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Effect of rooting media and IBA treatments on root to shoot ratio in terminal cuttings of guava (*Psidium guajava*) cv. Taiwan pink

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Abstract
The effect of Rooting media, IBA treatments as well as their interactions was found significant on the root and shoot parameters of guava terminal cuttings. Among the three different Rooting media i.e., coco peat, vermiculite and saw dust, coco peat registered highest values regarding fresh weight of roots, dry weight of roots, fresh weight of shoots, dry weight of shoots and root to shoot ratio of terminal cuttings in guava cv. Taiwan Pink. Among Indole-3-Butyric Acid treatments i.e., 250, 500, 750 ppm in solution form for 5 minutes and 1500, 3000, 6000 ppm in powder form, 3000 ppm of IBA performed the best.

Keywords: Rooting media, IBA, terminal cuttings, guava

Introduction
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. It has attained a respectable place and popularity amongst the dietary list of common people in our country owing to nutritious, deliciousness, pleasing flavour and availability for a longer period of time during the year at moderate price. It has great demand as a table fruit and as a raw material for the processing industries, leads to earn good foreign exchange (Purseglove, 1977) [13].

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) [6], air layering (Manna *et al*., 2004) [8], stooling (Pathak and Saroj, 1988) [11] and inarching (Mukherjee and Majumdar, 1983) [10]. 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) [4].

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.

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

Results and Discussion

Fresh weight of roots per cutting (g)

Fresh weight of roots varied significantly due to rooting medium, IBA treatments as well as their interactions at 135 DAP in guava which was presented in Table 1. The terminal cuttings planted in the coco peat medium had the maximum fresh weight of roots (5.83 g) followed by vermiculite medium (4.40 g) whereas, the minimum fresh weight of roots was observed in the saw dust medium (2.00 g). Dipping in IBA powder @ 3000 ppm strength resulted in the maximum fresh weight of roots (5.08 g) followed by IBA powder dip @ 6000 ppm (4.63 g) while the minimum fresh weight of roots (3.25 g) was registered by the solution dip with IBA @ 750 ppm.

Dry weight of roots per cutting (g)

Significant variations were observed in dry weight of roots at 135 DAP by the influence of rooting media, IBA treatments as well as their interactions which was presented in Table 2. The cuttings planted in the coco peat medium recorded a higher dry weight of roots (1.26 g), followed by vermiculite medium (1.10 g) and minimum dry weight of roots (0.49 g) observed in terminal cuttings planted in saw dust medium. Treatment with powder dip of IBA @ 3000 ppm recorded the maximum (1.58 g) dry weight of roots per cutting and followed by (1.40 g) powder dip of IBA @ 6000 ppm and minimum (0.43 g) dry weight of roots per cutting observed with solution dip of IBA @ 750 ppm.

There was significant interaction between rooting media and IBA treatments for dry weight of roots. The highest dry weight of roots (1.96 g) was recorded by the terminal cuttings planted in coco peat + dipping in IBA powder @ 3000 ppm (M_1G_5).

The studies made by Mayer *et al*. (2015) [9] also confirmed the same since they recorded maximum dry weight of roots in 3000 ppm of IBA treatment better than in 6000 ppm IBA with softwood cuttings of peach under intermittent mist system.

Fresh weight of the shoots (g)

The differences observed among the values of fresh weight of shoots by the influence of rooting media, IBA treatments as well as their interactions was found to be significant at 135 DAP in terminal cuttings guava cv. Taiwan Pink which was presented in Table 3. The terminal cuttings planted in the coco peat medium had the maximum fresh weight of shoots (18.87 g) followed by those planted in vermiculite (17.85 g). The minimum fresh weight was observed in saw dust (15.57 g). In this parameter IBA powder at a concentration of 3000 ppm performed the best with a high fresh weight (20.17 g) of shoots followed by those treated terminal cuttings with IBA powder @ 6000 ppm (19.08 g) and the minimum fresh weight of shoots was observed with solution dip of IBA 750 ppm (14.66 g).

There existed a significant interaction between rooting media and IBA treatments for fresh weight of shoots. Significantly maximum fresh weight of shoots (21.20 g) was found in terminal cuttings planted in coco peat medium + treatment with IBA powder @ 3000 ppm (M_1G_5).

Dry weight of shoots (g)

The dry weight of shoots at 135 DAP significantly varied due to rooting media, IBA treatments as well as their interactions which was presented in Table 4. The terminal cuttings planted in coco peat medium recorded significantly maximum dry weight (4.50 g) followed by those terminal cuttings planted in vermiculite (4.30 g). Minimum dry weight of shoot was obtained in terminal cuttings planted in sawdust (3.92 g). Application of IBA powder at a concentration of 3000 ppm performed the best with the highest dry weight of shoots (4.75 g) followed by those treated with IBA powder @ 6000 ppm (4.58 g) while the minimum shoot dry weight (3.63 g) was observed in solution dip with IBA at 750 ppm. These results are in accordance with Thayamini (2015) [17] in dragon fruit.

