



Effect of Phytohormones on rooting behaviour in air layers of *Phoebe cooperiana*, an economically important tree species of Arunachal Pradesh, India

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ABSTRACT

This study reports the response of air layers of *Phoebe cooperiana* (Common name: Tapil) to different concentrations of rooting hormones in mid hills of Arunachal Pradesh. Ten trees between the ages of 7 and 10 were selected at Boleng village of Siang district, Arunachal Pradesh, India for the experiment. Eight treatments comprising of IBA and NAA at concentrations of 1000 ppm, 2000 ppm and 3000 ppm each, Rootex hormone for semi-hardwood and control were applied to a total of 240 layers during April 2020. After 60 days, rooting percentage, mean number of roots and length of the longest root were recorded. Significant variation ($p < 0.05$) among treatments was observed for all root parameters. Among treatments, the highest rooting percentage and mean number of roots were obtained in layers treated with NAA 3000 ppm (80% and 21.33 respectively). The length of the longest root was the highest in layers treated with NAA 2000 ppm (4.23cm). The highest survival percentage of layers two months after transplanting was observed in those treated with NAA 3000 ppm (54.16%) and the least in control (23.07%). The technique offers an easy and cheap method of propagation for farmers as well as for government and private agencies to enhance seedling production of the species.

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INTRODUCTION

Tapil (*Phoebe cooperiana* (U.N Kanjilal ex A.Das; Family Lauraceae) is an indigenous fruit tree (IFT) naturally distributed in several states of north-east India and in the South East Asian countries. It yields an economically important fruit consumed by tribal communities in the state of Arunachal Pradesh, India. The fruit is eaten at all developmental stages promoting early harvest of immature fruits during August and continues till maturity during October. Fruits are sold at prices ranging from \$8 to \$9 for 100 fruits, or privately owned trees are leased at \$250–\$300 for a single season to local traders and middle-men (Dolley *et al.*, 2020). The species also possesses excellent timber quality (BII class timber) and has high demand in the entire region especially for furniture making (Payum *et al.*, 2013). Consequently it has become one of the favorite IFT species of the local people which can provide quick

intermittent returns within a short period as well as financial security in the future.

Scarcity of seed material and lack of knowledge on alternative propagation techniques impede plant multiplication of many IFTs. They are also seen as factors that inhibit farmers from cultivating these trees (Schreckenber *et al.*, 2002; Akinnifesi *et al.*, 2008). Therefore, developing protocols of vegetative propagation is one of the core activities in a domestication program of IFTs (Raebild *et al.*, 2011). It is also a viable alternative to meet seedling requirement for enriching agricultural landscapes and reviving natural populations. While there is considerable information on vegetative propagation of many IFT species of regional importance using stem cuttings (Tchoundjeu *et al.*, 2006; Mng'omba *et al.*, 2008; Antonia *et al.*, 2014), grafting (Mkonda *et al.*, 2001; Mng'omba *et al.*, 2007; Parveen, 2016) and air layering (Mapongmetsem & Diksia, 2014;

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Bhattacharjee *et al.*, 2018; Kamila & Panda, 2019), there is a lack of knowledge for many which are of local importance. In Arunachal Pradesh, planting materials of *P. cooperiana* are in high demand. However, due to the scarcity of seed and lack of alternative propagation methods, seedling production is limited and costly. The cost of a single seedling can be more than \$1, which becomes unaffordable for many marginal and small farmers. In light of the above, an investigation was undertaken to explore the amenability of different methods of vegetative propagation for the multiplication of the Tapil. Four methods of vegetative propagation including stem cuttings, budding, grafting and air layering were initially tried, out of which only air layering was successful and presented herewith.

MATERIALS AND METHODS

Air layering experiment of Tapil tree was carried out at Boleng village (28°33' 60"N; 94°96' 17"E; 390m above mean sea level), Siang district of Arunachal Pradesh, India, during April 2020. The climatic condition of the area is that of humid subtropical. The pre monsoon rain begins from month of March, and monsoon lasts up to October with the highest rainfall occurring during the month of June and July.

Ten mother trees between the ages of 7 to 10 in a single plantation were selected for air layering. Lower branches of the mother trees having a diameter of 2.0-2.5cm were chosen and a strip of the bark measuring 2-3 cm was removed from the selected branch. The exposed areas were then pasted with phytohormones at varying concentrations mixed with talc powder. The air layers were subjected to eight treatments which were Indole Butyric Acid (IBA) and Napthalene Acetic Acid (NAA) @ 1000 ppm, 2000 ppm and 3000 ppm each, commercial Rootex hormone for semi hardwood and control, which consisted only talc paste. The treated part was then covered with a ball of soil mixed with dried cow dung in a ratio of 1:1 (Das *et al.*, 2015). Soil and dried cow dung was the choice of rooting media because they are locally available and cost effective. The rooting media was then covered with polythene tubing and both the ends were secured firmly using gunny thread. A total of 240 layers were prepared in Completely Randomized Design (CRD) with each

treatment consisting of 30 layers in 3 replications distributed equally among the 10 trees.

