leaves. The increase in number of leaves per cutting might be due to the reason that the plant might diverted maximum assimilate quantities to the leaf buds, since the leaves are one of the production sites of natural auxins in them besides being very important for vital processes like photosynthesis and respiration (Wahab *et al.,* 2001).

IBA at 4000 ppm produced healthier, lengthy roots which might have helped in the absorption of water and nutrients. Better nutrient absorption could have encouraged production of more number of leaves by the cuttings. The increase in number of leaves with IBA 4000 ppm might be due to more number of roots, plant height and branches per cutting (Ismail and Asghar, 2007). The above results are in accordance with by Wahab *et al.* (2001), Malik *et al.* (2013) in guava. Similar results were reported by Riaz *et al*. (2007) in hardwood cuttings of kiwi.

Leaf area per cutting (cm^2)

In the present investigation, rooting media, IBA treatments as well as their interactions were found to have significantly influenced the leaf area per cutting. The mean leaf area per cutting increased from 15.46 cm^2 at 45 DAP to 164.60 cm^2 at 135 DAP (Table 3).

The terminal cuttings planted in the coco peat showed significantly maximum leaf area per cutting (193.66 cm^2) at 135 DAP and followed by those terminal cuttings

Table 1 : Effect of rooting media and IBA treatments on number of shoots per cutting of terminal cuttings in guava cv. Taiwan Pink

IBA treatments (G)	Number of shoots per cutting											
	At 45 Days			Mean	At 90 Days			Mean	At 135 Days			Mean
	Rooting media (M)				Rooting media (M)				Rooting media (M)			
	M_1	M_2	M_3		M_1	M_2	M_3		M_1	M_2	M_3	
250 ppm (G_1)	1.50	1.60	1.30	**1.47**	3.08	2.58	1.94	**2.53**	4.34	4.13	3.47	**3.98**
500 ppm (G_2)	1.60	1.72	1.44	**1.58**	3.04	2.55	1.91	**2.50**	4.14	3.93	3.15	**3.74**
750 ppm (G_3)	2.00	1.80	1.58	**1.79**	2.98	2.47	1.84	**2.43**	4.02	3.65	2.97	**3.54**
1500 ppm (G_4)	1.52	1.42	1.32	**1.42**	3.55	2.77	2.10	**2.80**	4.43	4.25	3.84	**4.17**
3000 ppm (G_5)	1.14	1.11	1.00	**1.08**	3.64	2.84	2.20	**2.89**	4.82	4.64	4.34	**4.60**
6000 ppm (G_6)	1.23	1.25	1.24	**1.24**	3.61	2.81	2.16	**2.86**	4.71	4.44	4.03	**4.39**
Mean	**1.50**	**1.48**	**1.31**	**1.43**	**3.31**	**2.67**	**2.02**	**2.67**	**4.41**	**4.17**	**3.63**	**4.07**
Factor	**M**	**G**	**M x G**		**M**	**G**	**M x G**		**M**	**G**	**M x G**	
SEm (±)	**0.01**	**0.02**	**0.04**		**0.01**	**0.02**	**0.03**		**0.01**	**0.01**	**0.02**	
LSD (0.05)	**0.04**	**0.06**	**0.11**		**0.03**	**0.05**	**0.08**		**0.02**	**0.03**	**0.05**	

G_1, G_2 and G_3 are treatments of guava terminal cuttings with IBA in solution form. G_4, G_5 and G_6 are treatments of guava terminal cuttings with IBA in powder form.

Table 2 : Effect of rooting media and IBA treatments on number of leaves per cutting of terminal cuttings in guava cv. Taiwan Pink

IBA treatments (G)	Number of leaves per cutting											
	45 Days			Mean	90 Days			Mean	135 Days			Mean
	Rooting media (M)				Rooting media (M)				Rooting media (M)			
	M_1	M_2	M_3		M_1	M_2	M_3		M_1	M_2	M_3	
250 ppm (G_1)	6.44	5.55	4.85	**5.61**	15.24	14.27	9.33	**12.94**	21.73	20.68	15.36	**19.25**
500 ppm (G_2)	6.56	5.67	5.14	**5.78**	15.20	14.22	9.30	**12.90**	20.28	18.42	14.75	**17.81**
750 ppm (G_3)	6.85	5.88	5.28	**6.00**	15.15	14.15	9.26	**12.85**	19.61	15.80	13.60	**16.33**
1500 ppm (G_4)	6.33	5.34	4.64	**5.43**	18.88	17.48	15.72	**17.36**	25.63	21.49	16.30	**21.14**
3000 ppm (G_5)	6.13	5.16	4.26	**5.18**	18.96	17.57	15.83	**17.45**	30.14	25.85	20.23	**25.40**
6000 ppm (G_6)	6.23	5.25	4.38	**5.28**	18.92	17.53	15.77	**17.40**	27.88	23.48	19.17	**23.51**
Mean	**6.42**	**5.47**	**4.76**	**5.55**	**17.06**	**15.87**	**12.53**	**15.15**	**24.21**	**20.95**	**16.56**	**20.57**
Factor	**M**	**G**	**M x G**		**M**	**G**	**M x G**		**M**	**G**	**M x G**	
SEm (±)	**0.006**	**0.008**	**0.014**		**0.005**	**0.008**	**0.013**		**0.115**	**0.163**	**0.282**	
LSD (0.05)	**0.018**	**0.024**	**0.043**		**0.016**	**0.023**	**0.040**		**0.342**	**0.484**	**0.838**	

