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DOUGLAS-FIR SEEDLINGS PLANTED BY FOUR METHODS...results after 10 years

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Bare-root Douglas-fir seedlings were planted by four methods in late February and late March on a hot, south-facing slope in northwestern California. The four techniques were: standard planting, deep planting at two different depths, and shading of the lower stem. After 10 growing seasons, there were no significant differences in survival attributable to planting technique or planting date. Height growth showed no response to planting method, but did show response to planting date. Trees planted in February averaged a foot taller than those planted in March, but the precise reason for this difference could not be pinpointed.

Oxford: 174.7 *Pseudotsuga menziesii* var. *menziesii:* 232.423[+232.324 + 561.1]
Retrieval Terms: Pseudotsuga menziesii var. *menziesii;* planting depth; planting date; seedling survival; height increment.

Hot, south-facing clearcut blocks planted to Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco var. *menziesii*) are often difficult to regenerate in northwestern California. The combination of high temperatures and summer drought often reduces survival to unacceptable levels. Various methods to improve survival and growth have been tried over the years, with varying degrees of success.

One such test was started on the Gasquet Ranger District, Six Rivers National Forest, in February and March 1965. The study involved the testing of planting techniques that have been successful elsewhere in improving either survival or growth of planted trees of other species under conditions of heat or drought.

The four treatments tested were: (1) deep planting (burying one-quarter of the stem); (2) very deep planting (burying one-half of the stem); (3) stem shielding (shading the lower portion of the stem and surrounding soil with a curved shield of heavy-gauge aluminum foil); and (4) control (normal planting depth and no stem shielding). The planting stock was 2-0 Douglas-fir which averaged 8 to 10 inches (20 to 25 cm) tall and was root-pruned to about 10 inches (25 cm).

In addition to testing four planting methods, two planting dates—late February and late March—were also tested. The first of these was well within the normal planting season, but the second could be somewhat risky (because of soil drying) at lower elevations in a dry year. Thus, the March planting date was tested to determine its possible influence on survival or subsequent height growth of seedlings.

The results of this study at the end of three growing seasons were reported earlier.[1] At that time, none of the planting techniques had caused significant differences in tree survival (it was excellent on all plots). Several treatments, however, seemed to improve height growth.

A revisit to the plots at the end of 10 growing seasons and an analysis of the data show that...

- Survival was not significantly affected by any of the planting treatments tested.
- Trees that were deep planted showed a height advantage after three growing seasons, but not after 10 seasons.
- Planting in February resulted in significantly greater height growth than did planting in March. Planting dates and length of storage were necessarily confounded in this study, however, so that the reason for the height advantage of February planting cannot be precisely identified.

STUDY SITE

The planting site was a clearcut block situated on the south-facing flank of a minor east-west ridge where elevation is about 2000 feet (610 m). Slope percent averaged 50 to 55. Before logging, the study site had supported a mixed stand of Douglas-fir and sugar pine (*Pinus lambertiana* Dougl.), with patches of young knobcone pine (*Pinus attenuata* Lemm.). Some tanoak (*Lithocarpus densiflorus* [Hook & Arn.] Rehd.) was also present.

The soils in this area are unmapped, but those on the study site resemble the Neuns series derived from Greenstone igneous rock. The upper foot is a brown, moderately gravelly loam, with a pH of 5.6 to 5.8. The subsoil is more finely textured, but also gravelly. Limited sampling showed no bedrock within 4 feet (1.2 m) of the soil surface.

Climatic data are not available for the study site itself, but long-term weather records have been maintained at the Gasquet Ranger Station, 3 miles to the northwest. The Station is, however, about 1800 feet (549 m) lower in elevation than the study site. The precipitation at Gasquet averages about 90 to 95 inches (229 to 241 cm) a year, with nearly 84 percent of the total falling during the 6 months from October through March. June through August is the dry season, averaging only a little over 2 inches (5 cm) of precipitation.

The study design was a split-plot, randomized block layout with three replications. The effect of planting dates was tested on the main plots, and of planting methods on the subplots. Each subplot consisted of a row of 20 seedlings hand-planted by a two-man crew. Each man planted half of the trees on each subplot.

10-YEAR RESULTS

After 10 growing seasons, survival was still good for all treatments. Of the 24 subplots, seven had no mortality recorded since the time they were planted. An additional 11 subplots had 95 percent survival, and five had 90 percent. Only one subplot had a survival of less than 90 percent—this one receiving the very deep planting treatment in March and having a survival of 80 percent at the end of 10 growing seasons. The good survival on nearly all plots can probably be attributed mainly to careful planting by two experienced, conscientious planters who were aware of the fact that the planting was for research purposes. Survival on regular production planting jobs at that time was around 60 to 70 percent after the first growing season.

On blocks 1 and 2, most of the mortality occurred during the first 3 years after planting. On block 3, mortality was about equally divided between the first 3 and the last 7 years.

For all blocks and both planting dates combined, 10-year survival for the control treatment averaged 95 percent. Survival for the stem-shielded trees also averaged 95 percent. Survival for the deep-planted trees averaged 96.7 percent, and for the very-deep-planted 92.5 percent. These differences are not statistically significant. Therefore, results on survival after 10 years are essentially the same as those after 3 years.

