

Nursery Evaluation of Effect of Root Trainer Size on Growth, Biomass and Quality Parameters of *Pinus wallichiana* Seedlings

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Abstract

Comparative study was carried out to standardize appropriate root trainer size for raising *Pinus wallichiana* seedling in the nursery. To screen out best root trainer size three commonly used sizes of root trainers were evaluated i.e. 300 cc, 150 cc and 100 cc. The seedlings were assessed for various growth, biomass and quality parameters. The results revealed that the effect of different sizes of root trainers was significant in respect of all growth, biomass and quality parameters of *Pinus wallichiana* seedlings. The root trainer 300 cc (C₃) performed best in almost all parameters i.e. seedling height (18.48 cm), collar diameter (2.35 mm), fresh shoot weight (1.83 g), total seedling fresh weight (3.14 g), dry shoot weight (0.55 g), dry root weight (0.46 g), total seedling dry weight (1.02 g), sturdiness (78.62) and Dickson's quality index (0.112). This indicates that large size container produced best quality seedling stock, whereas maximum plug compactness was observed in C₁ (100 cc) raised seedlings.

Key words : Root trainer, *Pinus wallichiana*, Growth, Biomass, Quality.

Pinus wallichiana locally known as “Kaiar” belongs to genus *Pinus* and family Coniferae. The common and trade name of *Pinus wallichiana* are blue pine and kail, respectively. Kail is found in moist and dry temperate forest type of western and central Himalayas i.e. Kashmir to Bhutan with an altitudinal zonation of 1,200 to 3,700 masl, which is greater than any other Himalayan conifer. It is tall evergreen tree with spreading or drooping branches, height varies from 30 to 36 m and girth of 2.5 to 3 m with straight bole of about 18 m under favorable conditions (1). *Pinus wallichiana* is most important coniferous tree species of the Himalayan region and is considered next only to Doedar (2). Besides timber, it is largely valued for its oleoresins and resistance to blister rust. Containers used for growing seedlings have passed through a number of revolutionary shapes and designs over time. A large number of plants are raised in poly ethylene bags especially in tropical regions. However, seedlings raised in poly ethylene bags suffer from certain disadvantages. The planting stocks produced in poly ethylene bags encounters severe problem of root coiling and distortion (3). Further, polyethylene bags require more space and volume of growing media and are difficult to handle due to their

size and weight (4). Furthermore, polythene is non-degradable, blocks the rain water seeping into soil so hinders the ground water recharging and burying of polythene bags in mountainous region loosens the grip on vegetation and soil binding, causing land slides. Polythene even destroys bacteria in the soil causing loss of fertility, hence polythene results in soil and water pollution (5). The seemingly healthy plant with such a root system fails to withstand even moderate pressure resulting in large scale wind throw, very often the coiled root strangulates itself as it grows, leading to stunted growth and untimely death of plant (6). To overcome these problems, root trainers are being increasingly introduced especially to prevent root coiling, distortion and pollution.

Root trainers are nursery containers made of high density polyethylene and designed with 4—5 vertical ribs and have open bottoms. The vertical ribs direct the root growth downward and thus avoid root spiraling. These also facilitate air pruning of roots to encourage lateral root development. Root trainers seedling production system facilitates development of vigorous fibrous root system (7). In this process, the over all surface area of absorption zone of roots increases and when planted in the field, the seedling

Table 1. Main features of the root trainers used in the study.

Root trainer	Volume (cc)	Top diameter (cm)	Length (cm) × breadth (cm)	Growing density/m ²
C ₁ 40 cells/tray	100	4	37 × 23	470
C ₂ 25 cells/tray	150	5	29.5 × 29.5	287
C ₃ 12 cells/tray	300	7	32 × 25	150

is expected to establish immediately and starts putting growth. It survives the prolonged drought period after planting because the root development is complete in the nursery itself (4). Root trainers occupy lesser space and require less growing medium and is much easier to transport to plantation site. Keeping these factors in view a trail was laid out to standardise the optimum size of root trainer for raising quality seedling stock of *Pinus wallichiana* in the shortest gestation period.

