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Effect of Seedling Height and Diameter of *Cedrus deodara* on Out Planting Survival

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ABSTRACT

A study was conducted to determine the effect of seedling height and diameter of polybag and bare root nursery stock of *Cedrus deodara* ("Deodar" or "Himalayan Cedar" or "Deodar Cedar") on survival after out planting. The graded nursery stock of deodar based on morphological parameters (height and collar diameter) was out planted during 2008 and 2009 rains in the field. It is found that polybag raised stock survived better in the field as compared to bare root stock. Naked root deodar stock performed differently in different year of planting on same site owing to local weather conditions controlling field survival to a great extent. In Present study, 15"- 18" height and 5-6 mm root collar diameter of polybag raised stock was found best for enhancing survival in the field. Similar results were recorded in case of naked root stock under normal rainfall/ snowfall conditions. In stress sites, stock height > 15" was found as better parameter related to survival.

INTRODUCTION

Quality planting stock is considered as an indicator of better performance in the field. The quality refers to superiority, vitality, genuineness and disease free material. The quality stock supposed to enhance the productivity of the forest as full genetic potential of stock under normal field conditions will be expressed. Higher cost of production of quality planting stock is fully compensated when we are sure of its better performance and faster growth in the field. The practice of utilizing quality planting stock is gaining popularity for getting higher survival in difficult sites with erratic climatic conditions. It is well known fact that the good planting sites have been already exhausted under various plantation programmes. Now tough sites are available to increase forest cover with refractory conditions and very less soil depth. Situation in Himalayan regions is more difficult owing to shift in monsoon rainfall pattern, less snowfall in winter months and frequent drought like conditions during summer. To overcome all these challenges, production and utilization of quality planting stock of forestry species is now a day's becoming essential in all plantation programmes being carried out in Himalayan states of the country.

The success of any plantation programme depends upon the quality of nursery stock. Compromises made during selection of nursery stock for out planting have significant effect on survival and growth of manmade plantations. The source of planting material i.e. seed or vegetative parts is another important factor as it determines

the genetic quality of the nursery stock, but morphological and physiological quality are equally important for better survival and rapid early growth. Nursery manager can control these parameters to a great extent.

Accordingly, Himalayan Forest Research Institute, Shimla has initiated the work on finalizing morphological parameters of quality for assessing Deodar nursery stock for getting higher survival in the field. There are some passing references on the basis of height; nursery stock is graded into different categories. In case of Deodar nursery stock with height more than 9" is considered fit for planting out. As per Himachal Pradesh Forest Manual, Volume –IV (1986) the size and age of the stock for planting varies with the site and the species. No plant with less than 20 cm in length should ordinarily be used. Exposed areas and sites subject to drought and excessive weed growth must be planted up with large plants. Ordinarily Deodar seedlings should be planted out when 1½ years old, but in difficult and weedy areas, 2½ years old transplants pricked out once should be used. However, Luna (1996) reported that Deodar nursery stock of 1½ years old should be of 20-25 cm and that of 2½ years old should be of 30-45 cm height at the time of out-planting. Tewari (1994) also reported similarly recommendations. Sharma (1998) also stressed the importance of quality seedlings for better field performance.

In the present study, the Deodar stock raised in nursery in polybag and bare root stock was graded into different height and collar diameter classes and out planted in the field to fix optimum values of these parameters to determine the quality of nursery stock based on these morphological parameters.

MATERIALS AND METHODS

The Deodar stock was raised at model Nursery, Baragaon Shimla, Himachal Pradesh-India. It is located about 15 km away from Shimla town on Dhalli-Shoghi bypass in Mashobra Range of Shimla Forest Division (Himachal Pradesh). The nursery is located on the Northern Aspect with 10-15 % slope. The area experiences light snowfall during December to March in winter. It is situated 1800 m above mean sea level (Long. 31°04'14.3"E and Lat. 77°10'15.7"N). The texture of the soil is clay loam.

For determining morphological seedling quality parameters of Deodar based on out-planting, the nursery stock of the species was raised in different seedling production systems and graded based on seedling height and root collar diameter and out planted accordingly for assessing survival as done by various workers (Bronson and Long 1994; Menzies 1988 and Manson and Trewin 1987). Out planting experiments were laid out during 2008 and 2009 rains in Randomized Block Design (RBD) with five morphological grades each based on height and root collar diameter with four replications.

