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Effects of rooting media and different IBA concentrations on air layering of Rambutan (*Nephelium lappaceum* L.)

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Abstract
A study of air layering in Rambutan (*Nephelium lappaceum* L.) involving two different rooting media and different concentrations of rooting hormone (IBA) showed significant variation in terms of air layering percent success, callus formation, average number of primary roots per air-layer, survival percentage after transplanting in poly-bags, days taken for bud sprouting, number of bud sprouts, number of leaves, number of branches and mortality percentage under Chettali conditions, Kodugu Dist., Karnataka, India. Coir fibre as rooting media and 2500ppm concentration of IBA as rooting hormone along with their interactions was found best among all other treatments with highest rate of air layering percent success and other related parameters.

Keywords: Rambutan; air layering; rooting media; auxin; IBA

Introduction
Rambutan (*Nephelium lappaceum L.*) or hairy litchi belonging to the family Sapindaceae is a delicious and juicy fruit. Indigenous to the Malay archipelago, it has spread and grown in the humid tropical regions of South-East Asia, central America and Africa where the temperature and humidity are high enough the year round (Tindall, 1994) [11]. In the recent past, this tropical fruit has spread to other humid tropical regions of the world including India. Rambutan, a medium sized evergreen tree grows upto 12-15 m high. It produces ellipsoidal fruits in clusters of long thick, soft, hairs or spines on the surface which are known as rambutan (in Malayan language 'rambut' stands for hair). The hairy outgrowth has eye catching red and yellow colors and it imparts a distinctive exotic appearance to its fruits. Like any other exotic fruit, expansion in area of rambutan in India is subjected to standardized vegetative propagation technique for rapid multiplication of the plant. Propagation from seeds produce male, female or hermaphroditic (producing flowers that are female with a small percentage of male flowers). Male trees do not produce a crop while the female trees require pollinator to bear well (Tindall, 1994) [11]. Hence, a standardized vegetative propagation is to be advocated to maintain the genetic integrity of a variety. At present the crop is under cultivation only in humid tropics of Kerala, Karnataka and Tamil Nadu states of India, Therefore, this is the time to assess appropriate vegetative propagation techniques and to obtain true-to-type planting materials, which is pre-requisite for strengthening of rambutan production in India. Hence, an attempt was made to investigate the efficacy of different media and concentrations of growth regulator (IBA) in air layering of rambutan as suitable vegetative propagation.

Materials and Method
The present study was carried out at Rambutan orchard of Central Horticultural Experiment Station (CHES), Chettalli, Kodagu, Karnataka, India (12°26' N latitude and 75°57' E longitude at 1050 m above mean sea level) during last week of October to January, 2017-2018. At Chettali, fruit bearing season of the rambutan crop was during September to mid-October, hence experiments were initiated after the crop harvest. Average temperature was 27.95 ºC with average relative humidity 79.60% during the period of experiment. The mother plant-CHES-28 was selected on the basis of growth vigour and maturity. One year old shoots of about 60-75 cm length having the diameter about pencil thickness (1.5 cm to 2.0 cm) were selected for study. Five shoot were selected for each replication in every treatment.

The numbers of nodes in each selected shoots were 7 to 8 with an average distance of 7-8 cm from node to node. In order to standardize air layering in rambutan two factors were considered under this experiment i.e., 1. Media in air layers-two types of rooting media viz. M_1: Coir fibre, M_2: Coco peat and 2. Auxin (IBA) plant growth regulator treatments at different concentrations viz. T_1: IBA 2500ppm, T_2: IBA 5000ppm, T_3: IBA 7500ppm, T_4: Control without IBA, resulting into total 8 treatments was taken up. After selection of branches, circular patch (3-4 cm length) of bark was removed just below the bud without injuring the underwood. IBA growth regulators of different concentrations and a control treatment were applied in solution form on the ringed surface of selected shoots by swabbing them with cotton according to the treatments. The growth regulator treated exposed portion of shoots were covered with two different rooting media substrate after removing the excess water from them, according to the treatments. White polythene (200 gauge thickness) was used as wrapper, tied up over the media substrate by jute fibre threads to uphold the media for proper rooting. After 60 days from the date of operation air-layers were detached by making a cut just below the lowest end of the ringed surface with sharp secateurs. The air layers were brought under shade after detachment and their polythene cover was removed gently. Care was taken so that the roots were not injured at the time of removing polythene wrappers followed by planting rooted air-layers in polythene bags containing mixture of soil + F.Y.M. + leaf mould (2:1:1). Design adopted was factorial randomized block design. There were two factors, eight treatments with three replications of each treatment. Twenty number of air layers in each replication. Parameters considered for data collection were; air layering percent success, callus formation, average number of primary roots per air-layer, survival percentage after transplanting in poly-bags, days taken for bud sprouting, number of bud sprouts, number of leaves, number of branches, mortality percentage. The data in percentages were transformed to arc sine values for statistical analysis. The data were subjected to statistical analysis using WASP 2.0 software (ICAR GOA-Central Coastal Agricultural Research Institute). Critical difference values were tabulated at five per cent level of significance, where "F" test were significant.

