Performance of Conifer Stocktypes on National Forests in the Oregon and Washington Coast Ranges[1]

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Abstract.--During the 1970's, container and bareroot stocktypes of conifer timber species were widely tested in the Coast Ranges of Oregon and Washington. Both survival and total height varied widely in tests on national forests. After 4 to 5 years, neither stocktype survived consistently better than the other. However, on these relatively moist sites with lush development of competing vegetation and high animal populations, larger nursery stock (represented by bareroot seedlings) tended to grow taller than stock that was initially smaller. Site factors seemed to influence survival and growth more than did the original stocktype.

INTRODUCTION

The decade of the 1970's saw rapid development of forest nursery technology. High demand for seedlings, lack of good sites for expansion of bareroot nurseries, and a perceived biological advantage of protected root systems fostered creation of container nurseries. The new stocktypes were being planted operationally, and they were also being tested throughout the Pacific Northwest to determine their suitability and limitations.

From 1974 through 1976, scientists from the Pacific Northwest Research Station of the USDA Forest Service initiated extensive field tests on the national forests in the Pacific Northwest Region. These planting trials were designed to systematically compare survival and growth of container and bareroot stocktypes on a wide variety of sites and in a number of different field conditions (Owston and Stein 1974). In addition, stocktype comparisons were part of a large, integrated study of reforestation systems on the Siuslaw National Forest in western Oregon (Stein 1984, unpubl.). Examination of the 4- or 5-year results of all these trials provides insight and guidance for the use of nursery stock in current reforestation operations (age was consistent within trials). This paper focuses on two primary species, Douglas-fir (Psuedotsuga menziesii (Mirb.) Franco) and western hemlock (Tsuga heterophylla (Raf.) Sarg.). Some trials of Sitka spruce (Picea sitchensis (Bong.) Carr.) and western redcedar (Thuja plicata Donn ex D. Don) are also described.

METHODS

For the Region-wide trials, container and bareroot seedlings of one species were planted on each of numerous test sites. The sites were part of the normal reforestation programs of the participating ranger districts. Four plots, each consisting of two rows of 25 trees of each stocktype, were to be established on each site. Variations in this design occurred on some sites to meet special objectives or to accommodate site conditions (e.g., several different sizes of containers were tested in a few of the trials by adding additional rows). Plot locations were selected so that slope, aspect, and composition of associated species were representative of the area and relatively homogeneous within individual plots. Unplantable spots were skipped, and rows were extended to provide the required 25 planting spots. Generally, survival was checked and seedling heights were measured every other year.

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Several steps were taken to ensure unbiased comparisons:

1. Within each trial, the container and bareroot seedlings were from the same seed source.
2. Both stocktypes were planted concurrently to eliminate weather as a variable.
3. Trees within a plot were planted by the same person, or planters were rotated between stocktypes to minimize planting quality as a bias.
4. Animal protection measures or other treatments were applied the same to each stocktype in a trial.

Similar methods were used for the integrated study on the Siuslaw National Forest, except that site preparation treatments and more stocktypes were included in large installations on six clearcuts (Stein 1984). Douglas-fir and western hemlock were both planted.

Each of the sites in the Region-wide study was considered separately for statistical analyses (analysis of variance). The results are indicated for example sites to be described in detail. The six sites in the Siuslaw study were designed and analyzed as one experiment (Stein 1984); these results will be detailed in a later research paper.

We provide an overview of coastal results by presenting the number the individual coastal study trials in which one stocktype did better, worse, or about the same as the other. For survival, one comparison considers performance to be the same if the mean survivals of both stocktypes are within 10 percent of each other. A second comparison considers performance to be the same if the means do not differ by more than 20 percent. These are arbitrary thresholds used to indicate a general levels of comparability that the authors feel are useful to reforestation specialists.

Similar comparisons were made for total height using arbitrary threshold values of 10- and 20-percent differences between mean heights to categorize stocktypes as being the same or different from each other.