Old abandoned plantations were selected for conducting out planting experiments in Shimla Forest division. The graded nursery stock of deodar based on morphological parameters were out planted during 2008 (both naked root and polybag raised) and 2009 (only naked root) in the field.

Deodar nursery stock raised as bare root stock as well as containerized stock in polybag of size 15 x 23 cm was graded on the basis of height into five classes (T1: <9"; T2: 9"- 12"; T3: 12"-15"; T4: 15"- 18" and T5: >18") with four replications. The plantation was raised at 3 x 3 m spacing

To determine root collar diameter as quality parameter deodar nursery stock raised as bare root stock as well as containerized stock in polybag of size 15 x 23 cm was graded on the basis of root collar diameter (T1: < 4mm; T2: 4-5mm; T3: 5-6mm; T4: 6-7mm and T5: >7mm) with four replication and then field planted directly at 3 x 3 m spacing

Surviving plants in each treatment were counted at the time of recording growth attributes of the out planted deodar plants in all the experiments. The experiments were laid out in Randomised Block Design and the data were

analysed following the procedure described by Gomez and Gomez (1984).

RESULTS

Determination of seedling height as quality parameter

Survival percent of deodar seedling raised in the nursery in polybags and as bare roots stock graded to various height classes is presented in Table 1. The survival was significantly different among various treatments for nursery stock raised in poly bags. However, the survival of bare root stock after one year and two years of planting in the field was found to be non significant. The highest survival percent after one year (94.44 %) and two years (61.11 %) of out planting was found in treatment T4 i.e. 15"-18" height class of poly bag stock followed by T5 (86.11 % - after one year; 47.22% - two years). The lowest survival (19.44 %) was recorded in treatment T1 i.e. <9" height class of poly bags raised stock. The bare root stock could not survival after one and half year of out planting in the field.

Table 1: Effect of seedling height of nursery stock on survival after one and two years of out planting

Treatment	Height class (inches)	Survival (%) after one year (Polybag)	Survival (%) after two year (Polybag)	Survival (%) after one year (Naked root)	Survival (%) after one & half year (Naked root)
T1	<9"	75.00	19.44	0	0
T2	9" - 12"	72.22	38.88	5.55	0
T3	12" - 15"	80.56	41.67	8.33	0
T4	15" - 18"	94.44	61.11	13.89	0
T5	>18"	86.11	47.22	5.55	0
CD 5%		9.50	10.01	NS	NS
Max. Value		94.44	61.11	13.89	0
Min. Value		72.22	19.44	0	0

Determination of seedling root collar diameter as quality parameter

Out planting survival percent, after one year and two years of plantation, of deodar nursery stock raised in the nursery and graded to various root collar diameter classes is given in Table 2. The highest survival percent (91.67%) was recorded in treatment T3 (Dia. class: 5-6cm) after two year of out planting for polybags raised stock. The lowest survival (36.11 %) was recorded in Treatment T1 (Dia. class< 4mm) after two year of out planting for polybags raised stock. The bare root stock could not survive after one and half year of out planting in the field.

Table 2: Effect of collar diameter on survival after one and two years of out planting

Treatment	Root Collar Diameter class (mm)	Survival (%) after one year (Polybag)	Survival (%) after two year(Polybag)	Survival (%) after one year (Naked root)	Survival (%) after one & half year (Naked root)
T_1	<4mm	50.00	36.11	13.89	0
T_2	4- 5mm	91.67	80.56	11.11	0
T_3	5- 6mm	94.44	91.67	2.78	0
T_4	6- 7mm	83.33	80.56	0	0
T_5	>7mm	94.44	80.56	2.78	0
CD 5%		10.60	8.84	7.16	NS
Max. Value		94.44	94.44	13.89	0
Min. Value		50.00	36.11	0	0

Large scale mortality in bare root stock of deodar in 2008 necessitated plantation in the similar site during 2009. The mean value of comparative survival for various height and diameter grades of bare root stock of Deodar after one year of out planting in the field is presented in Table 3 and 4. The data revealed that field survival was much better for bare root stock planted in 2009 as compared with 2008 out planting in same area. The highest survival (75.00%) was recorded in height class T4: 15"-18" and diameter class T3:5-6mm (72.22%) and were found to be significantly better than all other classes except height class T5: > 18" (72.22%) for 2009 out planted bare root stock. The minimum survival (36.11%) was recorded both for height class T1: <9" and diameter class T1: <4mm for 2010 out planted bare root stock.