Trees planted in February averaged a foot taller than those planted in March (5.2 vs. 4.2 feet) (1.58 vs. 1.28 m) (*table 1*). Analysis of variance indicated,

Table 1—*Heights of Douglas-fir trees after 10 growing seasons, by planting method and date, northwestern California*

Planting method and date	Average height	Range	Standard deviation
	feet		
Stem shielding:			
February	5.5	0.6-13.2	2.847
March	4.6	1.1-9.3	2.132
Average	5.1 (1.55 m)	–	–
Deep planting:			
February	5.2	1.5-14.9	2.735
March	4.2	1.0-12.6	2.081
Average	4.7 (1.43 m)	–	–
Very deep planting:			
February	5.0	0.8-12.6	2.574
March	4.1	0.8-11.0	2.298
Average	4.6 (1.40 m)	–	–
Control:			
February	5.0	1.3-10.9	2.237
March	4.0	0.9-7.9	1.801
Average	4.5 (1.37 m)	–	–
All methods:			
February	5.2 (1.58 m)	–	–
March	4.2 (1.28 m)	–	–

however, that this difference was not statistically significant at the 5 percent level of probability (not significant, in fact, until about the 13 percent level). Trees in the control treatment had the shortest average height among the four methods tested. The stem-shaded trees had the greatest average height, but exceeded the control trees by only 0.5 foot (0.15 m). As was true for planting date, analysis of variance indicated that differences among planting methods were not statistically significant.

The tremendous range in heights within each combination of planting date and planting method is especially striking. In each of the eight method/date combinations, the difference in height between the shortest and tallest of the survivors was at least 7 feet (2.13 m). In one treatment combination (deep planting in February) it was more than 13 feet (3.96 m). On four of the treatment combinations the shortest tree was less than 1 foot (0.30 m) tall, and on the other four it was between 1.0 and 1.5 feet (0.30 and 0.46 m). At the other extreme, the tallest tree was over 9 feet (2.74 m) tall on all treatment combinations except one (7.9 feet [2.41 m] on the control planting in March). The tallest tree in the entire study was 14.9 feet (4.54 m), and is on one of the subplots deep-planted in February.

The data suggest a possible relationship between tree height and distance from the ridgetop. Although numerous exceptions can be found, the shorter trees more often occur near the ridgetop and the taller ones farther downslope. For example, in the upper half of the plantation (i.e., the upper half of all 24 subplots) only eight trees are more than 7 feet (2.13 m) tall. By contrast, in the lower half of the plantation, 61 trees exceed this height.

Trees less than 2 feet (0.61 m) tall are more uniformly distributed, but these also seem to be somewhat influenced by slope position. There are 30 such trees in the upper half of the plantation and only 19 in the lower half. Mortality seemed less influenced by position on slope; 14 dead trees were found in the upper half of the plantation and 11 in the lower half.

The study was not designed to test for a possible correlation between tree height and distance from the ridgetop. Furthermore, the configuration of the ridgetop is such that precise measurements would be rather arbitrary. Nevertheless, it seemed worthwhile to do an analysis of covariance to see whether treatment differences might be significant when the influence of position on slope was removed.

Rather than using distance from ridgetop, I used distance from the upper edge of the plantation as the covariate, since it was a clearly identifiable reference line. With the influence of position on slope thus removed, planting date was found to be significant at the 1 percent level of probability, but planting method still failed to achieve significance—even at the 5 percent level. This latter finding was not surprising, since differences among the means for planting methods were relatively small.

DISCUSSION

Lest too much importance be placed on the relationship between height growth and position on slope, it should be pointed out that the entire plantation occupies only a slight segment of the total slope—all trees are within about 200 feet (61 m) of the ridgetop. Thus, no generalizations are appropriate concerning tree height growth relative to slope position within, say, an entire clearcut block—not even a small one. Only the near-ridgetop environment was represented in this study.

That trees generally grow better with increasing distance from the ridgetop is not a new discovery. It is well known that ridgetops are more exposed to desiccating winds, and often have less soil moisture, fertility, and soil depth than locations lower on the slope. Apparently, in the general ridgetop vicinity, planting spots even a short distance downslope are considerably more favorable than those near the top.

The very short trees were more uniformly distributed on the slope than were the tall trees. This difference suggests that, in addition to slope location, other factors influenced tree size and vigor. Some of the very small trees have sparse or chlorotic foliage, which may indicate a localized nutritional or pathological problem. Other possible explanations are poor planting of some trees (j-shaped roots, for example) or subsurface animal damage.

Animal damage to aerial parts appeared to be inconsequential. The trees had, in fact, been individually protected from deer during the first three growing seasons by a 4-foot-high (1.2-m) cylinder of poultry netting placed immediately after planting. This netting was removed at the end of the third growing season because it was then beginning to interfere with lateral shoot development, and also because browsing pressure on nearby unprotected natural seedlings did not seem to be serious.

Although the trees planted in February averaged greater height growth than those planted in March, the reasons for this superiority cannot be pinpointed. This is because the two groups of seedlings not only were planted on different dates, but also were subjected to different storage periods prior to planting. Both groups were lifted at the nursery on the same day in February to assure that all trees would be fully dormant when lifted. The trees slated for February planting were outplanted the next day, but those slated for March planting were cold-stored for 5 weeks before outplanting. Thus, either the later planting date, the 5 weeks of cold storage, or both may have been responsible for the poorer height growth of the March-planted trees.

Cold storage *per se* does not necessarily have an adverse effect on the survival or subsequent growth of bare-root seedlings. In an Oregon study, Zaerr and Lavender[2] noted that storage of 2-0 Douglas-fir seedlings for up to 9 weeks caused no significant reduction in first-year survival if trees were outplanted on a site essentially free of vegetative competition. This was the type of site used in the study reported here.

NOTES

[1] Strothmann, R. O. 1971. *Douglas-fir survival and growth in response to spring planting date and depth.* USDA Forest Serv. Res. Note PSW-228, 5 p., illus. Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif.

[2] Zaerr, Joe B., and Denis P. Lavender. 1972. *Some guidelines for planting 2-0 Douglas-fir in Oregon.* A preliminary report. Oreg. State Univ. Sch. Forestry–Forest Res. Lab., Res. Note 53, 3 p.

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