NURSERY STOCK

The majority of tests were performed using seedlings grown in relatively small containers, 2.4 to 4 cubic inches in volume, and average 2+0 bareroot seedlings (tables 1 and 2). Most of the container stock was grown at the Beaver Creek Seed Orchard of the Siuslaw National Forest, near Corvallis, Oregon. The containers used were either styrofoam blocks with cavities or individual plastic cells (RLP's). All of the container stock was planted as plug seedlings; i.e., removed from the containers before planting. The bareroot stock was produced mostly at the Humboldt Nursery in northern California or the Wind River Nursery in southwestern Washington.

Stein's (1984) study on the Siuslaw National Forest included several different classes of bareroot Douglas-fir stock, but only the medium-size class was considered in this paper. Only one size-class of western hemlock was used. Half of Stein's seedlings were protected from animal damage and half were not. We used the data from unprotected stock, because stock in the Region-wide study were also unprotected.

Of 28 trials included in our data, 13 were with Douglas-fir, 10 with western hemlock, 3 with Sitka spruce, and 2 with western redcedar.

Table l.--Characteristics of planting stock for example trials of Douglas-fir.

	Trial no.			
Description	1	2	3	4
When Planted	12/73	3/76	11/77	7/75
Bareroot type	2+0	2+0	2+0	2+0
Ave. ht. (cm)	Unk.	30	38	35
Ave. cal.(mm)	Unk.	Unk.	5.2	3.4
Container type	Styro-2	RLP	RLP	Styro-2
Root Vol.(cc)	40	65	65	40
Ave. ht. (cm)	20[1]	19	11	21
Ave. cal.(mm)	2.5[1]	Unk	2.1	2.5

[1]Estimated from species averages for seedlings produced at the same nursery during the same time period.

Table 2.--Characteristics of planting stock for example trials of western hemlock (WH), Sitka spruce (SS), and western redcedar (WRC) on the Siuslaw National Forest.

	Trial no.			
Description	5	6	7	8
Species	WH	WH	SS	WRC
When Planted	2/75	4/74	1/74	7/75
Bareroot type	2+0	Wildling	2+0	2+0
Ave. ht. (cm)	26	Unk.	20	Unk.
Ave. cal.(mm)	3.4	Unk.	2.8	Unk.
Container type	Styro-2	Styro-2	Styro-2	Styro-2
Root Vol.(cc)	40	40	40	40
Ave. ht. (cm)	15	14	27	20[1]
Ave. cal.(mm)	2.0	2.0	2.2	2.2[1]

[1]Estimated from species averages for seedlings produced at the same nursery during the same time period.

STUDY SITES

Details are given for four trials of Douglas-fir on the Olympic, Siuslaw, and Siskiyou National Forests (table 3) and trials of western hemlock, Sitka spruce, and western redcedar on the Siuslaw (table 14) to illustrate examples of variations encountered. Elevations of the sites ranged from 800 to 2,700 feet above sea level. Soil conditions varied from those typical of the Coast Ranges to shallow, rocky sites perceived or experienced to be difficult to reforest. All of them were on clearcuts and most of them had been burned for site preparation; but re-encroaching vegetative competition was variable.

Sites in the other 20 trials covered a similar range of conditions.

RESULTS

Example Sites

One readily apparent result is that differences in average survival were much greater between sites than between stocktypes within sites, Assuming little change in survival between 4th and 5th years, differences between sites ranged from 2 to 52 percent, whereas those between stocktypes within sites ranged from 0 to 12 percent (figs. 1 and 2).

Considering only the 5-year-old trials, the range of height differences between sites was 9 to 161 centimeters, whereas differences between stocktypes within sites ranged from 5 to 19 centimeters (figs. 3 and 14).

Table 3. --A summary of site conditions for example trials of Douglas-fir planted in the mid-1970's.