Table 3: Effect of seedling height of naked root Deodar nursery stock on survival after one year during different years of planting

Treatment	Height Class (inches)	Survival (%) (2008 planting)	Survival (%) (2009 planting)
T_1	<9"	0	36.11
T_2	9" - 12"	5.55	36.11
T_3	12" - 15"	8.33	63.89
T_4	15" - 18"	13.89	75.00
T_5	>18"	5.55	72.22
CD 5%		NS	9.63
Max. Value		13.89	75.00
Min. Value		0	36.11

Table 4: Effect of seedling diameter of naked root Deodar nursery stock on survival after one year during different years of planting

Treatment	Collar Diameter Class (mm)	Survival (%) 2009	Survival (%) 2010
T_1	<4mm	13.89	36.11
T_2	4- 5mm	11.11	50.00
T_3	5- 6mm	2.78	72.22
T_4	6- 7mm	0	58.34
T_5	>7mm	2.78	52.78
CD 5%		7.16	10.00
Max. Value		13.89	72.25
Min. Value		0	36.11

DISCUSSION

The poor performance of bare root stock after out planted in the field was due to the damage of root system during excavation of deodar seedlings from nursery bed and their subsequent handling till planting in the field. Moreover, drought like conditions prevailed during 2008-09 at plantation site and thus bare root stock could not sustain the plantation shock and resulted complete failure in the field. However, plantation shock was bare minimum in case of polybag raised seedlings where roots remained intact and some moisture and nutrients of potting media also taken to the planting site that add to the initial

establishment of the plants in the field. It was also observed earlier that uprooted roots of bare root seedlings are highly prone to desiccation (Mckay1996; Sarvas 2003). The process of removing seedling from their protective bundles at planting sites also increases risk of root desiccation (Mckay 1996). It was also reported by Mckay (1996) that the survival has been decreased owing to root desiccation in Sitka spruce and Douglas-Fir (Mckay and White 1996; and Tabbush 1987a), Loblolly pine *(Pinus taeda* L.*)* (Feret et al, 1985), a range of conifers (Heinrich 1977), Scots Pine (*Pinus sylvestris* L.) and Norway spruce (*Picea abies* L. Karst) (Huuri 1972). Takoustsing et al (2013) also reported that nursery cultural practices vary by species, nursery environment and out planting environment, the only way to fully understand seedling behaviors' promoted by nursery techniques and its effectiveness is to consider the conditions of the out planting site along with the expected seedling performance under those conditions. Similarly, Zaczek et al (1996) reported that six years after out planting, seedlings grown from 2-years old containerized stock were tallest (average 3.3m) and had excellent survival. Owston et al, (1992) while comparing bare root and container seedlings in northern California for Ponderosa pine, Jeffrey pine, Douglas-Fir and California white fir planted 10 years earlier on three sites in northern California showed that the container stock survived better in all situations, without exception. Furthermore, P+0 seedlings were as tall as or taller than the bare root stock (1+0 for white fir, 2+0 for the other species) except that of bare root seedlings of all species at all locations without exception. The success of the container seedlings attributes to their early ability to capture site resources. However, Thomson and Mc Minn (1989) found inconsistencies in the performance after 10 years of planting of 2-years old bare root and 2 year old container grown white spruce seedlings across a number of plantations in British Columbia and suggested that there were likely genetic variations in the planting stock. In many other studies, it has been reported that container seedlings generally survive better than bare root stock and produce early growth faster (Alm 1983, Mc Donald 1991, Barnett and Mc Gilvary 1993 and South et al 2005). Jinks and Kerr (1999) reported that survival was high (>87 percent) in Japanese paper pots raised seedlings of Corsican pine (*Pinus nigra* var. maritima) as compared to 2 year old bare root seedlings.

Planting of bare root stock in 2009 increased the survival of seedlings. South et al (1993a) also found that planting date had a dramatic effect on field performance and that planting into dry soil can reduce survival and growth. Thus differing seedling characteristics on the various planting dates may explain why planting period had a large impact on survival but the effect of conditions at time of planting need to be considered as well. Even Bayley and Kietzka (1996) reported that survival of Pinus patula could be significantly improved by identifying the best time of year and conditions for planting as well as improving stock quality. Our results are in conformity with these studies.

CONCLUSION

It was found that polybag raised stock survived better in the field as compared with bare root stock. Even naked root deodar stock performed differently in different year of planting on same site owing to local weather conditions controlling field survival to a great extent. 15"-18" height and 5-6 mm root collar diameter of polybag raised deodar stock was found best for enhancing survival in the field.

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