There was a significant interaction between rooting media and IBA treatments for maximum dry weight of shoots. Significantly maximum dry weight of shoots (5.10 g) was found in terminal cuttings planted in coco peat medium + treatment with IBA 3000 ppm (M_1G_5).

Root to shoot ratio (on dry weight basis)

The root to shoot ratio varied significantly by the influence of rooting media, IBA treatments as well as their interactions at 135 DAP which was presented in Table 5. The terminal cuttings planted in coco peat medium had significantly highest root to shoot ratio (0.27) followed by vermiculite (0.23). Lowest root to shoot ratio was observed in saw dust (0.11). Among IBA treatments, IBA powder dip @ 3000 ppm performed the best with the maximum root to shoot ratio (0.32) followed by those terminal cuttings treated with powder dip of IBA @ 6000 ppm (0.29) while minimum root to shoot ratio (0.11) was noticed with solution dip of IBA @ 750 ppm concentration.

The interaction between rooting media and IBA treatments were also found to be significant for root to shoot ratio. Significantly maximum root to shoot ratio (0.40) was found in terminal cuttings planted in coco peat medium + treatment with IBA powder dip @ 3000 ppm (M_1G_5).

A treatment combination would be more effective when it takes more time to show a reasonable number of shoots per cutting, because it would have triggered more rooting cofactors and diverted more energy for promoting root development during initial stages thus recording lesser number of shoots shortly after planting (Goudappa, 2016) [15]. It is the sustainable development of shoot sprouts that is more important rather than rapid rate of shoot development just after planting the cuttings for experimentation (Agbo and Obi, 2008) [2]. In the present study, the terminal cuttings planted in coco peat medium, recorded lower number of shoots per cutting during the initial stages (45 DAP) but sustained those shoots till the end probably because there was much balance between root development and shoot development.

Thus the merit of such treatments was exhibited in stability by 90 days after planting the cuttings in both root and shoot parameters in spite of backlogged situation in respect of shoot parameters in initial stages of experimentation.

It is interesting to note that there might be a reverse trend had the root to shoot ratio could be worked out in the initial stages. But because the roots could not be disturbed in more number of cuttings during the experimentation, the root to shoot ratio could be recorded only at 135 DAP which was in association with significantly better treatments in respect of both root and shoot parameters at that stage. The highest root to shoot ratio was recorded in terminal cuttings planted in

coco peat might be due to well development of root system relative to shoot system (Ratnakumari, 2014) [14].

Discussion

The interaction between rooting media and IBA treatments for fresh weight of roots was tested significant. Maximum fresh weight of roots (7.23 g) was found in the terminal cuttings planted in coco peat + dipping in IBA powder at 3000 ppm (M_1G_5).

The maximum fresh weight of roots was recorded by the terminal cuttings planted in coco peat which might be due to better aeration and drainage conditions and water maintenance capability (Khayyat *et al.,* 2007) [7]. IBA 3000 ppm recorded the maximum fresh weight of roots due to production of more number of roots as seen with the result on number of roots in the present study. The results are in line with Wahab *et al*. (2001) [18] in guava and Riaz *et al*. (2007) [15] in kiwi.

The studies made by Mayer *et al*. (2015) [9] also confirmed the same since they recorded maximum dry weight of roots in 3000 ppm of IBA treatment better than in 6000 ppm IBA with softwood cuttings of peach under intermittent mist system.

The terminal cuttings planted in coco peat gave the maximum fresh weight of shoots per cutting because coco peat increased the aeration, water holding capacity and nutrient retention at an optimum level essential for the early growth of plants (Cresswell, 1997) [3] resulting in increased number of leaves, length and number of shoots which helps in increased fresh weight of shoots. Maximum fresh weight of shoots per cutting was recorded when cuttings were treated with IBA powder @ 3000 ppm which might be because of an increase in the number of leaves, length and number of shoots per cutting.

Among the rooting media, terminal cuttings planted in coco peat recorded the maximum dry weight of shoot. It could be attributed due to increase in number of leaves, length and number of shoots per cutting. Among IBA treatments, IBA powder dip @ 3000 ppm performed the best. This might be due to the reason that auxins activated shoot growth could have elongated the stems and leaves through cell division accounting for a higher dry weight of shoot (Abraham, 1996) [1]. The promoting effect of IBA on shoot parameters can be attributed to the reason that the better rooting coupled with a better leaf growth might have led to a higher shoot sprouts and supported their development (Paul and Aditi, 2009) [12]. As discussed earlier IBA at 3000 ppm concentration favored many shoot parameters in positive direction and at the same time sustained the root strength to continue the vigour and vitality in taking up the nutrients as well as moisture from the growing media. The integrated effect over root and shoot parameters established the merit of IBA powder dip @ 3000 ppm concentration.