The layers were separated from the mother plant after 60 days of operation when the outer surface of rooting medium within the wrapped polyethylene sheet was full of newly formed roots (Figure 1A). The layers were carefully detached from the mother tree and dipped in water to remove the media before root parameters were recorded (Figure 1B). The mean rooting percentage per treatment was calculated by counting number of rooted layers divided by total layers per treatment and expressed in percentage. The mean number of roots was estimated by counting all primary roots of rooted layers in each replication and averaging them. Length of the longest primary root was measured from collar region to the tip of longest primary root and mean value was calculated in centimeters (cm). The detached layers were immediately planted in the prepared polybags of 20 x10 x 7cm filled with sand, soil and FYM in a ratio of 1:1:1 and kept under shade. Survival percentage was recorded two months after transplanting by counting number of seedlings that survived divided by total transplanted under each treatment (Figure 1C).

The data for different parameters were tabulated and statistically analyzed as per the methods outlined by Panse and Sukhatme (1967) followed by a post hoc LSD test at $p < 0.05$. Simple correlation coefficient was used to determine the degree of association among root parameters and survival percentages per the formula given by Weber and Moorthy (1952).

RESULTS

We observed significant difference ($P < 0.05$) in the response of air layers treated with different auxin concentrations for rooting percentage, mean root number and length of the longest root (Table 1). Between the auxins used, NAA treated layers responded better compared to IBA and the commercial rooting hormone 'Rootex' (Table 1). The rooting percentage was twice higher and the mean number of root almost four times more in NAA treated layers compared to IBA treated ones. The highest rooting percentage was obtained in layers treated with



Figure 1: 'A' – Rooted layers of *Phoebe cooperiana* 60 days after layering; 'B' – Rooted layers of *Phoebe cooperiana* treated with NAA @ 3000 ppm 60 days after layering; 'C' – Rooted seedling of *Phoebe cooperiana* treated with NAA @ 3000 ppm two months after transplanting

Table 1: Rooting percentage, number of roots per layer and length of the longest root of layers of *Phoebe cooperiana* treated with different concentration of rooting hormones

Sl. No.	Treatments	Rooting percentage	Number of roots per layer	Length of the longest root (cm)
1	IBA1000	43.33 (42.91)	5.43	1.34
2	IBA2000	33.33 (35.64)	4.87	1.45
3	IBA3000	63.33 (56.59)	5.03	1.85
4	NAA1000	76.67 (70.14)	12.93	3.79
5	NAA2000	73.33 (65.93)	13.90	4.23
6	NAA3000	80.00 (74.36)	21.33	3.76
7	ROOTEX	56.67 (51.65)	4.57	1.77
8	CONTROL	43.33 (42.07)	3.33	1.52
	Mean	58.75 (54.91)	8.93	2.46
	C.V. (%)	16.29	41.32	51.74
	F ratio	7.6341	9.0714	13.162
	S.Em	5.1646	2.133	0.3396
	C.D. @5%	13.875	5.719	1.018

*Figures in parenthesis indicate arc sine transformed values

NAA 3000 ppm (80%) and the lowest was with IBA 2000 ppm (33.33%). The rooting percentage of layers treated with NAA at 1000 ppm, 2000 ppm, 3000 ppm and IBA at 3000 ppm were significantly higher than the control (43.33%). The highest mean number of roots was also obtained for layers treated with NAA 3000 ppm and the lowest was in control (Table 1). Length of longest root was seen to be highest in layers treated with NAA 2000 ppm (6.62cm) and the lowest in IBA 1000 ppm (1.43cm). Rooting percentage between layers treated with NAA 1000 ppm and NAA 3000 ppm did not vary significantly; however, there was a large difference in the mean number of roots per layer (12.93 and 21.33, respectively).

The survival percentage of layers two months after transplanting ranged from 10.53% (IBA 3000 ppm) to 54.16% (NAA 3000 ppm). Higher survival percent was observed in layers treated with NAA as compared to IBA and 'Rootex' treated layers. The control had a survival percentage of 23.07% similar to layers treated with IBA 1000ppm (Figure 2). Positive correlations were obtained between all root parameters and survival percentage (rooting percentage $r^2= 0.47$; $p<0.05$ at d.f =6; length of longest root $r^2= 0.66$; $p<0.05$ at d.f =6); however, mean number of roots was the only parameter that was significant ($r^2= 0.79$; $p<0.05$ at d.f =6; Figure 3).

DISCUSSION

Vegetative propagation offers multiple benefits in the domestication of IFTs where *true-to-type* plants can be propagated in large scale and fruit bearing period reduced drastically. As mentioned earlier, we failed to obtain successful grafts and budded plants in the species and met with limited success in inducing roots among stem cutting. Air layering has an advantage over other techniques of vegetative propagation because reserve food of the parent branch induces well-developed roots and the need of scion-stock compatibility does not arise. Therefore, it becomes a viable option for difficult to root species like Tapil and also practiced in *Myrica esculenta* (Bhatt, 2000) and *Diospyros ebenum* (Mewar & Naithani, 2016).

