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Research article

Impact of seasonal changes on air layering and rooting hormone in *Spondias pinnata* (J. Koenig ex L. f.) Kurz.

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Abstract: Air layering trials were conducted in *Spondias pinnata* during four different seasons, winter (January), rainy (July), spring (March) and autumn (October). Juvenile branches with 1.00 to 2.00 cm diameter were girdled using Indole Acetic Acid (IAA) and Indole Butyric Acid (IBA) with the rooting hormones (100, 300 and 500 ppm) along with control. The impact of seasons and rooting hormone were investigated. Callus was formed at the girdled portions of all the air layers with or without hormones. Result revealed that July (Rainy season) proved to be better season for making air layers than other months *viz*. October (autumn), January (winter), and March (spring) in *Spondias pinnata* and IBA 500 ppm was more effective in promoting root formation.
Keywords: Rooting hormones - Air layers - Treatments - Season - Growth.

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INTRODUCTION

Air-layering is a method of reproducing plants by inducing roots to form a plant stem without cutting off the stem from the parent plant. It is an excellent way to replicate existing plant without disturbing the parent plant bearing fruit or flowering. Air-layering can produce larger plants which are readily mature, much faster than growing them from seed or cuttings. Air layering is used to reproduce a number of tropical fruit trees and shrubs. Air-layering is a method of producing a new plant that is identical to the parent plant in all respects, like fruit taste, colour and size. The new plant is formed while still attached to the parent plant upon which it depends for water and nutrients until roots develop. In this type of propagation a large plant can be developed in a relatively short period of time. Air-layering outdoor is performed best during spring and summer, although, it can be done during any season of the year. Spring and summer layers are usually rooted and ready for transplanting in winter (Dewayne & Thomas 2010). Air layering was first discovered by Chinese about 20 centuries ago and long known to horticulturists as a method of reproducing ornamental and cultivated plants (Mergen 1953). It is oldest techniques used by the gardeners to propagate many woody plants (Hossain 2007).

Vegetative propagation through air layering has an advantage over other methods, since reserve food of the parent branch induces the formation of well-developed root system. Also, the air layered branches in general, have balanced root system than cuttings, and develop rapidly on planting out. Season is the important factor for successful layering in woody plant because of rooting on layers enhanced by light and presence of sufficient moisture and optimum temperature (Bose *et al*. 1986). In India, this method of vegetative propagation has not been tried on forest trees on an appreciable scale. There are several vegetative methods for multiplication of the quality stock in forest tree species but air layering is often used as a method of propagation where the formation of roots from cuttings is slow (Hartmann & Kester 1975).

Hog-plum {*Spondias pinnata* (J. Koenig ex L. f.) Kurz.} is a deciduous, glabrous tree with edible fruit, growing up to 25 m in height. The tree is found wild or cultivated throughout the tropical Indian subcontinent. Despite a valuable and threatened plant, *S. pinnata* is not cultivated on a large scale in its native habitat. Due to the limited distribution of *S. pinnata* commonly known as Amra of family Anacardiaceae and their inadequate regeneration in nature the present study was conducted to standardize air layering, one of the vegetative methods of propagation to facilitate *ex-situ* conservation of this species.

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MATERIALS AND METHODS

Spondias pinnata (J. Koenig ex L. f.) Kurz. trees for air layering were selected from sites situated between latitude 25º07' to 25º10' N and longitude 81º54' to 81º58' E and at 98 m elevation during the year 2012. Air layering was conducted in randomized block design with three replications each. Each experiment consisted of seven treatments *i.e.* Control (lanolin paste only), IAA and IBA with 100, 300 and 500 ppm each prepared in lanolin paste. For each species 105 air layers (15 for every treatment) were made in four different seasons *i.e.* (i) Winter (January) (ii) Rainy (July) (iii) Spring (March) (iv) Autumn (October).

Juvenile branches with 1.00 to 2.00 cm diameter were selected for tying the air layers. The bark of the twig (approximately 1 inch wide ring) was removed with the help of knife and 100, 300 and 500 ppm IBA and IAA in the form of powder was applied to the wounded surface. Untreated layers served as control. Sphagnum moss about two handfuls moistened with water and thereafter squeezed to remove excess water was placed around the treated area and wrapped with a polyethylene sheet and finally tied at both ends with plastic thread to avoid the escape of moisture. In this experiment, the first observation on air layered branches to confirm root initiation was recorded after 40 days of setting the experiment and subsequently other observations were made after every tenth day for a period of two months to monitor the development of roots. When roots were visible through the transparent polythene sheet the air layers were detached from mother plant just below the girdle. After air-layers were cut down, plastic film and moss were removed and the roots were counted. A black polythene cover is said to be better than white one, though the latter is better to observe the progress of rooting from time to time. Some roots were broken when the tightly packed moss was removed and many root systems dried during the time, they were exposed for root count (Nautiyal 2002). Roots upto 1 mm and more in length were counted because some shorter protuberances have the appearance of emerging roots but consist of parenchymatous tissue (Mergen 1955). These rooted air layers were transplanted in polythene bags filled up with growing media containing sand, soil and FYM (1:1:2 ratio). These polybags were kept in shade for about one weeks and watered regularly until the root system was well established in the soil.