G_1, G_2 and G_3 are treatments of guava terminal cuttings with IBA in solution form. G_4, G_5 and G_6 are treatments of guava terminal cuttings with IBA in powder form.

Table 3 : Effect of rooting media and IBA treatments on leaf area per cutting of terminal cuttings in guava cv. Taiwan Pink

IBA treatments (G)	Leaf area per cutting (cm^2)											
	45 Days			Mean	90 Days			Mean	135 Days			Mean
	Rooting media (M)				Rooting media (M)				Rooting media (M)			
	M_1	M_2	M_3		M_1	M_2	M_3		M_1	M_2	M_3	
250 ppm (G_1)	25.42	18.41	10.28	**18.03**	106.68	99.86	65.31	**90.61**	173.80	165.44	122.84	**154.03**
500 ppm (G_2)	27.39	20.56	14.28	**20.74**	106.40	99.54	65.07	**90.33**	162.24	147.36	117.96	**142.52**
750 ppm (G_3)	33.25	26.15	21.73	**27.04**	106.05	99.05	64.79	**89.96**	156.84	126.36	108.76	**130.65**
1500 ppm (G_4)	15.32	13.20	8.37	**12.29**	132.13	122.36	110.04	**121.51**	205.00	171.92	130.36	**169.09**
3000 ppm (G_5)	6.71	4.35	4.41	**5.15**	132.69	122.99	110.78	**122.15**	241.08	206.80	161.84	**203.24**
6000 ppm (G_6)	14.06	7.95	6.46	**9.49**	132.44	122.68	110.36	**121.82**	223.00	187.80	153.36	**188.05**
Mean	**20.35**	**15.10**	**10.92**	**15.46**	**119.40**	**111.08**	**87.72**	**106.06**	**193.66**	**167.61**	**132.52**	**164.60**
Factor	**M**	**G**	**M x G**		**M**	**G**	**M x G**		**M**	**G**	**M x G**	
SEm (±)	**0.11**	**0.15**	**0.27**		**0.04**	**0.05**	**0.09**		**0.92**	**1.30**	**2.25**	
LSD (0.05)	**0.32**	**0.46**	**0.79**		**0.11**	**0.16**	**0.28**		**2.74**	**3.87**	**6.70**	

G_1, G_2 and G_3 are treatments of guava terminal cuttings with IBA in solution form. G_4, G_5 and G_6 are treatments of guava terminal cuttings with IBA in powder form.

Table 4 : Effect of rooting media and IBA treatments on total leaf chlorophyll content of terminal cuttings in guava cv. Taiwan Pink

IBA treatments (G)	Total leaf chlorophyll content (mg g^{-1} fresh weight)											
	45 Days			Mean	90 Days			Mean	135 Days			Mean
	Rooting media (M)				Rooting media (M)				Rooting media (M)			
	M_1	M_2	M_3		M_1	M_2	M_3		M_1	M_2	M_3	
250 ppm (G_1)	0.80	0.54	0.55	**0.63**	1.53	1.28	1.27	**1.36**	1.98	1.70	1.59	**1.75**
500 ppm (G_2)	0.64	0.39	0.31	**0.44**	1.31	1.04	1.07	**1.14**	1.47	1.45	1.37	**1.43**
750 ppm (G_3)	0.43	0.22	0.18	**0.27**	0.90	0.94	0.66	**0.83**	1.37	1.36	1.21	**1.31**
1500 ppm (G_4)	0.99	0.72	0.56	**0.76**	1.65	1.42	1.27	**1.45**	2.10	1.84	1.79	**1.91**
3000 ppm (G_5)	1.29	1.08	0.94	**1.10**	1.98	1.88	1.70	**1.85**	2.38	2.26	2.17	**2.26**
6000 ppm (G_6)	1.11	0.94	0.78	**0.94**	1.84	1.19	1.54	**1.52**	2.21	1.95	1.87	**2.00**
Mean	**0.88**	**0.65**	**0.55**	**0.69**	**1.54**	**1.29**	**1.25**	**1.36**	**1.92**	**1.76**	**1.66**	**1.78**
Factor	**M**	**G**	**M x G**		**M**	**G**	**M x G**		**M**	**G**	**M x G**	
SEm (±)	**0.011**	**0.016**	**0.027**		**0.011**	**0.016**	**0.028**		**0.014**	**0.020**	**0.034**	
LSD (0.05)	**0.033**	**0.046**	**0.080**		**0.034**	**0.048**	**0.083**		**0.042**	**0.059**	**0.102**	