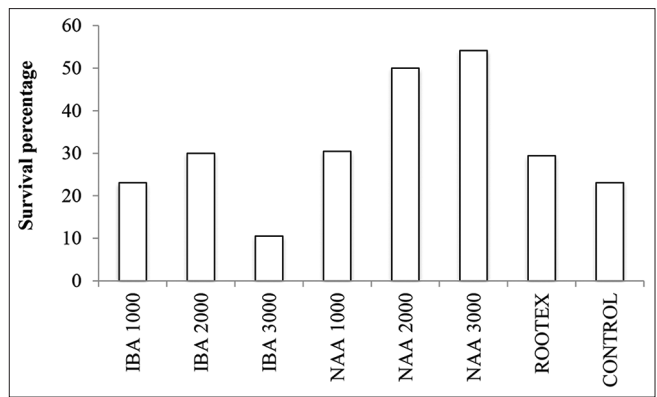


Figure 2: Survival percentage of layers of *Phoebe cooperiana* treated with different concentrations of hormones two months after transplanting

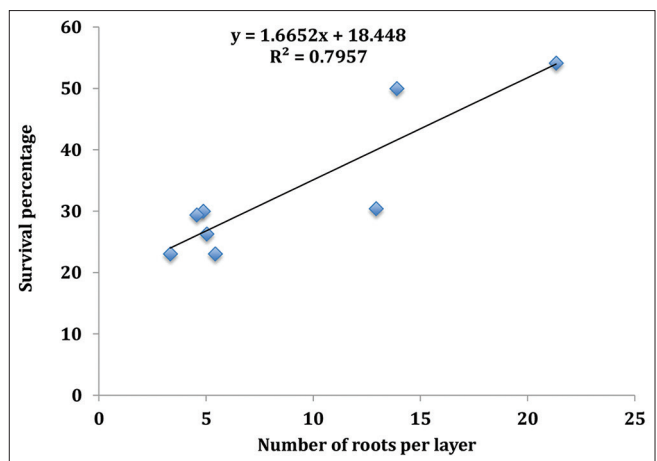


Figure 3: Correlation graph between number of roots and survival percentage of layers of *Phoebe cooperiana* two months after transplanting

Beside the contribution of endogenous auxins to root development (Overwoodre *et al.*, 2010; Tiberia *et al.*, 2011), many studies have shown that exogenous application of auxins results in increased initiation of lateral roots (Chhun *et al.*, 2003). However plant species are known to differ in their response to the type and concentration of auxin that is externally applied. We observed better response of Tapil layers for rooting percentage, mean number of roots and length of longest root in NAA treated layers compared to IBA (Table 1). A similar response was observed in cuttings of *Nyssa aquatica* treated with NAA which produced up to eight times more roots than cuttings treated with no auxin or IBA (Boyer & Graves, 2009). The application of NAA was also observed to significantly enhance rooting ability and root quality of layers compared to untreated or control layers, which becomes vital for generating more number of clonal material from selected genotypes.

Rooting percentage, mean root number and length of longest root were highest in layer treated with NAA 3000 ppm. The results are similar to that reported in air layering of litchi by Jan *et al.* (2003) wherein rooting percentage and number of roots per layer were highest in NAA@3000 ppm treated layers (74.36%

and 21.33cm, respectively) compared to other concentrations (0, 1000, 1500, 2000, 2500 and 3500 ppm). In our study, the maximum concentration of hormone used was 3000ppm. Chatterjee (1982) successfully propagated by air-layering of mango using concentrations of 5000 and 10000 ppm of IBA and NAA. Hence, there is a possibility of obtaining higher rooting percentage and better rooting quality in Tapil under higher concentrations of rooting hormones.

Successful seedling establishment is largely dependent on the capacity of seedlings to rapidly initiate new roots (Grossnickle, 2005). Likewise, proper root development is essential for successful establishment of layers. In the present study, we observed significant positive correlation between survival percentage and mean number of roots (Figure 2) which clearly indicates that root quality is crucial for survival, especially after the layers are separated from the mother plant and transferred to new environments. Type of rooting hormone and concentration are known to influence survival of layers by directly affecting root parameters in litchi and mango as well (Rahman *et al.*, 2000; Bhattacharjee *et al.*, 2018).

This study is the first report on successful multiplication of *Phoebe cooperiana* using vegetative tissue by air layering. Through this technique farmers can now propagate true-to-type trees of their choice to meet their own demand for planting materials. Additionally the method can also be exploited by institutions and agencies for establishing clonal banks for conserving wild gene pool of the species which is fast depleting in its natural habitat. Given that air layering as a method of multiplication is constrained by number of plantlets that can be generated from a single tree, the prospect of multiplication through stem cuttings should be revisited using other rooting hormones and over a wider range of concentration.

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