	Trial no.			
Description	1	2	3	4
National Forest	Siuslaw	Siskiyou	Siskiyou	Olympic
Ranger District	Mapleton	Gold Beach	Gold Beach	Soleduck
Elevation (ft.)	1,000	2,700	1,500	1,400
Aspect	South	Southeast	West	North
Site Index	IV	III	II	III
Soil Depth & Character	Shallow Gravelly	Medium Rocky	Medium Loam	Shallow Rocky
Site Preparation	Burned	Burned	Burned	Burned
Cover at Planting	Open	Brush (tanoak)	Open	Hvy. herbs & slash

Table 4. --A summary of site conditions for example trials of western hemlock (WI-I), Sitka spruce (SS), and western redcedar (WRC) planted in the mid-1970’s on the Siuslaw National Forest.

	Trial no.			
Description	5	6	7	8
Ranger District	Alsea	Hebo	Waldport	Mapleton
Species	WH	WH	SS	WRC
Elevation (ft.)	1,200	800	750	900
Aspect	North	South	East	W to N
Site index	II	II	II	III
Soil depth & character	Medium Well-drained	Medium Well-drained	Medium Loam	Shallow Rocky
Site preparation	Unburned	Burned	Burned	Burned
Cover at planting	Medium brush	Light brush	Open	Hvy. herbs & slash

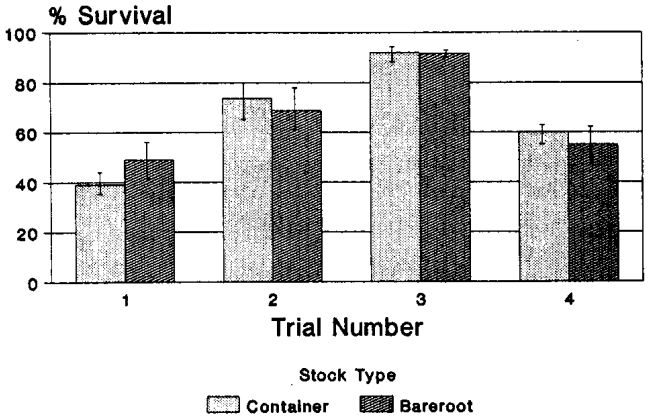

Figure l.--Average survival 4 (trials no. 1 and 4) or 5 years after planting of Douglas-fir stocktypes in example trials on coastal sites in Oregon and Washington. Vertical bars represent 1 standard error. None of stocktype differences are significant at the 95% level.

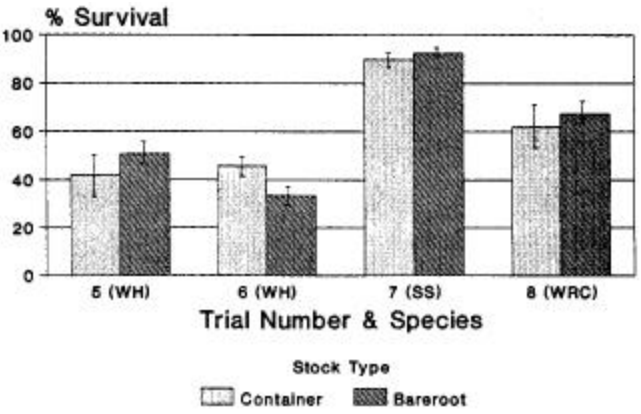

Figure 2.--Average survival 4 (trial no. 5) or 5 years after planting of western hemlock, Sitka spruce, and western redcedar stocktypes in example trials. Vertical bars represent 1 standard error. None of the stocktype differences are significant at the 95% level.

