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Effect of Plant Growth Regulators on Rooting and Sprouting of Different Stem Cuttings of Guava (*Psidium guajava* L.) cv. Lucknow-49 under Mist Chamber Condition

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An experiment was conducted to study the effect of plant growth regulators on rooting and sprouting of different stem cuttings in guava under mist chamber condition at Horticultural College and Research Institute, Periyakulam, Tamil Nadu. Plant growth regulators *viz*., Indole-3-Butyric Acid (IBA), Indole-3-Acetic Acid (IAA) and Naphthalene Acetic Acid (NAA) were used at different concentrations and applied to softwood, semi hardwood and hardwood cuttings. The highest sprouting percentage (76.66 %) with early sprouting (19.10 days) was observed in softwood cutting treated with IBA 4000 ppm concentration. The highest number of leaves (25.80) at 90 days after planting was observed in hardwood cutting treated with IBA 4000 ppm concentration. The highest rooting percentage (74.44 %) was recorded in softwood cutting treated with IBA at 4000 ppm concentration. Softwood cutting treated with IBA 4000 ppm exhibited better rooting and sprouting performance as compared to NAA and IAA. Among the three stem cuttings, softwood cutting is an effective explant for faster multiplication.

Key words: Guava, Stem cutting, Indole-3-Acetic Acid, Indole-3-Butyric Acid and Naphthalene Acetic Acid

Guava (*Psidium guajava* L.), a "poor man's fruit" belongs to tropical and subtropical climate. The genus, *Psidium* contains 150 species, most of which are fruit bearing trees. The basic chromosomal number of guava is 2n=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). It has attained a respectable place and popularity among 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.

In India, it thrives well up to an altitude of 1515 m but the best quality guava is produced in Indo-Gangetic plains where low night temperature (10ºC) prevails during winter season. Besides its high nutritive value, it bears heavy crop every year and gives handsome economic returns. In recent years, guava is getting more popularity in the international trade due to its nutritional value and development of various processed products like jelly, jam, sharbat, ice-cream, cheese, canned fruit, RTS, nectar, squash and powders are prepared from guava fruits (Singh *et al.,* 2005). In India, guava is cultivated in an area of 2.6 lakh hectare with a production of 38.26 lakh tonnes and productivity of 14.71 tonnes per hectare during (NHB, 2016-17). It 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 method. 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. 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 vegetative means.

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 areas. Thus, it leads to an idea about the utilization of rapid propagation method in guava. The scientific research on utilization of cuttings in guava propagation is very meagre. With this background, the present study was undertaken to standardize the suitable type of cuttings and to study the effect of different plant growth regulators for better rooting in guava cuttings.

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Material and Methods

The experiment was conducted at Department of fruit crops, Horticultural College and Research Institute, Periyakulam, Tamil Nadu under mist chamber condition. The site is located within to geographical location of 10.07°N 77.33°E. It has an average elevation of 356 meters above mean sea level. Temperatures during summer reach a maximum of 40°C and a minimum of 26.3 °C, though temperatures over 43 °C are not uncommon. Winter temperature ranges between 29.6 and 18 °C. The average annual rainfall is about 135 cm. The experiment was taken up with three types of cuttings *viz*., softwood, semi hardwood and hardwood cuttings and taken from five years old guava variety Lucknow-49. The cuttings were taken from the healthy mother plants and uniform shoots were selected as propagation materials. Softwood and semi hardwood cuttings were taken from the current season growth with 3-4 nodes each. Hardwood cuttings were taken from one year old shoots which were cut to have 4-5 nodes each and length of cuttings used for planting was 20-22 cm. The nodal cuttings were treated with plant growth regulators by quick dip method for 5 seconds either with Indole-3-Butyric Acid (IBA), Indole-3-Acetic Acid (IAA) and Naphthalene Acetic Acid (NAA) in different concentrations. The cuttings were planted in the respective growth media consisted of sand, soil and well decomposed FYM in the ratio of 1:2:1 and kept under mist chamber condition. After planting, the necessary nursery management practices such as watering and weeding were applied as per the recommendation of Grima *et al*. (2011).

The study was conducted in a factorial experiment (softwood, semi hardwood and hardwood cuttings) in a factorial Completely Randomized Designs (FCRD) with two factors and was replicated thrice. Each treatment consisted of twenty cuttings and a total 200 cuttings were used in the study. Data were collected three months from the date of planting by gently uprooting the nodal cuttings as recommended by Yeboan *et al*. (2009). The parameters evaluated were number of days to bud sprouting, sprouting percentage, number of leaves per cuttings and rooting percentage were recorded and the collected data on different growth parameters were statistically analyzed by adopting the procedures suggested by Panse and Sukhatme (1995).