Results and Discussion

Observations were recorded under the present investigation in order to find out suitable concentration of rooting hormone (IBA) and rooting media for successful air layering in rambutan. Among the two different rooting media substrates used, coir fibre was significantly better than coco peat in terms of success in rooting (22.50 %) [Table 1], low callus formation (0.46 cm) [Table 2], where maximum callus has been found in higher concentrations of IBA treatments. Similarly, higher number of primary roots (9.08) [Table 3], higher survival (53.12 %) [Table 4], higher number of bud sprout (2.67) [Table 6], highest leaves count per sprout (6.17) [Table 8] and least rate of mortality (46.88 %) [Table 9] was observed where coir fibre was used as a rooting media.

Amid the different concentration of IBA tried, significantly better response was observed in treatment T_1-IBA 2500ppm in terms of success in rooting percentage (26.67 %) [Table 1], with higher numbers of primary roots (10.83) [Table 3], higher percentage survival (64.58 %) [Table 4]. It also had a significantly higher number of bud sprout (3.17) [Table 6], highest count of leaves per sprout (7.17) [Table 8] and a comparatively lesser mortality rate (35.42 %) [Table 9].

Within the interaction treatments of different media and auxin (IBA) concentration, M_1T_1-Coir fibre with IBA 2500ppm was significantly the best treatment with percent success of rooting (37.21%) [Table 1.], higher numbers of primary roots (13.33) [Table 3], higher percentage of survival (87.50 %) [Table 4]. It also exhibited a significantly higher number of bud sprout (4.00) [Table 6], highest leaves count per sprout (8.33) [Table 8] and least rate of mortality (12.50 %) [Table 9]. Corresponding results were reported by Sarfo *et al.* (2016) [9] in rambutan air layers where palm fibre and sand used as rooting media exhibited highest survival representing, highest mean numbers of root and maximum mean numbers of shoot with IBA 2000 ppm. Equivalent reports were given by Rahman *et al*. (2002) [7] where layers prepared with IBA at 2500 ppm produced the maximum number and length of primary roots and obtained the highest percentage of success in the survivability of litchi layers. The best rooting performance and the final survival of air layers in the nursery after 90 days of severing was recorded to be the highest where layers were prepared with IBA at 2500 ppm.

Results were in accordance with Jan *et al.* (2003) [3], who studied the effects of different concentrations of IBA (1000, 1500, 2000, 2500, 3000 and 3500 ppm) on the rooting of litchi air layers. The highest number of roots per plant, shoots length and plant survival were recorded for layers treated with 2500 ppm of IBA. The present finding regarding the effect of IBA was in agreement with that of Mukhopadhaya (1986) [4] who reported an increasing trend for rooting and survival upto 2500 ppm, there after it declined. This may give an idea to the reason of declined rooting from the layers treated with more than 2500 ppm concentration of IBA with a higher callus formation which was unable to differentiate into roots. The present findings were analogous with Rahman *et al.* (2000) [6]. In their study in litchi, maximum number of roots was produce in layering treated with 2500 ppm of IBA. However increase in IBA concentration beyond 2500 ppm decreased the rooting since IBA increase cell wall elasticity which accelerate cell division and in turn increase root up to a certain level. Similarly large number of leaves was recorded in treatment with 2500 ppm of IBA in litchi. The layer treated with 2500ppm IBA produce more number of roots and thus absorbed more nutrients which in turn produced more number of leaves. The mean values regarding percent plant survival show that maximum percent plant survival were recorded in layer treated with 2500ppm of IBA in litchi.