Methods

The present study was conducted during March 2006 to August 2007 in the nursery of Faculty of Forestry, Sher-e Kashmir University of Agricultural Science and Technology of Kashmir (SKUAST-K) Shalimar, Srinagar (J & K). The experimental site i.e. forest nursery at Shalimar is located between 34.08° N latitude and 74.83° E longitude at an altitude of 1,587 m above mean sea level (msl). The average or mean temperature of the region varies from a minimum of –8 C in winter to a maximum of 34°C in the summer.

To find out the optimum size of root trainer for the production of quality planting stock, three commonly used sizes of root trainers i.e. 100, 150 and 300 cc were evaluated (Table 1).

The one month old seedlings of *Pinus wallichiana* were pricked out for planting in different sizes of root trainers, filled with growing medium i.e. M₁ (peat : vermiculite 1 : 1), M₂ (soil : sand : dal weed 1:1:2), M₃ (soil : sand : spent mushroom 1:1:2) and M₄ (soil : sand : forest litter 1:1:2). The experimental trail was laid with complete randomized design (CRD) taking three replications. The seedlings were maintained by regular watering (twice a day) and weeding. The seedlings were periodically administered with fungicide (copper oxychloride at 0.2%) and urea at 0.2%.

Five seedlings were randomly selected from each treatment per replication and various observations were recorded. Seedling height and collar diameter were measured with graduated scale and digital caliper respectively. For taking fresh weight i.e. total seedling, shoot and root, selected seedling were uprooted without disturbing the root system. The root plug containing potting mixture was gently washed with tap water till all the adhering particles of potting mixture were washed away from the root system. Excess of water was wiped out by placing them between the folds of blotting paper, to achieve the accurate estimations.

For estimation of dry weight of the seedling, the already cut root and shoot were separately dried at 60 C in paper bags for about 48 h in hot air oven and dry weight of shoot, root and total seedling dry weight was recorded using pan electric balance. The seedling quality parameters viz. sturdiness (the ratio of height to diameter), root shoot ratio were calculated for each treatment. Dickson's quality index (seedling weight (g) / height : diameter) was worked out following Dickson et al. (8). Plug compactness was also determined for each treatment, seedlings with plug were taken out of root trainers and dropped on ce-

Table 2. Effect of root trainer size on seedling growth and biomass of *Pinus wallichiana* (blue pine) – 18 month old.

Root trainer	Height (cm)	Collar diameter (mm)	Fresh shoot weight (g)	Fresh root weight (g)	Total seedling fresh weight (g)	Dry shoot weight (g)	Dry root weight (g)	Total seedling dry weight (g)
C ₁ 100 cc	17.86	2.05	1.17	0.89	2.06	0.40	0.25	0.66
C ₂ 150 cc	17.56	2.04	1.48	1.35	2.83	0.48	0.37	0.86
C ₃ 300 cc	18.48	2.35	1.83	1.31	3.14	0.55	0.46	1.02
CD at 5%	0.68	0.16	0.14	0.18	0.18	0.06	0.05	0.10
± SE	0.33	0.08	0.07	0.09	0.09	0.03	0.02	0.05

mented flour to check the plug compactness, a graduated scale was placed to record the length from which seedlings were dropped. The dropping of seedlings with plug was started from 5 cm, then the height was increased till the plug was broken 50% or more and this height was recorded as final reading or full break-age.

The data on growth, biomass and quality parameters of seedlings were subjected to analysis of variance using the computer software Minitab to examine the effect of treatments (root trainers) on all the parameters.

Results and Discussion

Tables 2 and 3 present the observations on different morphological and quality parameters recorded for root trainers raised seedlings of *Pinus wallichiana*. Significant variation was observed among the treatments (root trainer size) in all the growth, biomass and quality parameters studied for *Pinus wallichiana* seedlings. Seedling height was observed to be highest in root trainers (C_3 300 cc) 18.48 cm, followed by C_1 (100 cc) 17.86 cm and C_2 (150 cc) 17.56 cm which were found at par. The collar diameter also followed a similar trend, depicting a significantly maximum in C_3 (2.35 mm), followed by C_1 (2.05) mm and C_2 (2.04) which were observed to be statistically at par with each other.

The seedling height variation in different containers can probably be attributed to the size of containers. The effect of container size on seedling height is well documented (9, 10). Ward et al. (11) reported large *Acer saccharum* seedlings in large containers.