RESULTS

Observations recorded for the air–layers on root growth characters after been presented in Appendix I. Air layers have initiated callus development followed by root formation at the base of incision. However, the callus and root initiation varied considerably for different seasons.

Figure 1. Air layers of *Spondias pinnata*.

The air layer tests in *Spondias pinnata* have revealed that IBA significantly affected the rooting, number of primary and secondary roots per layer and mean length of the roots in air layers, whereas, other treatments did not affect the callus significantly (Fig. 1). IBA 500 ppm stimulated maximum rooting in air layers in all the four seasons of the year. The rainy seasons exhibited maximum rooting (57.7 %) in the air layers, followed by autumn (45.3%) winter (42.6) and spring (36.9 %) in IBA 500 ppm. The next maximum rooting in air layers after IBA 500 ppm was observed in IAA 500 ppm treatments. The number of primary and secondary roots per layer was also influenced by various concentrations of IBA and IAA treatments. The minimum rooting in air layers was recorded with IAA and IBA in control in all the seasons studied. The number of primary and secondary roots produced by the air layers was recorded as the maximum again with IBA 500 ppm. The rainy season produced the maximum number (18.0 ±2.80 and 5.20 ± 1.23) of primary and secondary roots in IBA 500 ppm followed by autumn (12.12 ±2.29 and 3.76 ±0.31) in IAA 500 ppm, winter (12.01±1.51 and 4.23 ±0.81) in IBA 500 ppm and spring (9.19 ±1.34) in IAA 500 ppm and 3.12 ±0.32 in IBA 500 ppm respectively). The mean length of roots was found maximum with IBA 500 ppm ,which ranged from 5.40 ±0.91 cm in rainy season in IBA 500 ppm followed by 4.10±0.45cm, 4.95 ±0.31cm , 3.72 ± 0.21 (in IAA 500 ppm in Autumn, Winter and Spring respectively). It was also observed that shade is essential for the success of air layers, as good results were observed in layers, which were under shade of the crown.

DISCUSSION

The rainy (July) season was more favourable for rooting of air layers in *Spondias pinnata* due to the fact that constant moisture is one of the essential conditions for successful air layering (Nautiyal 2002, Kadami & Dabral 1954). Callus formation was observed in January, March, July and October in all the treatments. However, the root initiation was more in July, compared to other months, due to higher temperature coupled with higher humidity (Nautiyal 2002). These results are in conformity with the findings of Chandra (1967) for *Magnolia grandiflora;* Shrivastava *et al*. (1994) for *Albizia lucida* and Nautiyal (2002) for *Ficus* spp. Rainy season with rooting hormone provides a favourable environment for inducing roots because of high humidity and rains. The rooting percentage varies in response to season, the high humidity (RH >75–95 %) and optimum temperature (>25–32 ºC) in rainy season favor maximum growth as sphagnum absorbs humidity while temperature helps in root initiation (Kumar *et al.* 2013). Kanwar & Kahlon (1986) reported that layering in Guava was successful when carried out between mid-July and early-October in India. The best rooting and survival in Guava were obtained in July and August in Bangladesh (Akhter 2002). Dhillon & Mahajan (2000) reported that August was the best time for air layering in litchi in respect of rooting success and survivability.

In the winter season the falling temperature might have an adverse effect on root formation in air layers. Better rooting response of air layers was observed with IBA 500 ppm during the month of July. These results have verified the findings of Chauhan & Dua (1982) and Puri & Nagpal (1988) in *Morus alba* and *Dalbergia sissoo*, respectively. Nagpal & Singh (1986) reported that IAA and IBA treatments enhanced the rooting capability in *Bauhinia variegata,* during pre-monsoon and monsoon period. The seasonal changes in the rooting response appears to be regulated by a balance of internal translocation of substances including carbohydrates, nitrogenous substance, hormonal growth regulators and co-factors acting synergistically with auxins (Khosla *et al*. 1982).

