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Effect of time and IBA concentrations on Soursop (*Annona muricata*): Air layering

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Abstract
An experiment was conducted in the year 2022-23 to study the effect of different concentrations of IBA and time of air layering (months) on rooting parameters of Soursop at Karunya Institute of Technology and Sciences, Coimbatore, Tamil Nadu. As the soursop seeds are poor in germination, propagation by air layering is carried out in this study. The results designate that IBA @ 4000 ppm was proven to be most effective for better rooting parameters (days required for initial root appearance, success percentage of rooted air layers, number of primary roots and secondary roots and length of primary roots). Compared to other treatments, air-layering done during the first two weeks of August, treated with 4000 ppm IBA, and using sphagnum moss as a growing medium has been found to be much more effective.

Keywords: Air layering, IBA, time, media, soursop

Introduction
An evergreen fruit tree species known as soursop (*Annona muricata* L.), a member of the Annonaceae family, and it is known for its anti-cancer properties. It is the largest fruit among the Annonaceae family. The tropical and subtropical regions of the world account for the majority of its distribution. It has been classified into three general classifications: sweet, sub-acid and acid and then it is again subdivided as round, heart-shaped, oblong, or angular and finally it is classified according to flesh consistency, which varies from soft and juicy to firm and comparatively dry (Maheswari and Sindhuja, 2020) [11]. Anonaceous acetogenins found in soursop leaves shown to have strong repressing effects against six human cancers caused in the body parts like lung, breast, colon, pancreatic, kidney (Vieira *et al*., 2010) [19].
Typically, seeds are used to propagate soursop trees. The seeds lose viability soon and do not store for a very long time (Ken and Robert, 2011) [6]. Air-layering, or marcottage, is the most popular layering system for fruit trees. Although layering is more difficult than taking cuttings and grafting, it offers the advantage of allowing the part that is being propagated to continue absorbing water and nutrients from the parent plant as it grows roots (Hazarika and Langthasa, 2021) [4]. A part of a branch that is still attached to the tree and almost close to the tip is cinctured (ring-barked) to remove cambial tissue before coming to contact with a moist substrate or medium. After one to three months, depending on the season and the type of plant and also when roots are numerous and visible (some have transformed from white to cream in color), the air layer can be harvested by making an incision below the newly planted area. The wood beneath the air layer aids in giving the new roots support in the polythene bags. When the covering is removed, the root ball is planted and supported in medium shade. When this new plant shows signs of new vegetative growth the bag or pot can be taken into full sun, allowed to root and grow further, and then transplanted to the field. (Love *et al*., 2017) [10]. Air layering involves an interruption of the downward translocation of organic substances. The ability of air-layered shoots to root is determined by an assortment of variables that depend on the crops, cultivars, and biochemical components (*viz*., carbohydrates, nitrogen, sugars, starch, phenols, auxin levels, etc.) and the climatic conditions prevailing in the season (*viz*., temperature, relative humidity, rainfall, etc.) of layering. All these factors decide the success establishment of air layering. Rooting medias like Sphagnum moss and sawdust are being used extensively for rooting purposes (Singh and Maheswari, 2011) [17]. The ability to produce numerous plants from a single parent plant is another benefit of air layering propagation. This is essential for *Annona muricata*, which is frequently grown in backyard gardens and on small family farms (Islam *et al*., 2018) [5].

Materials and Methods

The experiment was conducted at the instructional north farm of the School of Agricultural Sciences, Karunya Institute of Technology and Sciences, Coimbatore, Tamil Nadu during 2022-2023 and the geographical coordinates of Coimbatore are Longitude - 76° 57' 58.03" East Latitude 11° 00' 19.98" North Coimbatore stands at 432 meters above sea level. The experiment was laid out in factorial RBD with three months (August, September and October) air layering and two different levels of IBA concentrations (3000 and 4000 ppm) along with control (untreated). Thus, nine treatments were replicated to three and one unit comprises of twenty-seven layers.

Preparation of Indole-3-butyric acid (IBA) lanolin paste

IBA is in powder form which is then converted into paste using 95% ethyl alcohol. For preparing 3000 ppm of IBA lanolin paste, IBA powder of 300 mg was weighed and transferred to beaker. Subsequently, 5 ml of 95% ethyl alcohol was added to it. It was shaken thoroughly and dissolved well. Then 100 g of lanolin is taken and heated. Thereafter the prepared IBA is mixed with melted lanolin paste and stirred with glass rod until alcohol was evaporated. Thus, the lanolin paste was prepared. The same procedure is followed for 4000 ppm.

