IMPORTANCE OF TOP-ROOT RATIOS FOR SURVIVAL OF DOUGLAS-FIR SEEDLINGS

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Coniferous seedlings with tops more than three times heavier than the roots are considered poor risks for planting (1). However, results of a study reported here indicate that a high top-root ratio is not necessarily detrimental to survival of seedlings that have well-developed root systems.

Seedlings studied were 2-0 Douglas-fir grown from seed collected in the southern Oregon Coast Range at elevations varying from 300 to 600 feet. Excessive watering and fertilizing during the seedlings' second year in the nursery resulted in a high percentage of plants with large tops. Terminal and lateral shoots of many seedlings were still succulent in mid-November 1961, when they were lifted, packed in moist shingle tow, and put into cold storage.

A bale containing 2,000 seedlings was provided in December 1961 by the State office of Bureau of Land Management (in Portland). John F. Lanz and Erik V. Abolins of the Coos Bay District, Bureau of Land Management, helped find a suitable area for planting and supervised the planting.

Methods

Seedlings were sorted into three classes according to height of top: 5 to 10 inches, 10 to 15 inches, and 15 to 20 inches. Height of top was measured from the root collar to the, terminal bud. Seedlings in each of the three classes were separated into plants with good and poor roots. This sorting, which was done visually, was somewhat arbitrary because of gradation in extent of root systems (fig. 1). These six groups of seedlings were subdivided into seedlings with and without succulent shoots. The percentage of seedlings falling into each of these 12 groups is shown in table 1.

Ratios of tops to roots were determined by weight and height for 60 seedlings in each of the three size classes (table 2). The average weight of the tops of seedlings in the 15- to 20-inch class was more than three times as much as that of the roots, but the tops of seedlings shorter than 15 inches weighed less than three times as much as their roots.

The site selected for planting was a nearly level plateau at an elevation of 400 feet in the western foothills of the Coast Range about 4 miles northeast of Coquille, Oreg. The area had been scarified the year before, and competing vegetation had not yet appeared. The soil, a well-drained Brown Latosol, was identified as silt loam comparable to the Preacher series in the Alsea Basin.

Six hundred seedlings were planted in five blocks; each block contained 10 seedlings from each of the 12 groups listed in table 1. The position of seedlings in blocks was assigned by random numbers.

