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Effect of Indole 3-butyric acid (IBA), rooting media and their interaction on different rooting and growth characteristic of air-layers in guava (*Psidium guajava* L. cv. L-49)

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Abstract: The present investigation was undertaken to study the effect of different concentrations of Indole 3-butyric acid (0, 2000, 4000, 8000 and 10000 ppm), different types of rooting media (*i.e.* sphagnum moss, coco peat, vermicompost, sphagnum moss + coco peat and sphagnum moss + coco peat + vermicompost) and the interaction of these in different combinations on rooting and growth characteristic of guava, cv. L-49. The results revealed that the exogenous application of Indole 3-butyric acid (IBA) 8000 ppm with media combination of sphagnum moss + coco peat + vermicompost (I_3M_5) significantly increased the root characters *i.e.* success percent of air-layers (83.3 %), callus formation (23.7), number of primary roots (24.21) and secondary roots (32.57); and growth characters *i.e.* number of leaves (48.17), branches (7.92) and sprouts (8.48) and survival percentages (83.18) over the other treatments and control. Among the rooting media, the combination of sphagnum moss + coco peat + vermicompost (M_5) produced the highest rooting percentage (71.27), root characters and growth characters during months of July and August.

Keywords: Air layering, Guava, Indole 3-butyric acid, Rooting media

INTRODUCTION

Guava (*Psidium guajava L.*), a native of Tropical America (from Mexico to Peru), is quite popular fruit crop of India due to its wide adaptability range, pleasant taste, flavor, reasonable price and availability for a long period of time during the year. In India, the total area under guava cultivation was approximately 255 Thousand Hectares with an estimated annual production of 4048 Lakh Tonnes (Anonymous, 2016). 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). 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 cutting (Kuperberg 1953), layering (Manna *et al.,* 2004), grafting (Singh *et al.,* 2005) and budding (Kaundal *et al.,* 1987). Air layering is only reliable method of guava 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). The success in air layering of guava 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). 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). Plenty of literature is available on these aspects for different fruit crops like pomegranate (Patel *et al*. 2012), lichi (Chawla *et al*. 2012; Das and Prasad, 2014) 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. Thus, specific investigation on scientific lines is re-

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quired to be carried out so as to achieve the demand of fruit growers for the cheaper availability of planting material with vigorous growth. Keeping in view the above facts, a systematic study was planned to quantify the effect of growth regulator *i.e.* Indole 3-butyric acid (an auxin group of hormone), different rooting media *i.e*. sphagnum moss, coco peat, vermicompost and their combinations; and their interactions on the different rooting and growth characteristics of air-layers in guava cv. L-49 with the aim to come up with a combination that provides better rooting and growth characters.

MATERIALS AND METHODS

The present investigation was carried out on eight year old trees having uniform growth and spaced at 6x6 m^2 at Instructional-cum-Research Fruit Orchard, KNK College of Horticulture, Mandsaur, RVSKVV, Gwalior (M.P.) during July 2013 to November 2013. The experiment was laid out in a factorial randomized block design with three replications. Five types of media combinations (sphagnum moss, coco peat, vermicompost, sphagnum moss + coco peat (1:1) and sphagnummoss + coco peat + vermicompost (1:1:1) were used separately and also with combination of five levels of IBA (*i.e*. 0 ppm, 2000 ppm, 4000 ppm, 8000 ppm and 10000 ppm) as treatments in this study. For the experiment, 75 plants of guava of uniform vigour and size were selected. For air-layering, about 1–2 years old healthy branches of pencil thickness were selected. The length and diameter of branches were approximately 45–60 cm and 11 cm, respectively. Ten air-layers under each treatment and 750 air-layers under the whole experiment were operated.

In the present experiment, growth regulators formulation was prepared in talc powder base after dissolving it in absolute alcohol (Kumar, 2011). After selection of branches, a ring of bark about 2-2.5 cm were girdled carefully just below the bud without injuring the underwood by giving two circular cuts about 45-60 cm below the top end of a selected shoot of guava. Already prepared growth regulators formulation was applied evenly on all sides of the upper cut of the ring. The cut portion was covered with different types of rooting media and white coloured polythene wrappers as per the treatment combination. Each treatment was replicated on another plant.

After 55 days from the date of operation, air-layers were detached by making a cut just below the lowest end of the ring surface with sharp secateurs. The air-layers were brought under shade after detachment and their polythene covers were removed gently followed by planting rooted air-layers in polythene bags containing a mixture of soil, sand and farm yard manure in the ratio of 4:2:4. Two air-layers were selected from each treatment *i.e.* six from all three replications for observation at the time of detachment of air-layers. After transplanting of successful air-layers, four plants under each replication of treatment were selected for further growth studies. All observation for growth studies were recorded at an interval of the fortnight. The data were then analyzed according to the method given by Panse and Sukhatme (1978) for the factorial randomized block.