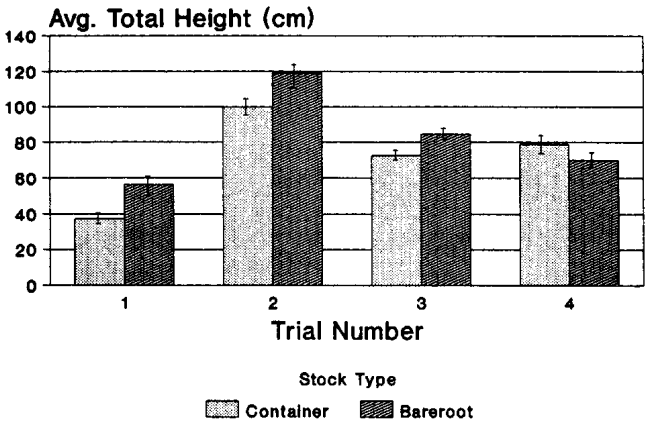

Figure 3.--Average total height 4 (trials no. 1 and 4) or 5 years after planting of Douglas-fir stocktypes in example trials. Vertical bars represent 1 standard error. Stocktype differences in trials no. 1 and 3 are significant at the 95% level.

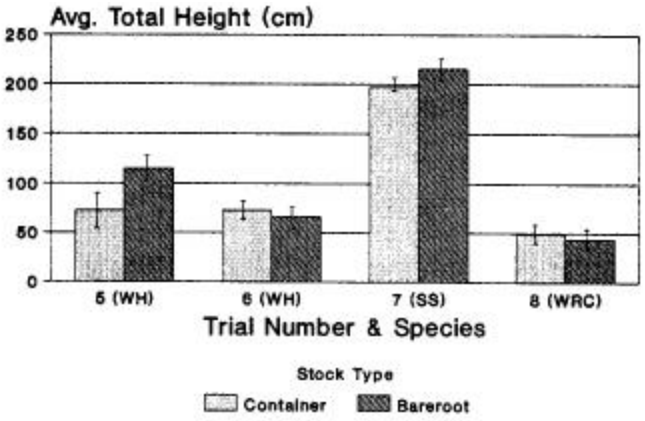

Figure 4.--Average total height 4 (trial no. 5) or 5 years after planting of western hemlock, Sitka spruce, and western redcedar stocktypes in example trials. Vertical bars represent 1 standard error. Stocktype differences in trials no. 5 and 7 are significant at the 95% level.

In two other tests where containers both 2.4 and 4.0 cubic inches in volume were used, survival differences were only 3 to 4 percent and inconsistent; height differences in the seedlings after 4 or 5 years were only 6 to 7 percent of average total height, but the larger containers yielded the tallest average seedling height in both cases. In another trial of Sitka spruce, where containers with volumes of 2.4 and 8.0 cubic inches were used, survival after 5 years was 90 percent and 100 percent, respectively; average total height was 197 and 265 centimeters, respectively.

Overall Comparisons

A total of 28 stocktype study sites were installed by the PNW Research Station on coastal sites in Oregon and Washington (counting Stein's sites twice--once for each of the two species). Figures 5 and 6 display the numbers of these sites in which one stocktype or the other does better, worse, or about the same as the other.

The most striking observations from these comparisons are:

1. Stocktype very seldom made a large difference in survival (i.e., 20% or more).
2. Even small differences in survival between stocktypes (10% to 19%) occurred in only about half of the tests, and one type was better about the same number of times as the other.

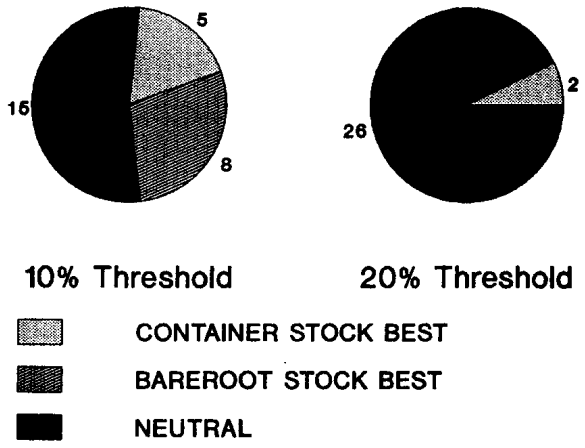

Figure 5.--Number of individual trials in which one stocktype had better, the same, or worse average survival than another.

