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Effect of Root Conditioning on Growth and Survival of *Phoebe goalparensis* Hutch. Seedlings in Subtropical Humid Region of Arunachal Pradesh, India

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ABSTRACT

A suitable root conditioning treatment encourages development of fibrous root network which plays an important role in outplanting performance in seedlings. To overcome the problem of root coiling in polybag and possibility of root conditioning in *Phoebe goalparensis*. Hutch seedlings, the experiment consists of base-cutting, root-trainer, different combinations of undercutting and wrenching along with control (untreated seedling in raised bed and polybag) was investigated for their out planting success at Experimental Farm of College of Horticulture and Forestry, CAU, Pasighat, Arunachal Pradesh. Results one year after outplanting for survival were 96.21 % in control (i.e. seedling under polybag with root coiling deformation), and 95.51 % in base-cutting polybag at 1.5 cm from bottom (which need transportation care during outplanting). Owing to get the improved outplanting survival and minimum transportation cost, the bare-rooted seedlings with undercutting depth of 18 cm in July and six times wrenching from month of September to June exhibited 87.38% survival, followed by undercutting depth of 18 cm in July and four times wrenching from month of September to April was 80.18% survival. The results revealed that the undercutting and wrenching treatments were considered appropriate for better performance of seedlings to withstand outplanting stress. The seedling which was not subjected to any undercutting and wrenching treatments (bare root control in raised bed) had lowest outplanting survival (49.94%).

Introduction

Phoebe goalparensis. Hutch is a tall evergreen tree, compact crown with height of approximately 36 metres and a girth of 3.8 metres, having a clean bole of 14 to 17 m length and is distributed in North-East India in the foot-hills of Eastern Himalayas up to an altitude of 1250 m asl. This tropical rainforest species belonging to slow growing timber species of the family *Lauraceae.* It is commonly known as bonsum, nikahi or Assam teak. It is one of the commercial important timber species of Northeast India used for fine furniture, grade-I plywood, musical instruments, sporting goods and for cabinet work (Kundu *et al.*, 2012). Further, it has been observed that the populations of this species are decreasing alarmingly in its natural habitat, largely because of timber operation for wood based industries. Shashidhar *et al.*, (2011) found a decline in the availability of *Phoebe goalparensis* while on the other hand the potentials of the plant have virtually not been improved. The conservation of this species is necessary for future availability of the source through production of quality planting stock and their afforestation programming. The production of planting stock with a large, vigorous root system and a shoot-to-root ratio to match the needs of the outplanting site is a key element in successful seedling establishment in forest plantations (Riley and Steinfeld, 2005).

The success of any plantation programme mainly depends upon the quality of seedlings. Root culturing (undercutting and wrenching) is a method for conditioning seedlings of certain species which ensures better survival on adverse sites. Moreover, the transportation cost from nursery site to plantation site can be reduced to certain extent. Keeping in view the importance of *Phoebe goalparensis*, a study was carried out to find the effect of base-cutting, undercutting and wrenching on growth and survival performance of this species in subtropical humid region of Arunachal Pradesh.

Materials and Methods

The present experiment was carried out at College of Horticulture and Forestry, CAU, Pasighat, (Arunachal Pradesh). The geographical location of the research field is 28° 04' 43" N latitude and 95° 19' 26" E longitude and having an altitude of 153 m asl. The climate of this area is generally humid sub-tropical; cold weather prevails from November to February. Average annual rainfall is 2500 mm, maximum rainfall occurs between June and September. Pre-monsoon rain starts from the month of May and post-monsoon rain prevails up to October, the annual mean maximum temperature is 31±1.1ºC and the mean minimum temperature is 18±1.2ºC. The collected mature seeds were depulped, soaked in ambient water for 24 hrs and sown in the nursery trays during November, 2014 and after 95 days of sowing, the seedlings (at 2-4 leaf stage) were transplanted to raised beds in nursery; polybag (size of 12.5 x 22.5 cm) and hiko-tray (i.e. root trainer size of 150 cc) in randomized, replicated statistical design in nursery, respectively. The plants were planted in the field and randomized block design (RBD) was employed with four replications and eight treatments having nine plants per replication with a spacing of 2 m x 3 m along with two border rows in the periphery of experimental plot to study their survival percent after one year of the outplanting. The different treatments were applied as per the schedule given in Table 1. The dry weight of the shoots and roots was taken from the destructive sample of a plant immediately after outplanting in June, 2016. It was done by keeping the sample in forced-air oven till it is completely dried to a constant weight.