RESULTS AND DISCUSSION

Effect of IBA interaction with rooting media on root characters: The results indicated that IBA concentrations, rooting media and their interaction exhibited a significant effect on rooting and root parameters**.** The IBA concentration of 8000 ppm with media combination of sphagnum moss + coco peat + vermicompost (I_3M_5) significantly increased the success percent of air-layers (83.33 %), callus formation (23.70), number of primary roots (24.21) and number of secondary roots (32.57) over other treatment combinations (Table 1). The success percentage decreased on average 10 % with increasing the concentration of IBA above 8000 ppm in all the combinations of media, while in a case of media combinations with IBA 8000 ppm, media combination of sphagnum moss + coco peat + vermicompost resulted in more success over other combinations of media. This could be because of the adequate quantity of auxin for cambial activity is necessary for initiation of root primordial, therefore the highest performance was seen at balanced concentration of IBA @ 8000 ppm which is suppprted by Bhagat *et al.*(1998) .The enhanced expression of root primordial and profuse development of root system as observed in the present investigation could be due to synergistic mode of action between auxins and other constituents in plant tissues control organ formation (Westwood, 1973). Besides the application of hormone, the other reason which resulted in present observations could be an accumulation of certain chemical substances (carbohydrates, rooting co-factors etc.) at the base of cut which might have stimulated the meristem to divide quickly and produce roots (Kumar and Syamal, 2005). The mobilization and utilization of carbohydrate and nitrogen fraction in the presence of cofactor at wounding portion might have helped in better root initiation, number and root length Gregary and Samantarai (1950).The higher percentage of callus formation may be due to synergistic effect of the plant growth regulators controlling the initiation of root primordial and development of profuse root system as it is a well-known phenomenon that callus formation in air-layered twigs is the first apparent system of the auxin adenine balance. It arises from cells in the region of the vascular cambium and adjustment phloem.

The highest primary root length (11.15 cm) was obtained in IBA 8000 ppm with media combination of sphagnum moss + coco peat + vermicompost (I_3M_5) which is highest among all other treatments. The pa-

Table 1. Interaction effect of IBA concentrations, with different rooting media combination on rooting, root parameters in air layering.

Treatment		Callus for.	Success%	No. P. root	No. S. root	P. length	S. length	P. diameter	Fresh wt.	Dry wt.
SM	M1	15.80	65.77	13.12	21.83	6.54	2.77	0.29	2.15	0.41
CP	M2	12.70	65.24	12.14	19.72	6.16	2.7	0.28	2.12	0.39
SM + CP	M3	16.89	67.64	13.65	22.17	6.58	2.86	0.33	2.43	0.48
VC	M4	9.95	64.31	11.16	17.60	5.84	2.56	0.27	1.97	0.38
SM + CP + VC	M5	19.03	71.27	14.67	23.04	7.68	3.64	0.41	2.52	0.53
CD at 5%		2.36	1.78	0.79	2.15	1.16	0.74	0.10	0.064	0.010
IBA@2000 ppm+SM	I1M1	12.20	63.41	7.98	17.52	5.79	1.81	0.27	1.65	0.32
IBA@2000 ppm+CP	I1M2	8.10	63.03	7.35	15.22	5.67	1.64	0.22	1.5	0.29
IBA@2000 ppm+SM+CP	I1M3	13.62	65.11	8.26	17.60	6.25	2.26	0.37	1.85	0.35
IBA@2000 ppm+VC	I1M4	7.70	60.43	7.14	15.21	5.46	1.18	0.14	1.06	0.25
IBA@2000 ppm+SM+CP+VC	I1M5	17.39	65.43	9.25	18.38	5.46	3.40	0.44	1.88	0.38
IBA@4000 ppm+SM	I2M1	15.73	67.20	11.66	22.26	6.74	2.46	0.28	2.33	0.42
IBA@4000 ppm+CP	I2M2	8.30	66.83	11.07	21.37	6.17	2.43	0.27	2.26	0.39
IBA@4000 ppm+SM+CP	I2M3	16.43	68.92	13.34	23.43	5.98	2.54	0.29	2.38	0.44
IBA@4000 ppm+VC	I2M4	8.12	66.08	10.32	15.32	5.49	2.36	0.18	2.21	0.36
IBA@4000 ppm+SM+CP+VC	I2M5	18.23	71.75	14.49	24.21	8.35	4.52	0.50	2.59	0.47
IBA@8000 ppm+SM	I3M1	19.80	72.84	22.26	30.13	8.55	4.17	0.46	3.34	0.64
IBA@8000 ppm+CP	I3M2	19.17	71.63	21.37	29.25	6.61	4.04	0.37	3.29	0.61
IBA@8000 ppm+SM+CP	I3M3	21.70	72.99	23.43	31.45	8.93	4.42	0.47	3.54	0.78
IBA@8000 ppm+VC	I3M4	16.57	70.28	17.90	26.32	6.21	3.32	0.34	3.18	0.58
IBA@8000 ppm+SM+CP+VC	I3M5	23.70	83.33	24.21	32.57	11.15	5.83	0.48	3.60	0.83
IBA@10000 ppm+SM	I4M1	20.77	72.20	17.22	26.26	7.87	4.12	0.33	2.34	0.52
IBA@10000 ppm+CP	I4M2	19.30	71.15	15.22	20.82	6.57	3.28	0.31	2.30	0.47
IBA@10000 ppm+SM+CP	I4M3	21.20	73.64	17.60	27.50	8.29	4.41	0.43	2.69	0.68
IBA@10000 ppm+VC	I4M4	10.08	69.47	15.21	17.90	6.12	3.21	0.30	2.27	0.45
IBA@10000 ppm+SM+CP+VC	I4M5	21.80	74.40	18.38	28.26	8.88	4.60	0.44	2.85	0.72
CD at 5%		NS	3.98	1.77	4.83	NS	NS	NS	0.145	0.022