G_1, G_2 and G_3 are treatments of guava terminal cuttings with IBA in solution form. G_4, G_5 and G_6 are treatments of guava terminal cuttings with IBA in powder form.

planted in vermiculite medium (167.61 cm^2), significantly minimum (132.52 cm^2) leaf area per cutting was recorded by the terminal cuttings planted in saw dust.

Among the IBA treatments, the highest leaf area per cutting (203.24 cm^2) was noticed in the terminal cuttings treated with IBA powder @ 3000 ppm followed by (188.05 cm^2) terminal cuttings treated with IBA powder @ 6000 ppm, while the lowest leaf area per cutting (130.65 cm^2) was observed with solution dip of IBA @ 750 ppm.

There existed a significant interaction between rooting media and IBA treatments for leaf area per cutting. Significantly maximum leaf area per cutting (241.08 cm^2) was found in terminal cuttings planted in coco peat medium + treatment with IBA powder @ 3000 ppm (M_1G_5).

The highest leaf area was recorded in terminal cuttings planted in coco peat which might be attributed to the better aeration, drainage conditions and moisture retentive capability (Khayyat *et al.,* 2007). The cuttings treated with IBA powder @ 3000 ppm recorded the highest leaf area than the cuttings treated with IBA powder @ 6000 ppm. Production of high number of roots and also shoots as well sustaining them over a period of time between 45 and 135 days after planting of cutting is indicative for the fact that the energy metabolism in the cells would have been active in such cuttings. Nutrient uptake with healthy and strong root system could have boosted the rate of photosynthesis gaining much stronger position to nurture the growing leaves and expanding them leading to a maximum leaf area per cutting (Ismail and Asghar, 2007). These results are in line with Ismail and Asghar (2007) and Sukhjit (2015) in hardwood cuttings of peach.

Total leaf chlorophyll content (mg g^{-1} fresh weight)

The total leaf chlorophyll content varied significantly by the influence of rooting media, IBA treatments as well as their interactions at 45, 90 and 135 DAP in guava (Table 4). There was an increase in the total leaf chlorophyll content from 0.69 mg g^{-1} fresh weight at 45 DAP to 1.78 mg g^{-1} fresh weight at 135 DAP.

It was observed that the maximum total leaf chlorophyll content per cutting at 135 DAP was recorded in terminal cuttings planted in coco peat medium (1.92 mg g^{-1}fresh weight) followed by those planted in the vermiculite (1.76 mg g^{-1}fresh weight) and minimum total leaf chlorophyll content (1.66 mg g^{-1}fresh weight) was recorded in terminal cuttings planted in saw dust.

Among IBA treatments, the highest total leaf chlorophyll content (2.26 mg g^{-1}fresh weight) was noticed in terminal cuttings treated with IBA powder @ 3000 ppm followed (2.00 mg g^{-1}fresh weight) by those treated with IBA powder @ 6000 ppm and the lowest total leaf chlorophyll content was observed in terminal cuttings of IBA solution dip @ 750 ppm (1.31 mg g^{-1} fresh weight).

There existed a significant interaction between rooting media and IBA treatments for maximum total leaf chlorophyll content. Significantly maximum total leaf chlorophyll content (2.38 mg g^{-1}fresh weight) was found in terminal cuttings planted in coco peat medium + treatment with IBA powder @ 3000 ppm (M_1G_5).

The terminal cuttings treated with IBA powder @ 3000 ppm recorded maximum total leaf chlorophyll content than others. The increased leaf area with increased concentrations of auxins might have activated the process of photosynthesis resulting in more chlorophyll content of leaves per cutting. Growth hormones have been shown to play an important role in regulating the amount and distribution of assimilates in plants (Galston and Davies, 1969). Ratnakumari (2014) observed that cuttings with more number of leaves enhanced nutrients uptake thereby increased the photosynthates production and provided sufficient food contents for the metabolic activities of the plants by means of mounting the levels of light harvesting pigments especially chlorophylls. Similar results were reported by Kaur *et al.* (2002) in grapes; Sivaci and Yalcin (2006) in *apple.* These results are in line with Oscar and Javier (2014) in cape gooseberry.

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