Besides other factors, the growing density of containers also influences morphology and growth of seedlings. In the present study, the root trainer 300 cc had higher container volume and low growing density ($150/m^2$) than that of other containers (root trainers) and therefore resulted in higher seedling height and collar diameter. Shoot height and stem diameter of white spruce seedlings increased with increase in container volume and spacing (12).

The effect of root trainer size was found to be significant in respect of fresh weight recorded. The maximum fresh shoot (1.83 g) and total seedling fresh weight (3.14 g) were observed in C_3 (33 cc) root trainer raised seedlings, followed by C_2 and C_1 whereas maximum fresh root weight (1.35 g) was recorded in C_2

Table 3. Effect of root trainer size on seedling quality parameters of *Pinus wallichiana* seedling (blue pine)—18 month old.

Root trainer	Root/shoot (dry weight basis)	Sturdiness	Dickson's Quality Index	Plug compactness (breaking height in cm>50%)
C_1	0.64	90.70	0.062	26.50
C_2	0.78	89.70	0.088	25.08
C_3	0.86	78.62	0.112	20.33
CD at 5%	0.10	7.80	0.012	1.50
± SE	0.05	3.80	0.006	0.73

(150 cc) followed by (C_3 300 cc) 1.31 g which were found at par. The fresh weight variation between root trainer size has like-wise emerged due to differences in growing density and container volume, as larger the container size more the availability of nutrient for longer period and more the surface area to hold water for better growth of seedlings (13).

The dry matter productions (biomass) in seedlings raised under various root trainer sizes were found to be significant. Highest biomass accumulation in terms of shoot (0.55 g), root (0.46 g) and total seedlings (1.02 g) was recorded in (C_3 300 cc) root trainer, whereas lowest values for dry shoot (0.40 g), dry root (0.25 g) and total seedling dry weight (0.66 g) were observed with root trainer (C_1 100 cc) raised seedlings. Midnawati and Rostiwati (14) found positive relationship between seedling weight and increasing container volume in *Agathis loranthifolia*.

The growing density of containers has also been reported to affect the biomass accumulation by seedlings as an increase in dry weights of white spruce and Douglas fir seedlings with increase in spacing (12, 15). Similar results have been observed in the present study as the dry weight of *Pinus wallichiana* seedling decreased with increasing growing density from root trainer 300 cc ($150/m^2$) to root trainer 100 cc ($470/m^2$).

Results thus reveal that size of a container has profound influence on seedling growth and biomass parameters as the size of container has significant role in carrying capacity of potting mixture, which supports the growth and development of seedling at nursery stage. Larger container provides more sur-

face area to hold water and space for root development resulting in better growth of seedlings.

When the root trainers were compared on the basis of seedling quality parameters (Table 3), the seedlings raised in root trainer (C_3 300 cc) produced highest values for root : shoot ratio (0.86) followed by C_2 (0.78) which was at par and sturdiness (78.62), the low sturdiness value helps in promoting vigorous early growth in plantation (16). The Dickson's quality index, which indicates the over all quality of seedlings was also observed to be maximum (0.112) in root trainer (C_3 300 cc) raised seedlings, whereas minimum value (0.062) was observed in (C_1 100 cc) root trainers. It was observed that plug compactness was comparatively better in C_1 100 cc (26.50 cm) and C_2 150 cc (25.08 cm) root trainers as compared to C_3 300 cc (20.33 cm) root trainer.

The root trainer 300 cc raised stock out performed over other root trainer size viz. 150 and 100 cc. The results may be attributed to the size of containers which provide more space for proper growth and development. Besides that, the growing density of containers also influences the quality parameters of seedling. Therefore, the 300 cc root trainers having higher container volume and low growing density ($150/m^2$) performed better, the results achieved were in conformity earlier reports (16). But the plug compactness was observed to be maximum in C_1 and C_2 as compared to C_3 ; this may be due to more volume of potting mixture and the root system could not occupy the container completely as compared to C_1 and C_2 . The results are in conformity with Rathore et al. (13).

Conclusion

It is concluded that the root trainer 300 cc (C_3) performed best with *Pinus wallichiana* seedlings in most of the parameters studied (growth, biomass and quality parameters).

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