I_1= IBA 2000ppm, I_2= IBA 4000 ppm, I_3= IBA 8000 ppm, I_4= IBA 10000 ppm, M= media combination, SM= Sphagnum moss, CP= Coco peat and VM= vermicompost

Table 2. Interaction effect of IBA concentrations, with different rooting media combination on growth parameters in air layering.

Treatment		Number of leaves	Number of branches	Number of sprouts	Survival percentage
SM	M1	30.52	4.20	4.96	62.26
CP	M2	29.64	3.86	4.61	60.50
SM + CP	M3	32.94	5.86	5.13	63.31
VC	M4	25.98	3.38	3.83	56.03
SM + CP + VC	M5	36.05	6.58	6.61	64.99
CD at 5%		5.46	1.30	1.40	5.91
IBA@2000 ppm+SM	I1M1	26.50	2.75	3.50	65.54
IBA@2000 ppm+CP	I1M2	26.22	2.58	3.25	63.78
IBA@2000 ppm+SM+CP	I1M3	31.40	4.33	4.25	65.66
IBA@2000 ppm+VC	I1M4	24.16	2.25	3.08	37.82
IBA@2000 ppm+SM+CP+VC	I1M5	31.73	7.17	6.67	65.85
IBA@4000 ppm+SM	I2M1	30.92	4.17	4.17	67.72
IBA@4000 ppm+CP	I2M2	29.42	2.83	4.00	67.52
IBA@4000 ppm+SM+CP	I2M3	31.92	5.33	6.33	68.41
IBA@4000 ppm+VC	I2M4	24.58	2.50	3.33	66.11
IBA@4000 ppm+SM+CP+VC	I2M5	38.25	7.67	7.00	68.43
IBA@8000 ppm+SM	I3M1	35.08	6.17	6.00	80.74
IBA@8000 ppm+CP	I3M2	34.00	5.25	6.00	73.65
IBA@8000 ppm+SM+CP	I3M3	41.67	6.67	7.00	81.39
IBA@8000 ppm+VC	I3M4	26.14	4.33	4.33	69.94
IBA@8000 ppm+SM+CP+VC	I3M5	48.17	7.92	8.48	83.18
IBA@10000 ppm+SM	I4M1	31.25	5.42	6.00	70.55
IBA@10000 ppm+CP	I4M2	30.10	4.58	5.83	67.41
IBA@10000 ppm+SM+CP	I4M3	37.75	5.58	6.58	74.89
IBA@10000 ppm+VC	I4M4	24.92	3.58	4.25	62.69
IBA@10000 ppm+SM+CP+VC	I4M5	44.33	7.75	7.42	79.40
CD at 5%		NS	NS	NS	NS