Values of survival percentage were transformed (arcsine-square-root transformation) prior to analysis and were backtrans formed for graphic presentation. The data on height (cm), collar diameter (mm), shoot dry biomass (g), root dry biomass (g) and survival percent was subjected to analysis of variance by following the model suggested by Panse and Sukhatme (1985).

Results and Discussion

It is evident from the Table 2 that the height varies from 10.34 to 13.45 cm and collar diameter varies from 6.02 to 7.78 mm and the difference in height as well as in collar diameter growth was non-significant before the application of treatments (July, 2015). Undercutting, wrenching and base-cutting treatments had a marked influence on seedling height, collar diameter, root and shoot dry biomass, and survival percent. The data on height and collar diameter after undercutting, wrenching and base-cutting treatments shows significant ($p < 0.05$) maximum seedling height as well as collar diameter in an ascending trend upto June, 2016 (11 months after treatments in nursery) in T_1, T_2, T_3, T_4, T_5, followed by T_6, T_7 and minimum value recorded in hiko-trays (T_8). However, the height growth in T_6 (48.90 cm), T_7 (47.43 cm) and collar diameter in T_6 (13.10 mm), T_7 (13.13 mm) were reduced significantly, indicating that undercutting followed by most frequently six time wrenching treatment; and base cutting placed in raised mesh-wire stand developed stress in plants and check the height as well as diameter growth in comparison to other treatments. The findings are in line with the findings of Chauhan *et al.*, (2008).

Table.1 Schedule for different treatments and their codes

Sl. No	**Treatments**	**Codes**
1.	Control (in transplanting bed)	T_1
2.	Control (under poly bag size of 12.5 x 22.5 cm)	T_2
3.	Undercutting (July, 2015)	T_3
4.	Undercutting* and wrenching** (Undercutting depth of 18 cm in July, 2015 & one time wrenching in September, 2015)	T_4
5.	Undercutting and wrenching (Undercutting depth of 18 cm in July, 2015 & four times wrenching i.e., twice in September, 2015 & twice in April, 2016)	T_5
6.	Undercutting and wrenching (Undercutting depth of 18 cm in July, 2015 & six times wrenching i.e. twice in September, 2015, twice in April, 2016, and twice in June, 2016)	T_6
7.	Base cutting *** at 1.5 cm of polybag size - 12.5 x 22.5 cm (in April, 2016)	T_7
8.	Hiko Trays (150 cc)	T_8

* Undercutting: Manual undercutting was done at different depths by using a sharp narrow blade.

** Wrenching: Wrenching is done manually by passing a thick bar underneath the root system at a 45^0 angle. This lifts the seedlings, loosening the soil around the roots. Wrenching breaks the contact between the soil and root tips, resulting in a complete root pruning.

*** Base-cutting: Base is cut off at 1.5 cm bottom part of polybag (12.5 x 22.5 cm) to remove the root coiling formation, and then placing the polybags on raised (0.50m from ground) angle iron stand of welded square mesh of 11 gauge, 25mm x 25mm mesh size.

Table.2 Variances in the height and collar diameter growth of seedlings in nursery

