FOREST RESEARCH LABORATORY
RESEARCH NOTE 72

# EFFECT OF AUGER PLANTING ON SURVIVAL AND GROWTH OF DOUGLAS-FIR ON DROUGHTY SITES

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## ABSTRACT

Two-year-old Douglas-fir bareroot seedlings were hoe- and auger-planted on droughty south and southwest aspects in southwest Oregon. After 2 years, no differences in height, diameter, or seedling biomass could be detected. Auger-planted seedlings survived significantly better on the southwest aspect.

## INTRODUCTION

Reforesting droughty south-facing slopes has proven to be particularly difficult in some areas of the Siskiyou Mountains in southwest Oregon. The reasons for this are complex, but a major influence on seedling performance is moisture availability. The Mediterranean-like climate of mild, wet winters and dry summers (temperatures frequently exceed 32°C in July and August) and competition from numerous brush and grass species combine to create an unfavorable environment for seedling establishment. Furthermore, site-specific guidelines for reforestation of these areas have not been adequately developed.

Previous work has suggested that, though little may be gained in less severe environments, auger planting may improve survival of Douglas-fir [*Pseudotsuga menziesii* (Mirb.) Franco] where soil moisture is deficient (Miller 1969). The experiment reported here was therefore designed to compare the effects of auger and hoe planting on the survival and growth of Douglas-fir seedlings planted on droughty sites.

## STUDY SITES

In 1979, two unstocked, clearcut sites in southern Josephine County (lat. 42° 4' N., long. 123° 35' W) were selected for the study. Both sites have an average 550-m elevation. The first site is on a south aspect with a distinctly concave 26-percent slope, the second is on a southwest aspect with a slightly convex 55-percent slope. Soils on both sites are typic Haploxerults with a clay loam texture and an average coarse fragment content of 29 percent. Mean soil bulk density at 20 cm is 1.2 g/cm$^3$ (SE 0.05) on the

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south aspect and 1.3 $g/cm^3$ (SE 0.05) on the southwest aspect. Scattered brush that remained on the sites after harvest was cut with chainsaws and handpiled outside the study plots.

## METHODS

All seedlings were Douglas-fir 2-0 bareroot stock from the same seedlot. Before planting on February 25, 1980, baseline data for dry-weight biomass of shoots and roots were established from 100 seedlings selected at random from packing bags. Roots of all seedlings were dipped in a peat-moss slurry to prevent root desiccation during planting. One hundred fifty seedlings were planted on each aspect by each method (300 per aspect) in a randomized complete-block experimental design, three blocks of 50 seedlings per treatment replicate. Auger holes were 10 cm across and approximately 38 to 46 cm deep. Planting hoes penetrated the soil to depths of 25 to 30 cm. At planting, seedlings were individually tagged for identification and protected against deer browsing by flexible Vexar® tubes. Simultaneously, another 150 seedlings, to be used in measuring predawn xylem pressure potential, were planted by each method on each aspect. Planting crews were rotated after each replication to avoid bias due to individual variation in planting quality.

Percent survival was recorded in the fall of 1980 and 1981, and height and diameter were measured at planting and at the time survival data were recorded. Predawn xylem pressure potential readings were taken by the pressure chamber method (Waring and Cleary 1967) at 3-week intervals during the summer of 1980 on nine randomly selected seedlings from each treatment (18 per aspect at each measurement date).

At the end of 1981, ten randomly selected live seedlings from each treatment on each aspect were carefully excavated for measurement of dry weight biomass of shoots and roots. In addition, planting quality was assessed by excavation of 20 live and 20 dead seedlings from each treatment on each aspect.

A chi-square 2 x 2 contingency-table analysis tested independence of survival rates and planting treatment by aspect (Steel and Torrie 1960). The same technique was used to evaluate planting quality and survival by planting treatment. Analysis of variance tested seedling morphological characteristics by aspect for treatment effects due to planting method (Steel and Torrie 1960).

## RESULTS AND DISCUSSION

### PLANTING QUALITY

An important aspect of this study is that power augers produced consistently higher planting quality than hoes despite changes in slope and soil bulk density. Though no seedlings were planted with exposed root crowns, a random subsample of 80 seedlings per treatment (40 live and 40 dead) revealed that many hoe-planted seedlings were improperly planted:

| Poorly planted | Auger-planted | Hoe-planted |
|---|---|---|
| J- or L-rooted | 6 | 29 |
| Air pockets | 0 | 5 |
| Total | 6 | 34 |

Surprisingly, chi-square analysis with 2 x 2 contingency tables showed that, within a given planting treatment, seedling survival was independent of planting quality; but the data represent only 2 years of observation, and long-term effects of inferior planting on survival and growth are unknown.

Regardless of planting method or quality, lateral roots of seedlings on both aspects extended horizontally beyond the area disturbed during planting, although most roots of auger-planted seedlings were concentrated within 5 cm of the auger hole. No casehardening or glazing of auger holes was observed.

## XYLEM PRESSURE POTENTIAL

Predawn xylem pressure potential of auger- and hoe-planted seedlings differed little on the south aspect, but differences were pronounced on the southwest aspect (Figure 1).