Current research results were also in line with Lins *et al*. (2015) [3] studying the influence of season and different substrates on rooting of air layers of litchi (*Litchi chinensis* Sonn.) cv. Bengal in Brazil reported the period between September and March was more suitable to the propagation of litchi, when there were rooting percentages above 90 %, in addition to the formation of large amount of roots. The layering of litchi cv. Bengal is held between the months of September and November; coconut fiber can be used as the best substrate, obtaining good results of rooting (average temperature 25-30 ºC). Yau and Murphy (2000) [12] reported that raw form of coco peat was unsuitable for use as it contained phytotoxic elements which inhibit plant growth.

The results also confirm the findings of Sharma *et al.* (1990) [10] who treated 50 percent of layer shoot of cv. China and Shahi after a week of rains with 2500ppm of IBA and obtained highest survival in all China cv. treated with 2500ppm of IBA. Contrasting finding was reported by Raut *et al.* (2015) [8] in karonda, where IBA 5000 ppm was effective with respect to minimum days for rooting, increased number of roots per layer, height of rooted layers and number of leaves, root to shoot ratio and highest survival percentage. Similarly, Das and Prasad (2014) [1] reported that IBA 5000 ppm proved better in maximum rooting layers, high survival percentage and maximum fresh weight of roots, in litchi cv. Purbi.

Table 1: Effect of plant growth regulator and rooting media on success in rooting percentage (%) in air layers of rambutan.

Auxin-IBA treatments(T)	Substrate rooting media(M)		Mean(T)
	M1-Coir Fibre	**M2- Coco peat**	
T1-2500ppm	36.67 (37.21)	16.67 (23.85)	26.67 (30.53)
T2-5000ppm	23.33 (28.27)	13.33 (21.14)	18.33 (24.71)
T3-7500ppm	16.67 (23.85)	18.33 (24.80)	17.50 (24.32)
T4-Without IBA (Control)	13.33 (21.14)	16.67 (23.85)	15.00 (22.49)
Mean(M)	22.50 (27.62)	16.25 (23.41)	
	M	T	Interaction(MXT)
S.Em±	1.30	1.84	2.60
CD (5%)	3.98	5.62	7.94

Values in the parenthesis are arc sign transformed data

Table 2: Effect of plant growth regulator and rooting media on callus formation (cm) in air layers of rambutan.

Auxin-IBA treatments(T)	Substrate rootin media(M)		Mean(T)
	M1-Coir Fibre	**M2- Coco peat**	
T1-2500ppm	0.40	0.35	0.38
T2-5000ppm	0.55	0.58	0.57
T3-7500ppm	0.67	0.65	0.66
T4-Without IBA (Control)	0.22	0.52	0.37
Mean(M)	0.46	0.52	
	M	T	Interaction(MXT)
S.Em±	0.02	0.03	0.04
CD (5%)	0.06	0.09	0.13

Table 3: Effect of plant growth regulator and rooting media on average number of primary roots in air layers of rambutan.

Auxin-IBA treatments(T)	Substrate rooting media(M)		Mean(T)
	M1-Coir Fibre	**M2- Coco peat**	
T1-2500ppm	13.33	8.33	10.83
T2-5000ppm	10.33	9.00	9.67
T3-7500ppm	9.33	7.67	8.50
T4-Without IBA (Control)	3.33	3.00	3.17
Mean(M)	9.08	7.00	
	M	T	Interaction(MXT)
S.Em±	0.32	0.46	0.64
CD (5%)	0.98	1.38	1.95

Table 4: Effect of plant growth regulator and rooting media on survival percentage in air layers (%) of rambutan.