Treatments	HT (cm)	CD (mm)	HT (cm)	CD (mm)	HT (cm)	CD (mm)	HT (cm)	CD (mm)
	(July-2015) **		(December-2015)		(April-2016)		(June-2016)	
T_1	12.30	6.84	23.49	9.72	36.03	13.09	50.5	14.29
T_2	13.45	7.78	23.8	10.90	37.22	13.15	51.03	15.06
T_3	11.98	6.24	22.08	8.26	36.10	12.11	51.75	14.74
T_4	13.23	6.78	21.90	10.04	40.67	14.02	55.48	16.14
T_5	12.48	6.98	21.70	8.75	33.10	9.15	54.85	10.15
T_6	10.95	6.67	20.55	8.39	29.73	11.05	48.90	13.10
T_7	12.25	7.15	21.25	10.16	31.74	12.27	47.43	13.13
T_8	10.34	6.02	15.18	7.45	16.88	8.58	17.50	8.82
Mean ± SE (Range)	12.12±1.04 (10.34-13.45)	6.81±0.55 (6.02-7.78)	21.42±0.78 (15.18-23.8)	9.21±0.84 (7.45-10.90)	32.68 ±1.39 (16.87-40.67)	11.68±0.90 (8.58-14.023)	47.18 ±2.89 (17.5-55.48)	13.18±0.93 (8.82-16.14)
M.S.S.	4.42	1.17	28.690	5.50	209.630	15.20	604.714	25.26
F- Test	2.06^{NS}	1.93^{NS}	23.79*	3.87*	54.25*	9.36*	36.19*	14.53*
C.D. (5%)	2.15	1.14	1.63	1.75	2.91	1.87	6.05	1.94
C.V. (%)	12.08	11.43	5.17	12.94	6.02	10.91	8.67	10.01

*Significant at the 0.05*p*level; ^{NS} Non-significant at the 0.05 *p* level.

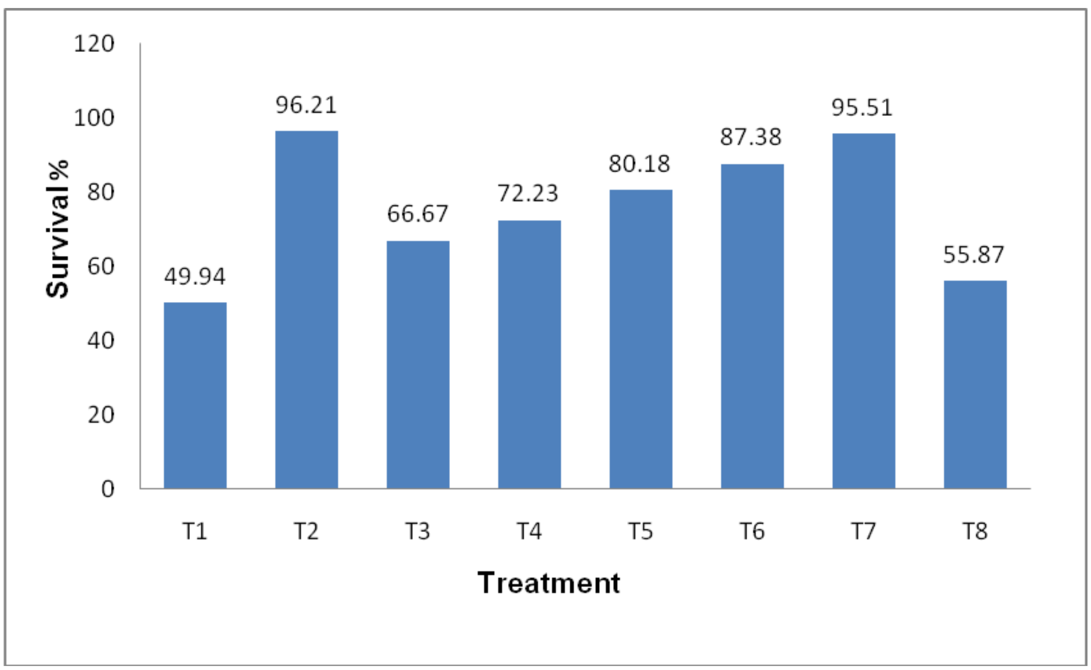
** growth values before root culturing.

Table.3 Variances in the height and collar diameter growth of outplanted seedlings in field and shoot dry biomass (g), root dry biomass (g)