Results and Discussion

Effect of PGR on rooting percentage and number of days to bud sprouting in guava at 60 DAP

Significant differences were observed in different types of cuttings and growth regulators as well as their interactions on rooting percentage of guava cuttings (Table 1). The softwood cuttings (C_1) recorded the

Table 1. Effect of growth regulators and types of cuttings on rooting percentage (at 60 DAP) and number of days to bud Sprouting of guava cuttings

Growth regulators (T)	Rooting percentage (%)			Mean	Number of days to bud sprouting (days)			Mean
	Types of cuttings (C)				Types of cuttings (C)			
	Softwood Cuttings (C_1)	Semi Hardwood Cuttings (C_2)	Hardwood Cuttings (C_3)		Softwood Cuttings (C_1)	Semi Hardwood Cuttings (C_2)	Hardwood Cuttings (C_3)	
IBA 2000 ppm (T_1)	75.05	65.00	60.00	66.68	19.40	19.93	20.33	19.89
IBA 3000 ppm (T_2)	78.00	73.25	61.05	70.77	18.73	18.52	20.27	19.17
IBA 4000 ppm (T_3)	83.65	75.00	65.10	74.58	19.17	17.73	20.40	19.10
IAA 1000 ppm (T_4)	68.33	63.12	60.00	63.82	18.36	19.20	20.13	19.23
IAA 2000 ppm (T_5)	74.02	61.66	58.32	64.67	19.20	19.80	20.90	19.97
IAA 3000 ppm (T_6)	78.15	70.00	66.04	71.40	18.23	19.93	20.60	19.59
NAA 500 ppm (T_7)	73.33	63.71	55.00	64.01	19.40	19.47	20.47	19.78
NAA 1000 ppm (T_8)	66.66	68.05	58.12	64.28	20.20	19.05	20.20	19.82
NAA 1500 ppm (T_9)	66.00	70.00	63.30	66.43	19.32	18.60	21.33	19.75
Mean	73.69	67.75	60.77	67.40	19.11	19.14	20.51	19.59
Factor	C	T	C x T		C	T	C x T	
SE.d	0.34	0.60	1.03		0.29	NS	NS	
CD at 5%	0.69**	1.20**	2.08**		0.58**	NS	NS	

highest percentage of rooting (73.69 per cent) and the lowest rooting percentage (60.77 per cent) was recorded in hardwood cuttings (C_3). The effect of plant growth regulators on rooting percentage, IBA 4000 ppm (T_3) recorded the highest percentage (74.58 per cent) of rooting and the lowest percentage (63.82 per cent) of rooting was observed in IAA 1000 ppm (T_4).

In interactions, the highest rooting percentage (83.65 per cent) was observed in softwood cuttings with IBA 4000 ppm (C_1T_3) followed by (78.15 per cent) in softwood cuttings with IAA 3000 ppm (C_1T_6) and the lowest rooting percentage (55.00 per cent) was observed in hardwood cutting with NAA 500 ppm (C_3T_7). Exogenous application of auxin breaks starch in to simple sugars, which is needed to a greater extent for the production of new cells and for increased respiratory activity in the regeneration tissue at the time of initiation of new root primordia (Nanda, 1975). Presence of leaves on cuttings also could have helped in the initiation of roots (Newton *et al.,* 1992). Van der Krieken *et al.* (1993) reported that IBA have enhanced the rooting by increase of internal auxins. Treatment of cuttings with increasing concentrations of IBA coupled with endogenous auxins improves the percentage of rooting in cuttings as reported by Melgarejo *et al.* (2000). The present results were similar with the findings of Kareem *et al.* (2013) in guava propagation through softwood cuttings with 4000 ppm of IBA.