Auxin-IBA treatments(T)	Substrate rooting media(M)		Mean(T)
	M1-Coir Fibre	M2- Coco peat	
T1-2500ppm	87.50 (72.90)	41.67 (40.00)	64.58 (56.45)
T2-5000ppm	38.89 (33.44)	33.33 (35.00)	36.11 (34.22)
T3-7500ppm	52.78 (46.75)	42.59 (40.69)	47.68 (43.72)
T4-Without IBA (Control)	33.33 (35.00)	33.33 (35.00)	33.33 (35.00)
Mean(M)	53.12 (47.02)	37.73(37.67)	
	M	T	Interaction(MXT)
S.Em±	5.86	7.31	8.29
CD (5%)	12.58	17.79	25.16

Values in the parenthesis are arc sign transformed data

Table 5: Effect of plant growth regulator and rooting media on days taken for bud sprouting in air layers of rambutan.

Auxin-IBA treatments(T)	Substrate rooting media(M)		Mean(T)
	M1-Coir Fibre	**M2- Coco peat**	
T1-2500ppm	24.33	23.00	23.67
T2-5000ppm	19.00	22.67	20.83
T3-7500ppm	22.00	20.33	21.17
T4-Without IBA (Control)	28.67	21.33	25.00
Mean(M)	23.50	21.83	
	M	T	Interaction(MXT)
S.Em±	0.44	0.63	0.89
CD (5%)	1.34	1.90	2.69

Table 6: Effect of plant growth regulator and rooting media on number of bud sprouts in air layers of rambutan.

Auxin-IBA treatments(T)	Substrate rooting media(M)		Mean(T)
	M1-Coir Fibre	M2- Coco peat	
T1-2500ppm	4.00	2.33	3.17
T2-5000ppm	2.33	1.67	2.00
T3-7500ppm	2.67	1.67	2.17
T4-Without IBA (Control)	1.67	1.33	1.50
Mean(M)	2.67	1.75	
	M	T	Interaction(MXT)
S.Em±	0.19	0.27	0.39
CD (5%)	0.59	0.83	1.18

Table 7: Effect of plant growth regulator and rooting media on number of branches in air layers of rambutan.

Auxin-IBA treatments(T)	Substrate rooting media(M)		Mean(T)
	M1-Coir Fibre	M2- Coco peat	
T1-2500ppm	2.67	1.67	2.17
T2-5000ppm	1.33	1.33	1.33
T3-7500ppm	1.67	1.67	1.67
T4-Without IBA (Control)	1.33	1.33	1.33
Mean(M)	1.75	1.50	
	M	T	Interaction(MXT)
S.Em±	0.17	0.25	0.35
CD (5%)	0.53	0.75	1.06

Table 8: Effect of plant growth regulator and rooting media on number of leaves per sprout in air layers of rambutan.

Auxin-IBA treatments(T)	Substrate rooting media(M)		Mean(T)
	M1-Coir Fibre	M2- Coco peat	
T1-2500ppm	8.33	6.00	7.17
T2-5000ppm	6.00	5.67	5.83
T3-7500ppm	6.33	5.33	5.83
T4-Without IBA (Control)	4.00	3.67	3.83
Mean(M)	6.17	5.17	
	M	T	Interaction(MXT)
S.Em±	0.24	0.34	0.48
CD (5%)	0.73	1.03	1.46

Table 9: Effect of plant growth regulator and rooting media on mortality percentage (%) in air layers of rambutan.

Auxin-IBA treatments(T)	Substrate rooting media(M)		Mean(T)
	M1-Coir Fibre	M2- Coco peat	
T1-2500ppm	12.50 (17.10)	58.33 (50.00)	35.42(33.55)
T2-5000ppm	61.11 (56.56)	66.67 (55.00)	63.89 (55.78)
T3-7500ppm	47.22 (43.24)	57.41 (49.31)	52.31 (46.28)
T4-Without IBA (Control)	66.67 (55.00)	66.67 (55.00)	66.67 (55.00)
Mean(M)	46.88 (42.16)	62.27 (52.32)	
	M	T	Interaction(MXT)
S.Em±	5.86	7.31	8.29
CD (5%)	12.58	17.79	25.16

Conclusion

The results of present investigation revealed that rooting hormone IBA at 2500ppm concentration with coir fibre as media substrate was the most effective in air layers of rambutan giving higher rate of rooting success and survival after transplant at Chettali conditions. Further studies regarding seasonal variation should be adopted to commercialize air layering technique in rambutan.

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