Gridling

Gridling was done by the removal of bark of about 2 cm width around the shoot at 30-35 cm from the selected shoot tip. After 30 days of pre-conditioning, air layering was done in the gridled part of the shoot.

Preparation of rooting media and treatment application on the twig

One (1) kg of sphagnum moss was soaked in clean water overnight until it gets wet and ready to be used as rooting media along with the prepared lanolin paste of two concentrations of IBA (3000 ppm and 4000 ppm). For this study, three *Annona muricata* trees were selected which were healthy, vigorous, and in young stage. After the selection of trees, one-year-old twigs around 30 cm in length and pencil thickness were selected randomly for air layering. All the selected twigs had an average of 0.8 to 1.2 cm diameter and were tagged before air layering. The leaves were detached from the ringing point of the selected twigs, then a ring of bark (phloem) was removed around 2.5 to 3.5 cm long by giving two round cuts at both ends of the ring using a sharp blade. The ring was made around 55 to 65 cm away from the tip of one year old shoot. The cambium layer from the ringed part of the twig was removed gently by rubbing it with cutting blades. After the removal of the cambium layer, the lanolin paste was applied, and the rooting media (sphagnum moss) was placed on the ringed portion and wrapped with transparent plastic sheet (15 × 15 cm) of 100-200 µ gauge to see the new roots and tied tightly with strings. Treated and untreated branches produced roots around one to two months after ringing at the dorsal sides of the branches.

Detachment of air layers from the mother trees

After treatment application, the air-layered twigs produced roots and were ready for detachment. The rooted air layers were detached from the mother trees when the roots were brown and well-developed. The twigs were detached from the trees by cutting with a sharp saw just below the lower end of the ringed surface. Without damaging the attached rooting medium ball, the wrapping material (polythene sheet) was removed, and the air layers were transplanted into well-prepared polybags with red soil, coco peat and FYM in 1:1:1 ratio.

Result and Discussion

Effect of time of air layering (months) on rooting parameters

Significant difference has been recorded on the time of air layering as data represented in Table.1. The air layering done during the first fortnight of August (43.82 days) took least numbers of days for root appearance followed by first fortnight of September (45.87 days) and October (46.53 days). Significantly, the data indicates highest percent of rooted layers in November (66.67%) which is followed by October and September (64.44% and 55.55%). Considerably maximum number of primary roots and secondary roots were also found in the month of August (10.00 and 38.33 respectively) which is followed by September (8.78 and 36.22 respectively) and October (8.11 and 35.44 respectively). Maximum length of primary roots was found in August (7.48 cm) followed by September (7.40 cm) and October (6.96 cm) respectively. Variations in climatic and environmental conditions like high relative humidity, an optimal temperature, and the incidence of rains possibly may be responsible for this accelerated rooting. The results are in the line with the findings obtained by Khan *et al* (2016) [7] and Manga *et al* (2017) [12] in the fruits Litchi and Mango. The physiological state of the shoots that were available for layering during August in the current experiment was favourable for root initiation and subsequent development, leading to a greater percent of rooting.

Effect of IBA concentrations on the rooting parameters

The data represented in the Table.1 revealed that early appearance of root (32.42 days), number of primary and secondary roots (14.78 & 56.44) and maximum length of primary root (8.98 cm) was obtained in the treatment with IBA @ 4000 ppm which showed a significantly superior to other treatments. Significantly maximum percentage of rooted air layer with IBA @ 4000 ppm (93.33%), followed by IBA @ 3000 ppm (73.33%). It may be the result of rooting co-factors accumulating above the ringed portion due to the impact of IBA. Higher IBA concentrations may cause the root to develop length due to hormonal effects, internal substance accumulation, and basipetal (downward) movement of those substances (Tyagi and Patel, 2004) [18]. This result was in accordance with the findings of Kumar and Syamal (2005) [8], Singh (2001) [16] in Guava and Gowda *et al*., (2006) [3] in rose apple.