Treatments	HT (cm)	CD (mm)	HT (cm)	CD (mm)	HT (cm)	CD (mm)	Shoot dry biomass (g)	Root dry biomass (g)
	(September-2016)		(January-2017)		(May-2017)		(May-2017)	
T_1	63.00	14.33	63.95	15.33	64.56	16.08	60.30	16.10
T_2	59.20	15.36	59.69	16.86	60.95	17.28	52.20	15.00
T_3	58.8	14.85	64.28	14.95	66.28	15.70	64.69	24.77
T_4	62.23	16.47	67.78	16.53	72.53	17.36	68.49	31.60
T_5	60.00	10.34	63.34	10.39	71.09	11.14	54.30	27.43
T_6	57.85	13.24	61.00	13.27	63.00	14.52	53.13	16.06
T_7	51.12	13.49	53.07	13.59	57.81	14.34	45.10	11.60
T_8	17.70	8.865	19.96	8.8875	19.99	9.012	1.45	1.19
Mean ± SE (Range)	53.74±4.32 (17.7-63.00)	13.37±0.59 (8.87-16.48)	56.63±3.56 (19.96-67.78)	13.73±0.70 (8.89-16.86)	59.53±2.57 (19.99-72.53)	14.43±0.75 (9.01-17.36)	49.95±0.54 (1.45-68.49)	17.97±0.58 (1.19-31.60)
M.S.S.	899.99	26.41	952.63	32.32	1116.22	35.01	1283.60	265.84
F- Test	24.12*	38.57*	37.67*	33.37*	84.28*	30.94*	2916.74*	529.64*
C.D. (5%)	8.98	1.22	7.39	1.45	5.35	1.56	1.16	1.24
C.V. (%)	11.37	6.19	8.88	7.17	6.11	7.37	1.34	4.03

*Significant at the 0.05*p*level

Fig.1 Outplanting survival per cent of *Phoebe goalparensis* seedlings



It is apparent from the Table 3 that in the first season after outplanting (September, 2016) treatment T_1, T_2, T_3, T_4, T_5, T_6, stock grew significantly better in height and diameter followed by T_7 and minimum value exhibited for plants of hiko-trays (T_8). After one year of outplanting (May, 2017), height growth of root conditioned treatments were enhanced in T_4(72.53), T_5(71.09), T_3(66.28), T_6(63.00) followed by T_7(57.81) indicating stock had become established and recovered from outplanting shock. One year after outplanting the survival of the conditioned seedlings by undercutting, wrenching and base-cutting not only survive better than untreated seedlings, but also have better height increment. The maximum survival was exhibited by T_2 (96.21 %) control (untreated seedling under poly bag) and T_7 (95.51 %) base cutting at 1.5 cm of polybag followed by T6 (87.38%) and T5 (80.18%), the minimum survival T_1 (49.94 %) was exhibited in control (in transplanting bed) (Figure 1). In elucidate with the findings, the control (T_1) with maximum survival comprises the relevant fact of undisturbed ball of soil but circling of roots cause root deformation and poor seedling quality. The results indicated that undercutting and wrenching treatments encouraged lateral fibrous root system has higher water and nutrient absorption area and a large number of active root tips, which benefit seedling establishment (Thompson, 1985 and Deans *et al.*, 1990). Root pruning and wrenching treatments have also resulted in higher survival after outplanting for *Pinus taeda* (Shoulders, 1963), *Pseudotsuga menzieseii* (Tanaka *et al.,* 1976), *Quercus rubra* (Schultz and Thompson, 1997) and *Ulmus villosa* (Chauhan *et al.*, 2008). The maximum root/shoot ratio T_8(0.82) of hiko-trays plants displays significant reduced shoot growth and bulky fibrous root development, but being small planting stock it finds difficult to establish in competition to weeds in forestry plantation programmes. The results of dry shoot and dry root biomass (based on oven-dried weight in May, 2017) reveals an increase in root/shoot ratio for bare-rooted seedlings T_5(0.50), T_4(0.46), T_3(0.38), T_6(0.30) followed by unconditioned (control) seedlings T_1(0.26) and T_1(0.28) and minimum for base-cutting T_7(0.25). The minimum root/shoot ratio exhibited in base-cutting stock accounts satisfactory plant height and free of rook kinks, hence the findings suggest with potential for high survival and improved growth after outplanting.

The present study indicated that year-end survival was high for treatment T_7 (seedlings of base-cutting) followed by two undercutting and wrenching treatments i.e. T_6 (undercutting depth of 18 cm and six times wrenching), and T_5 (undercutting depth of 18 cm and four times wrenching) of *Phoebe goalparensis* Hutch. in comparison to the seedlings planted without any treatment. Therefore, to get better survival percent and to minimize the transportation cost the bare-rooted planting stock T_6 and T_5 may be economical.

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