I_1= IBA 2000ppm, I_2= IBA 4000 ppm, I_3= IBA 8000 ppm, I_4= IBA 10000 ppm, M= media combination, SM= Sphagnum moss, CP= Coco peat and VM= vermicompost

rameters like secondary root length (5.83 cm), fresh weight of roots (3.60 g) and dry weight of roots (0.83 g) were highest in IBA 8000 ppm with media combination of sphagnum moss + coco peat + vermicompost (I_3M_5). IBA 4000 ppm with media combination of sphagnum moss + coco peat + vermicompost (I_2M_5) showed higher root diameter followed by IBA 8000 ppm with media combination of sphagnum moss + coco peat + vermicompost (I_3M_5). Thus, it can be inferred from the present observation that root diameter is mainly dependent on media combination *i.e*. IBA play little role in root thickness. The increase in the length of primary roots and secondary roots could be due to hormonal effect and accumulation of other internal substances - their basipetal or downward movements (Rymbai and Reddy 2010a). External application of auxin which further stimulates the movement of natural auxin and other materials in a downward direction from the leaves and shoots tips which accumulate at the incision made on the shoot resulting in the formation of roots with higher fresh and dry weight. In the present study, higher concentration of IBA, growth of roots is stimulated leading to increase in length and weight might be due to the cell elongation and modification in the physiological process. Similar findings have been previously reported by Singh *et al.* (1995), Patel *et al.* (1996), Tomar *et al.* (1999), Singh (2002), Tyagi and Patel (2004), Kumar and Syamal (2005) Lal *et al.* (2007), Rymbai and Reddy (2010a,b) and Maurya *et al.* (2012) .

Effect of IBA interaction with rooting media on growth characters: The treatment combination IBA 8000 ppm (I_3M_5) showed the highest number of leaves (48.17), highest number of branches (7.92), highest number of sprouts (8.48) with maximum survival percentages (83.18 %) over other treatment combinations (Table 2). The response of IBA @ 8000 ppm might be due to more number of primary roots, secondary roots and root length at this concentration which could have been caused by absorption of nutrients, food material and moisture from the soil, ultimately resulting in higher establishment percentage (Tyagi and Patel 2004). The maximum number of leaves might be due to the availability of more mineral nutrients and efficient absorption by the vigorous root system. The maximum number of branches could have been due to stimulation of adventitious root production to produce hormones. The surplus number of food materials and other necessary minerals might have resulted in higher growth and ultimately more number of branches in plant. The maximum number of sprouts may be due to the modification in physiological process of plants and formation of

more number of roots. Similar findings have been reported by other workers *i.e.* Tomar *et al.* (1999), Singh (2002), Rymbai and Reddy (2010 a) and Maurya *et al.* (2012).

Effect of rooting media on root characters: The media combination of sphagnum moss + coco peat + vermicompost (M_5) significantly increased the success percent of air-layers (71.27 %), number of primary roots (14.67), number of secondary roots (23.04), primary root length (7.68 cm), secondary root length (3.64 cm), primary root diameter (0.41 cm), callus formation (19.03 mm), fresh weight of roots (2.52 g) and dry weight of roots (0.53 g) over the sphagnum moss, coco peat, vermicompost singly or other combinations.(Table 1). This increase could be attributed to proper aeration, good nutrient availability and high water holding capacity by the media M_5. Recently, some other workers (Singh *et al.* 2007, Rymbai and Reddy 2010, Maurya *et al.* 2012 and Rymbai *et al.* 2012) have also reported similar findings.

Effect of rooting media on growth characters: The highest number of leaves (36.05), branches (06.58), sprouts (06.61) and maximum survival percentages (64.99 %) were found in media combination of sphagnum moss + coco peat + vermicompost (M_5) (Table 2). The above mentioned increase could be due to more number of primary and secondary roots, and root length at this combination which might have induced better absorption of nutrients, food material and moisture from the soil and ultimately leading to higher establishment percentage. This finding is in agreement with the results obtained by Singh *et al.* (2007), Maurya *et al.* (2012) with organic media and Rymbai *et al.* (2012) with coco peat and moss in guava.

Conclusion

Guava is one of the very important fruit crops of India owing to its rich taste, nutrient composition, reasonable price and availability round the year. The effect of IBA, different rooting media and combination of the two was studied on the air-layer of the plant. IBA @ 8000 ppm with media combination of sphagnum moss + coco peat + vermicompost resulted in 80% success of air-layers, more number of primary (24.21) and secondary roots (32.57), longest primary (11.15) and secondary (5.83) roots for rooting characters while highest number of leaves (48.17), sprouts (8.48) and branches (7.92) in case of growth characters of the guava air-layers. The study concludes that by the exogenous application of the above mentioned treatment the success rate of air-layers could be increased and rooting and growth characters of air-layers could be enhanced.

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