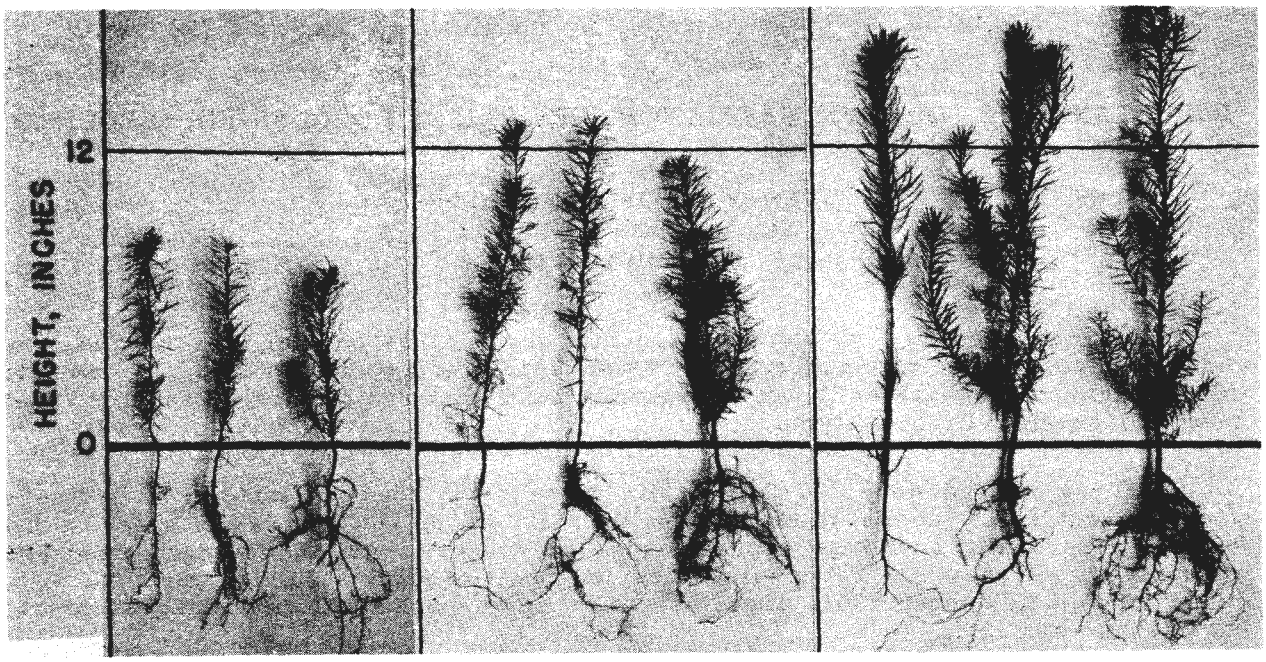

Figure 1.--Roots of seedlings to the right and left in each of the three size classes represented were classified as good and poor, respectively.

TABLE 1.--Tally of 2,000 seedlings sorted into 12 groups according to combinations of morphological characteristics

Roots (by length of top)	Succulent shoots	Seedlings in group
		Percent
5 to 10 inches:		
Poor	Present	3
Do	Absent	8
Good	Present	4
Do	Absent	9
		24
10 to 15 inches:		
Poor	Present	8
Do	Absent	18
Good	Present	11
Do	Absent	9
		46
15 to 20 inches:		
Poor	Present	6
Do	Absent	7
Good	Present	7
Do	Absent	10
		30

TABLE 2.--Ratios of top to root of 2-0 Douglas-fir in size classes studied. Each value is based on 30 measurements

Root development (by length of top)	Top-root ratios			
	By height		By oven-dry weight	
	Average	Range	Average	Range
5 to 10 inches:				
Poor	1.2	0.6-1.7	1.7	0.9-2.1
Good	1.1	.7-1.7	1.5	.8-1.9
10 to 15 inches:				
Poor	1.8	1.6-2.6	2.5	1.4-3.1
Good	1.8	1.7-2.6	2.1	1.6-3.0
15 to 20 inches:				
Poor	2.7	2.5-3.3	3.6	2.5-6.1
Good	2.3	1.9-3.1	3.2	2.1-4.2

Additional seedlings in three groups of 80 with 15- to 20-inch tops were top-pruned in three degrees of severity before planting--three-fifths, two-fifths, and one-fifth of their lengths. A fourth group was not pruned. Each group contained an equal number of seedlings with good or poor roots. Twenty seedlings from each group were planted randomly in each of four plots.

All plantings were made between January 3 and 5, 1962. An enclosure of chicken wire 3 feet high was placed around each individual seedling immediately after planting. These cages prevented clipping and browsing by animals, so test results were not confused by such damage.

Results

Survival of seedlings, graded according to the 12 combinations of morphological characteristics, was recorded on November 1, 1962 (fig. 2). Size of tops and quality of root systems were the variables of significance for survival (table 3). Further statistical analysis, using the method of least significant difference, led to these conclusions:

1. Survival of seedlings with 15- to 20-inch tops was significantly lower than for those with smaller tops. Differences were not significant between survival of trees with 10- to 15-inch tops and those with 5- to 10-inch tops.

2. Survival of seedlings with poor roots was significantly lower than for seedlings with good roots, regardless of size of top.

3. Survival of seedlings with succulent shoots was lower than for those without succulent shoots, except for seedlings with 10- to 15-inch tops and good roots. However, differences were not statistically significant.

Pruning tops of seedlings was a complete failure. None of the pruned seedlings, regardless of degree of pruning, survived. More than90 percent of these trees were already dead in June. Survival of unpruned seedlings on November 1, 1962, was 78 percent for those with good roots and 41 percent for those with poor roots.