Scientists of the various parts of the globe engaged in tree improvement programmes, achieved poor to good success of air layering in different tree species. Good success on rooting and root characteristics of air layering in *Chebulic mycobalum* has been recorded by Misra & Jaiswal (1994) after treatments with Indole Butyric Acid (IBA). IBA has been found to stimulate root initiation in air layers of many plant species like *Carissa carandas* and *Dalbergia sissoo* (Puri & Nagpal 1988). Air layering has been reported in many other forest tree species *viz. Ficus krishnae* & *Ficus auriculata* (Tomar & Singh 2011), *Bombax ceiba* (Venkatesh *et al.* 1978), *Gmelina arborea* (Arya & Haque 1982), *Prosopis cineraria* (Solanki *et al*. 1984). *Acacia nilotica* (Sharma *et al*. 2004), *Eucalyptus microtheca* (Hussain & Ponnuswami 1964), *Guadua angustifolia* (Verma *et al*. 2013) etc.

CONCLUSION

The results of the study show that air layering method is a potential, viable and economical method of vegetative propagation for *Spondias pinnata.* Air layering is relatively simple and very easily adopted by farmers due to high success rate and low mortality. From the results obtained by air layering , it can be concluded that July (Rainy season) proved to be better season for making air layers than other months *viz.* October (autumn), January (winter), and March (Spring) in *S. pinnata*. The hormone treatments proved successful in inducing the root initiation in comparison to control. IBA 500 ppm was more effective in promoting root formation and growth while minimum rooting was recorded with IAA and IBA (control). The number of primary and secondary roots produced was recorded as maximum with IBA 500 ppm.

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Appendix I. Effect of air layering time (season) and rooting hormone on root initiation in *Spondias pinnata*.

	RAINY					AUTUMN					WINTER					SPRING				
	A	**B**	**C**	**D**	**E**	**A**	**B**	**C**	**D**	**E**	**A**	**B**	**C**	**D**	**E**	**A**	**B**	**C**	**D**	**E**
CONTROL	60.2	5.34	1.20 ±0.03	0.88 ±0.15	0.91 ±0.30	60.0	2.78	0.97 ±0.09	0.00	1.01 ±0.06	50.8	1.66	2.01 ±0.11	0.32 ±0.04	1.41 ±0.21	50	0.83	1.59 ±0.30	0.00	1.01 ±0.08
IBA 100	82.1	28	6.20 ±0.70	1.53 ±0.24	3.91 ±0.69	79.2	22.6	3.91 ±0.12	0.96 ±0.01	2.17 ±0.22	80.3	23.8	2.13 ±0.34	0.25 ±0.07	1.80 ±0.21	83.4	20.6	2.13 ±0.20	1.02 ±0.01	1.31 ±0.21
IBA 300	92.6	40.2	12.0 ±1.73	3.73 ±0.30	4.09 ±0.56	90.2	31.6	6.24 ±0.32	1.29 ±0.16	3.26 ±0.25	81.2	41.3	6.91 ±0.82	1.93 ±0.21	3.31 ±0.21	91.6	27.7	5.20 ±0.41	2.00 ±0.21	2.14 ±0.39
IBA 500	97.1	57.7	18.0 ±2.80	5.20 ±1.23	5.40 ±0.91	91.6	45.3	10.01 ±1.24	2.29 ±0.19	3.92 ±0.31	88.7	42.6	12.01 ±1.51	4.23 ±0.81	4.31 ±0.40	92.8	36.9	7.79 ±0.80	3.12 ±0.32	2.97 ±0.21
IAA 100	83.0	22.0	3.40 ±0.43	0.61 ±0.12	3.40 ±0.61	81.7	21.6	3.46 ±0.56	0.92 ±0.06	3.01 ±0.40	79.6	17.1	4.21 ±0.21	1.65 ±0.11	2.21 ±0.07	90.9	14.9	4.21 ±0.30	0.98 ±0.02	3.13 ±0.21
IAA 300	91.3	38.4	10.0 ±1.08	2.02 ±0.23	4.24 ±0.62	94.6	27.9	5.13 ±0.21	1.56 ±0.04	1.98 ±0.11	88.1	17.9	5.91 ±0.34	2.13 ±0.14	3.11 ±0.21	90.3	20.1	3.19 ±0.52	0.86 ±0.10	1.75 ±0.12
IAA 500	95.9	47.2	14.2 ±3.42	3.97 ±0.81	4.70 ±0.86	95.9	39.2	12.12 ±2.29	3.76 ±0.31	4.10 ±0.45	96.2	40.3	10.41 ±3.22	3.41 ±0.11	4.95 ±0.31	96.2	30.6	9.19 ±1.34	2.23 ±0.22	3.72 ±0.21

Note: A = Percent callused layer, B = Rooting percent, C= No. of Primary roots, D = No.of Secondary roots, E = Root Length.