Table 2. Effect of growth regulators and types of cuttings on sprouting percentage (at 60 DAP) and number of leaves (at 30 DAP) in guava cuttings

Growth regulators (T)	Sprouting percentage (%) at 60 DAP			Mean	Number of leaves at 30 DAP			Mean
	Types of cuttings (C)				Types of cuttings (C)			
	Softwood Cuttings (C_1)	Semi Hardwood Cuttings (C_2)	Hardwood Cuttings (C_3)		Softwood Cuttings (C_1)	Semi Hardwood Cuttings (C_2)	Hardwood Cuttings (C_3)	
IBA 2000 ppm (T_1)	78.05	68.12	63.02	69.73	4.81	4.89	5.23	4.98
IBA 3000 ppm (T_2)	83.33	76.24	65.00	74.86	5.64	5.34	5.94	5.64
IBA 4000 ppm (T_3)	85.00	76.66	68.33	76.66	5.88	5.69	6.45	6.01
IAA 1000 ppm (T_4)	71.66	65.24	61.66	66.19	3.72	4.21	4.28	4.07
IAA 2000 ppm (T_5)	78.33	66.21	64.25	69.60	4.21	4.68	4.67	4.52
IAA 3000 ppm (T_6)	80.00	73.33	68.34	73.89	4.89	5.11	5.10	5.03
NAA 500 ppm (T_7)	76.66	62.11	58.21	65.66	3.22	4.55	4.12	3.96
NAA 1000 ppm (T_8)	68.21	70.00	60.22	66.14	3.73	4.97	4.35	4.35
NAA 1500 ppm (T_9)	70.54	71.66	66.00	69.40	4.46	5.24	4.98	4.89
Mean	76.86	69.95	63.89	70.24	4.51	4.96	5.01	4.83
Factor	C	T	C x T		C	T	C x T	
SE.d	0.50	1.00	1.34		0.04	0.06	0.11	
CD at 5%	0.87**	1.74**	2.32**		0.07**	0.13**	0.22**	

The significant difference on the different types of cuttings on number of days to bud sprout concomitant and their interactions was found to be non-significant. Lowest number of days was taken bud sprouting (19.11) from softwood cuttings (C_1) and the highest number of days (20.51) for taken for bud sprouting was from hardwood cuttings (C_3) were registered. Number of days for was found to be non-significant. The minimum number of days to bud sprouting was found in hardwood cuttings with IBA 4000 ppm. The findings of Rahman *et al.* (2004) concomitant with the result that the applied growth regulators had no significant development on shoot development. The bud sprouting was due to the food materials that are present inside the cuttings.

Effect of PGR on sprouting percentage and number of leaves in guava cuttings

Significant influence of types of cuttings and growth regulators and their interactions were observed in sprouting percentage (Table 2). Softwood cuttings (C_1) recorded the highest sprouting percentage (76.86 per cent) and the lowest (63.89 per cent) was recorded in hardwood cuttings (C_3). Among growth regulators, IBA 4000 ppm (T_3) recorded the highest sprouting percentage (76.66 per cent) followed by IBA 3000 ppm recorded the sprouting percentage of (74.86 per cent) and the lowest (65.66 per cent) of sprouting percentage was observed in NAA 500 ppm (T_7). The highest sprouting percentage (85.00

per cent) was observed in softwood cuttings with IBA 4000 ppm (C_1T_3) followed by IBA 3000 ppm recorded the sprouting percentage (83.33 per cent) of softwood cuttings and the lowest sprouting percentage (58.21 per cent) was observed in in hardwood cuttings with NAA 500 ppm (C_3T_7). Sprouting percentage was found maximum in softwood cuttings with IBA 4000 ppm (C_1T_3). Bud sprouting is mainly attributed to the quantum of stored carbohydrate in the cuttings. However, with auxin application to the cutting there is an increase in sprouting, highlighting the role of certain material produced in the roots, which are responsible for sprouting. These qualities facilitated for an early advantage of sprouting and gaining good amount of strength by terminal cuttings that helped further during the development of root system resulting in higher chances for their better field establishment. The results are in line up with the findings of Kareem *et al.* (2016) in guava softwood cuttings with IBA 4000 ppm.

Number of leaves at 30 DAP varied significantly due to types of cuttings and growth regulators as well as their interaction between themselves. Hardwood cuttings (C_3) recorded the highest number of leaves (5.01) and the lowest (4.51) was recorded in softwood cuttings (C_1). Among growth regulators, IBA 4000 ppm (T_3) recorded the highest number of leaves (6.01) followed by IBA 3000 ppm (5.64) and the lowest of number of leaves (3.96) was observed in NAA 500 ppm (T_7). Highest number of leaves (6.45) was observed in hardwood cuttings with IBA 4000 ppm (C_3T_3) followed by IBA 3000 ppm (5.94) and the lowest number of leaves (3.22) was observed in softwood cuttings with NAA 500 ppm (C_1T_7).