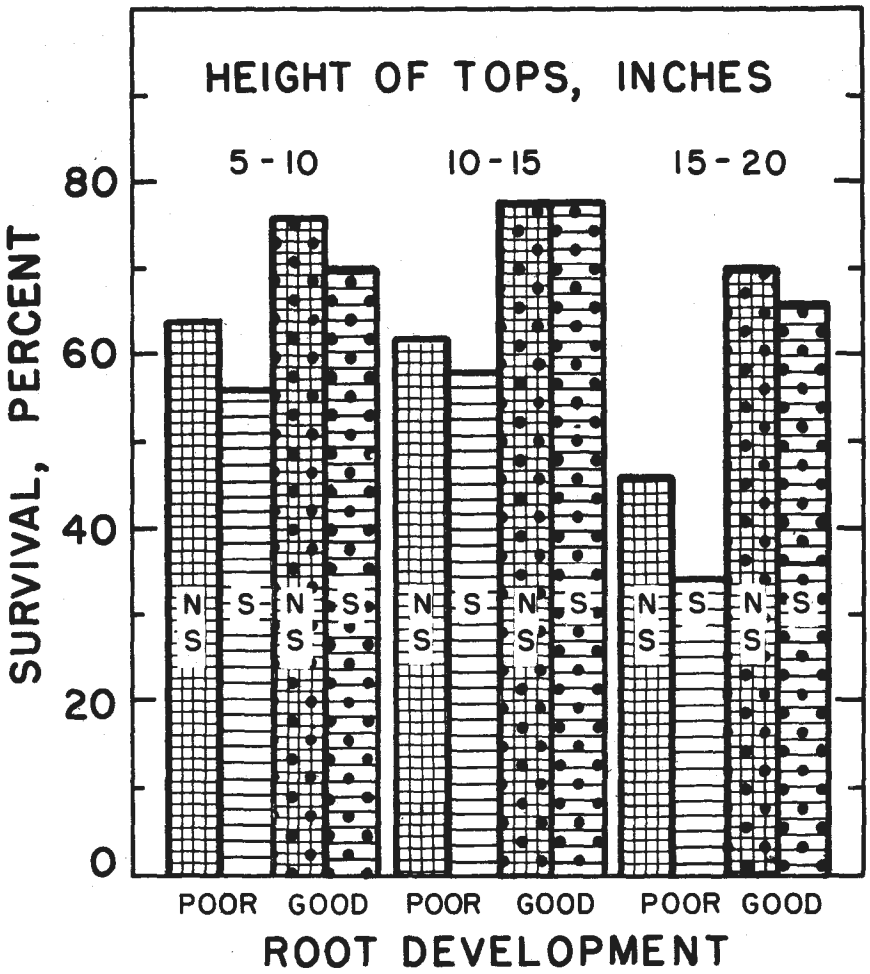

Figure 2.--Effect of root development on survival of 2-0 Douglas-fir seedlings during the first year in the field. Seedlings with succulent shoots are included in columns marked S; NS signifies absence of such shoots.

TABLE 3.--Analysis of variance of first-year survival of 2-0 Douglas-fir graded according to 12 combinations of morphological characteristics

Source of variation	Degrees of freedom	Mean square
Replications	4	1.4333
Tops	2	[1] 12.9167
Roots	1	[1] 58.0166
Succulence	1	4.8166
Tops x roots	2	2.9167
Tops x succulence	2	.5167
Roots x succulence	1	.8168
Tops x roots x succulence	2	.1166
Error	44	2.1061

[1] Significant at the 1 percent level of probability.

Discussion and Conclusions

Seedlings with high ratios of top to root are undesirable for planting, particularly on severe sites.. Results indicate that the absorbing capacity of their root systems often is unable to counteract transpirational losses of crowns (2). The top-root ratio critical for survival probably varies with several factors, such a's species, physiological condition of stock, site, and climate.

Data presented in this studyindicate thata seedling with a well-developed root system has a better chance of survival, even if its top does weigh three times more than its roots, than a seedling with poor roots and a top that weighs less than three times the weight of its roots. Therefore, to designate categorically a ratio of 3 to 1 between top and root weights as the acceptable limit for survival seems unwarranted, at least for Douglasfir seedlings.

Pruning the tops of large seedlings improves balance between tops and roots. This method is practiced successfully on Douglas-fir seedlings in some nurseries. However, top-pruning cannot be recommended as a treatment following early lifting of stock.

Douglas-fir stock of the kind described in this report should be graded prior to planting. If time and facilities permit only visual grading, root development is a reliable criterion for eliminating seedlings that are poor risks. Succulence of shoots, however, seems to be a questionable criterion for predicting performance of stock. Presence or absence of succulent shoots is probably an insufficient basis for accurately judging hardiness of seedlings.

Literature Cited

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