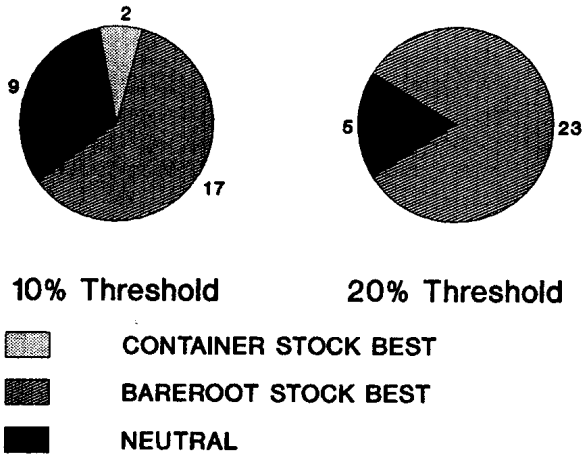

Figure 6. --Number of individual trials in which one stocktype was taller, the same, or shorter in average total height than another.

3. In terms of total height after 4 to 5 years, bareroot seedlings showed an advantage at both the 10- and 20-percent thresholds.

DISCUSSION

In terms of survival, bareroot and container stocktypes have performed fairly similarly on coastal sites. Individual cases when one stocktype has done much better than another can sometimes be traced to a specific case of poor or mishandled stock, and we suspect that has been the case in other, untraceable situations.

Some readers might be surprised at the relatively low survival of both stocktypes in some of the examples. We ascribe this to two causes: (1) sites selected for container vs. bareroot tests were often the very toughest on the national forests, because the silviculturists selecting the sites were looking for answers to difficult problems; and (2) seedlings were not protected from animal damage in most of the tests. In situations where half of the seedlings of each type were protected and half unprotected, the protection treatment (tubing with rigid plastic mesh) significantly improved survival of both stocktypes (Stein 1984, unpubl.).

In terms of growth on coastal sites, initial seedling size seemed more important than if it was raised in a container or in a bareroot seedbed. The few tests of different container sizes in the Region-wide study and Stein's data for different size classes of bareroot stock (Stein, 1984 unpubl.) indicated that larger seedlings grew better than smaller ones. The relatively mesic environment makes top/root ratio less critical than in dry areas. Also, large seedlings have an advantage in withstanding animal damage and being able to stay ahead of the regrowth of competing vegetation.

It is our opinion that factors of seedling physiological condition, size at time of planting, and environmental conditions on the planting site override differences in performance potential between stocktypes. This is based on personal experience, studying available data, and examining the literature (Owston, this volume). Empirical trials of stocktypes are probably only useful for very specific areas and situations where particular types are related directly and consistently to distinct sizes and conditions of seedlings.

It was the hope of many early proponents of container seedlings, including the authors, that the protected, relatively undamaged root systems and opportunity to fine-tune their condition in greenhouses would provide a biological advantage that would more than offset their generally smaller initial size. This has not been the experience on the coastal national forests in the Pacific Northwest. Also, a stocktype trial in the Oregon Coast Range by one Oregon paper company resulted in larger bareroot stock both surviving and growing better than smaller bareroot or container stock (Iverson and Newton 1980).

Other ownerships have had different results--probably because of size and condition factors, as already mentioned. For example, Georgia-Pacific Corporation had consistently better survival with container seedlings than with bareroot stock in plantings along the Pacific Northwest coast in the 1970's (Hahn and Hutchison 1978).

In conclusion, we recommend that reforestation specialists in the Coast Ranges of Oregon and Washington and areas of similar site conditions look first for where they can consistently obtain healthy, well-conditioned planting stock with a good balance between tops and roots. Within those choices, they should opt for the largest seedlings they can afford when considering the overall environmental and economic objectives of their organizations.

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