Effect of PGR on number of leaves in guava cuttings

There was significant difference in types of cuttings and growth regulators and their interactions for number of leaves on 60 DAP (Table 3). Hardwood cuttings (C_3) recorded the highest number of leaves (15.61) and the lowest number of leaves (12.18) was recorded in semi hardwood cuttings (C_2). Among growth regulators, IBA 4000 ppm (T_3) recorded the highest number of leaves (18.38) followed by IAA 2000 ppm (14.54) and the lowest number of leaves was (10.73) observed in NAA 500 ppm (T_7). The highest number of leaves (20.87) was observed in hardwood cuttings with IBA 4000 ppm (C_3T_3) followed by in softwood cuttings with IBA 4000 ppm (20.47) and lowest number of leaves (10.00) was observed in in semi hardwood cuttings with NAA 500 ppm (C_2T_7). There was also significant difference in types of cuttings and growth regulators and their interactions for number of leaves at 90 DAP. The hardwood cuttings (C_3) registered the highest number of leaves (21.08) and the lowest number of leaves (17.98) was recorded in semi hardwood cuttings (C_2). Among growth regulators, IBA 4000 ppm (T_3) recorded the highest number of leaves (25.71) followed by in IBA 3000 ppm (20.78) and the lowest number of leaves (15.15) was observed in NAA 500 ppm (T_7). The highest number of leaves (29.91) was observed in hardwood cuttings with IBA 4000 ppm (C_3T_3) followed by IBA 3000 ppm (27.52) and the lowest number of leaves (13.21) was observed in hardwood cuttings with NAA 500 ppm (C_3T_7). Maximum number of leaves per cutting was observed in hardwood cuttings with IBA

Table 3. Effect of growth regulators and types of cuttings on number of leaves at 60 DAP and 90 DAP in guava cuttings

Growth regulators (T)	Number of leaves at 60 DAP				Number of leaves at 90 DAP			
	Types of cuttings (C)			Mean	Types of cuttings (C)			Mean
	Softwood Cuttings (C1)	Semi Hardwood Cuttings (C2)	Hardwood Cuttings (C3)		Softwood Cuttings (C1)	Semi Hardwood Cuttings (C2)	Hardwood Cuttings (C3)	
IBA 2000 ppm (T1)	10.13	10.87	14.73	11.91	18.13	15.18	21.05	18.12
IBA 3000 ppm (T2)	13.20	13.13	16.20	14.18	18.37	16.44	27.52	20.78
IBA 4000 ppm (T3)	20.47	13.80	20.87	18.38	20.07	27.15	29.91	25.71
IAA 1000 ppm (T4)	14.00	10.93	17.80	14.24	17.14	18.67	19.36	18.39
IAA 2000 ppm (T5)	12.31	14.60	16.73	14.54	20.29	17.81	22.32	20.14
IAA 3000 ppm (T6)	14.27	13.60	14.47	14.11	21.15	14.13	24.97	20.08
NAA 500 ppm (T7)	10.40	10.00	11.80	10.73	15.80	16.44	13.21	15.15
NAA 1000 ppm (T8)	10.33	10.53	13.53	11.46	14.36	20.40	14.88	16.55
NAA 1500 ppm (T9)	12.73	12.13	14.40	13.09	20.53	15.64	16.47	17.55
Mean	13.09	12.18	15.61	13.63	18.43	17.98	21.08	19.16
Factor	C	T	C x T		C	T	C x T	
SE.d	0.10	0.17	0.31		0.13	0.23	0.40	
CD at 5%	0.21**	0.36**	0.62**		0.27**	0.47**	0.81**	

4000 ppm (C_3T_3). Generally, more number of leaves was observed in cuttings with more number of roots. Maximum number of leaves was produced in cuttings treated with IBA irrespective of concentration which was 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 was due to the reason that the plant diverted maximum assimilate quantities to the leaf buds, since the leaves are one of the production sites of natural auxins besides being very important for vital processes like photosynthesis and respiration (Wahab *et al.*, 2001). The results are similar with the findings of Soni *et al.* (2016) in hardwood cuttings of guava.

Conclusion

On the basis of results revealed from the study, it is concluded that plant growth regulators significantly influenced the growth parameters of guava cutting. Among different plant growth regulators, IBA 4000 ppm showed highest rooting percentage, highest sprouting percentage, early sprouts and highest number of leaves. Softwood cutting treated with IBA 4000 ppm exhibited better rooting and sprouting performance as compared to NAA and IAA. Thus, Softwood cutting is recommended as along with IBA 4000 ppm for successful propagation of guava cutting.

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