Conclusion

The study revealed that, among the three different Rooting media *i.e.*, coco peat, vermiculite and saw dust, coco peat registered highest values regarding fresh weight of roots, dry weight of roots, fresh weight of shoots, dry weight of shoots and root to shoot ratio of terminal cuttings in guava cv. Taiwan Pink. Among IBA treatments *i.e.*, 250, 500, 750 ppm in solution form for 5 minutes and 1500, 3000, 6000 ppm in powder form, 3000 ppm of IBA performed the best. It could be quite safe to recommend that clonal propagation of guava through Terminal cutting is reliable for nursery plants production as it is quick, easy and economical method of vegetative propagation.

Table 1: Effect of rooting media and IBA treatments on fresh weight of roots per cutting (g) of terminal cuttings in guava cv. Taiwan Pink at 135 DAP

IBA treatments (G)	Fresh weight of roots per cutting (g)			Mean
	Rooting media (R)			
	Coco peat(M_1)	Vermiculite(M_2)	Saw dust(M_3)	
250 ppm (G_1)	5.32	4.18	1.94	3.81
500 ppm (G_2)	5.09	3.60	1.80	3.49
750 ppm (G_3)	4.86	3.27	1.64	3.25
1500 ppm (G_4)	5.72	4.78	2.07	4.19
3000 ppm (G_5)	7.23	5.64	2.38	5.08
6000 ppm (G_6)	6.77	4.93	2.20	4.63
Mean	5.83	4.40	2.00	4.08
Factor	M	G	M x G	
S Em±	0.01	0.01	0.01	
CD at 5%	0.03	0.02	0.03	

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 dry weight of roots per cutting (g) of terminal cuttings in guava cv. Taiwan Pink.

IBA treatments (G)	Dry weight of roots per cutting (g)			Mean
	Rooting media (R)			
	Coco peat(M_1)	Vermiculite(M_2)	Saw dust(M_3)	
250 ppm (G_1)	1.12	0.97	0.36	0.81
500 ppm (G_2)	0.85	0.54	0.31	0.56
750 ppm (G_3)	0.70	0.36	0.23	0.43
1500 ppm (G_4)	1.25	1.02	0.53	0.93
3000 ppm (G_5)	1.96	1.94	0.85	1.58
6000 ppm (G_6)	1.73	1.79	0.70	1.40
Mean	1.26	1.10	0.49	0.95
Factor	M	G	M x G	
S Em±	0.008	0.011	0.008	
CD at 5%	0.023	0.032	0.055	

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 fresh weight of shoots per cutting (g) of terminal cuttings in guava cv. Taiwan Pink.

IBA treatments (G)	Fresh weight of shoots per cutting (g)			Mean
	Rooting media (R)			
	Coco peat(M_1)	Vermiculite(M_2)	Saw dust(M_3)	
250 ppm (G_1)	18.24	17.13	15.53	16.96
500 ppm (G_2)	17.03	16.53	13.14	15.56
750 ppm (G_3)	16.53	15.24	12.23	14.66
1500 ppm (G_4)	19.76	18.22	16.43	18.14
3000 ppm (G_5)	21.20	20.47	18.86	20.17
6000 ppm (G_6)	20.46	19.53	17.25	19.08
Mean	18.87	17.85	15.57	17.43
Factor	M	G	M x G	
S Em±	0.01	0.01	0.01	
CD at 5%	0.02	0.02	0.04	

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 dry weight of shoots per cutting (g) of terminal cuttings in guava cv. Taiwan Pink.

IBA treatments (G)	Dry weight of shoots per cutting (g)			Mean
	Rooting media (R)			
	Coco peat(M_1)	Vermiculite(M_2)	Saw dust(M_3)	
250 ppm (G_1)	4.36	4.24	3.83	4.14
500 ppm (G_2)	4.13	4.00	3.65	3.92
750 ppm (G_3)	3.81	3.65	3.43	3.63
1500 ppm (G_4)	4.77	4.47	4.09	4.44
3000 ppm (G_5)	5.10	4.84	4.32	4.75
6000 ppm (G_6)	4.87	4.64	4.22	4.58
Mean	4.50	4.30	3.92	4.24
Factor	M	G	M x G	
S Em±	0.01	0.01	0.01	
CD at 5%	0.02	0.02	0.04	

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 5: Effect of rooting media and IBA treatments on on root to shoot ratio (on dry weight basis) of terminal cuttings in guava cv. Taiwan Pink.

IBA treatments (G)	Root to shoot ratio (on dry weight basis)			Mean
	Rooting media (R)			
	Coco peat(M_1)	Vermiculite(M_2)	Saw dust(M_3)	
250 ppm (G_1)	0.25	0.22	0.09	0.18
500 ppm (G_2)	0.20	0.13	0.08	0.13
750 ppm (G_3)	0.18	0.09	0.06	0.11
1500 ppm (G_4)	0.26	0.22	0.12	0.20
3000 ppm (G_5)	0.40	0.38	0.19	0.32
6000 ppm (G_6)	0.35	0.38	0.16	0.29
Mean	0.27	0.23	0.11	0.20
Factor	M	G	M x G	
S Em±	0.003	0.005	0.008	
CD at 5%	0.010	0.015	0.025	

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.

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