Table 1: Effect of IBA concentrations and time of air layering on rooting parameters in Soursop layers

Treatment	Days taken for initial root appearance	Success percent of rooted layers (%)	No. of primary roots	No. of secondary roots	Length of the primary roots
T_1 - August	43.82	66.67	10.00	38.33	7.48
T_2 - September	45.87	64.44	8.78	36.22	7.40
T_3 - October	46.53	55.55	8.11	35.44	6.96
SE. d (±)	0.73	2.49	0.51	0.67	0.14
CD	1.54	5.27	1.08	1.43	0.30
C_1 - Control	67.33	20.00	5.67	10.67	5.68
C_2 - IBA @ 3000 ppm	36.47	73.33	6.44	42.88	7.16
C_3 - IBA @ 4000 ppm	32.42	93.33	14.78	56.44	8.98
SE. d (±)	0.72	2.48	0.52	0.68	0.15
CD	1.53	5.26	1.09	1.44	0.31

Table 2: Interaction effect of IBA concentration and time of air layering on rooting parameters in Soursop layers

Treatment	Days taken for initial root appearance	Success percent of rooted layers (%)	No. of primary roots	No. of secondary roots	Length of the primary roots	Root nature
T_1C_1	61.50	20.00	6.00	13.00	6.10	Thick and brittle
T_1C_2	36.3	80.00	7.00	44.66	7.40	Moderate and fibrous
T_1C_3	31.27	100.00	17.00	60.33	9.30	Profuse and fibrous
T_2C_1	69.50	20.00	6.00	10.00	6.03	Thick and brittle
T_2C_2	35.8	80.00	6.35	42.33	7.23	Moderate and fibrous
T_2C_3	32.33	93.33	15.33	55.00	9.10	Profuse and fibrous
T_3C_1	71.00	20.00	5.00	9.00	4.93	Thick and brittle
T_3C_2	37.3	60.00	6.33	41.66	6.87	Moderate and fibrous
T_3C_3	33.67	86.67	12.00	54.00	8.56	Moderate and fibrous
SE. d (±)	1.26	4.30	0.88	1.17	0.25	
CD (0.05)	2.66	9.12	1.87	2.49	0.52	

Interaction effect of IBA concentration and time of air layering on rooting parameters of soursop layers

The results indicated that combined effect of IBA concentrations and the time of layering was significantly influenced the rooting characters and it is presented in Table 2. IBA @ 4000 ppm + first fortnight of August (T_1C_3) recorded minimum days taken for root appearance (31.27 days) which was followed by IBA @ 4000 ppm + first fortnight of September (32.33 days). These results may be due to favourable environmental condition during August month. The same trend followed in the other rooting parameters. The highest percent of rooted layers (100.00%), maximum number of primary and secondary roots (17.00 and 60.33 respectively) was obtained in IBA @ 4000 ppm + first fortnight of August (T_1C_3) for all the three months. The increase in roots may be the result of rooting co-factors building up above the ringed region under the influence of IBA. Similar results were observed by Patil *et al*. (2011) [14] in Guava. Length of the primary root reached maximum (9.30 cm) in the treatment with IBA @ 4000 ppm + first fortnight of August (T_1C_3) and minimum (4.93 cm) in the treatment with control in the month October. The root length was increased by the synthesis of enzymes which are related to cell enlargement when IBA concentration is high along with environmental factors during the month of August. These results are more or less similar to the results obtained by Athani *et al*., 2001 [1] in guava. Kumar *et al*., 2007 [8] also found a significant difference on Guava cv. Allahabad Safeda air-layering. Rymbai and Reddy, 2010 [15] found that the treatment combination IBA @ 4000 ppm + Sphagnum moss + 15th August is the best combination for the maximum length of the primary root in Guava cv. L-49 air-layering under Andhra Pradesh condition. The roots are profuse and fibrous in the treatments with IBA @ 4000 ppm + first fortnight of August (T_1C_3) and IBA @ 4000 ppm + first fortnight of September (T_2C_3) and the roots are moderate and fibrous in the treatments T_1C_2, T_2C_2, T_3C_2, T_3C_3. The roots produced in the layers of control was thick and brittle. IBA at higher concentration (4000 ppm) offered better results than at lower concentrations or under control, suggesting that the amount of auxin accessing the cambial activity may be sufficient to initiate rooting (Bhagat *et al*., 1999) [2]. These results are in conformity with the finding of Rymbai and Reddy (2010) [15].

Conclusion

The present investigation revealed that soursop can be propagated by air layering. Among the different treatment combinations, air layering (T_1) in August (C_3) recorded significantly highest percentage of success of layering (100.00%), required less number of days for root appearance (31.27 days). Based on the above results it was concluded that rooting can be enhanced in air layering of soursop by exogenous application of IBA at 4000 ppm with moist sphagnum moss as rooting media layering during the first fortnight of August. Besides it also improved root characters like percent of rooted layers, number of roots and root length. In brief, air layering propagation is a reliable and efficient way to propagate *Annona muricata*.

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