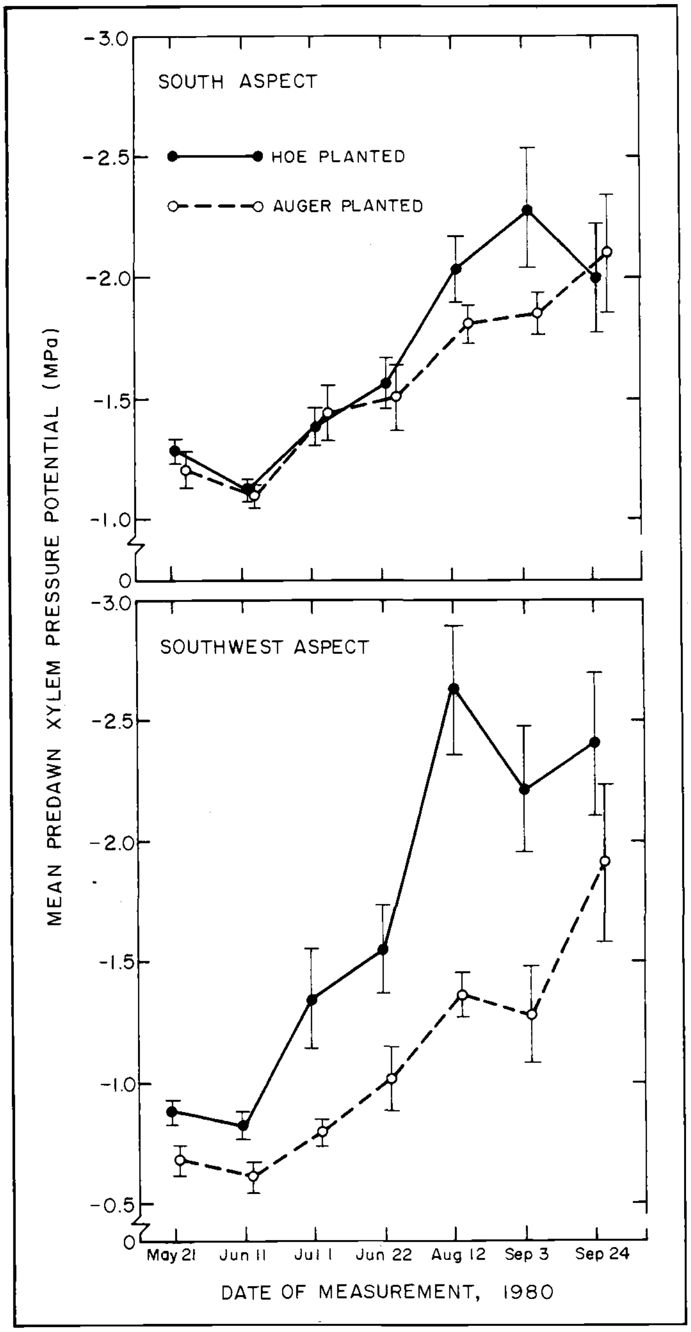


FIGURE 1.

MEAN PREDAWN XYLEM PRESSURE POTENTIAL OF DOUGLAS-FIR SEEDLINGS (± ONE STANDARD ERROR), BY ASPECT AND PLANTING TREATMENT.

Levels generally increased with increasing drought through September 1980. The highest levels were recorded after July 22, when hoe-planted seedlings on the southwest aspect showed the greatest increase in stress. Although root biomass did not differ significantly between the two planting treatments on the southwest aspect, decreased predawn xylem pressure potential in auger-planted seedlings may indicate that there was more moisture in the rooting zone. This is a tentative hypothesis, however; poor planting may have adversely affected xylem pressure potential of hoe-planted seedlings, even though survival was not shown to be dependent on planting quality. J- or L-rooted seedlings generally did not extend roots as deep as properly planted seedlings.

## SEEDLING SURVIVAL AND GROWTH

After 2 years, survival of auger- and hoe-planted seedlings on the south aspect was 48 and 42 percent, respectively (Table 1). On the southwest aspect, auger-planted seedlings survived 30 percent better than hoe-planted seedlings. Seedling survival on both aspects declined most during the latter half of the first summer after outplanting--the mortality due to heat and moisture stress. Severe

TABLE 1.

SURVIVAL (%) OF DOUGLAS-FIR SEEDLINGS, BY ASPECT AND PLANTING TREATMENT.

| Aspect and treatment | November 1980 | October 1981 | Chi-square[a] |
|---|---|---|---|
| South | | | |
| Auger | 67 | 48 | 1.05[ns] |
| Hoe | 58 | 42 | |
| Southwest | | | |
| Auger | 86 | 67 | 27.23* |
| Hoe | 58 | 37 | |

[a]Chi-square statistic based on 1981 survival.

[ns]Not significant.

*Survival dependent on planting method at $P = 0.05$.

grass competition on both aspects was probably a major problem. Some additional mortality occurred in May 1981, mostly among seedlings in poor condition at the end of the previous year. The low survival rate of auger-planted seedlings on the south aspect, relative to those planted by the same method on the southwest aspect, is unexplained. Despite a careful examination of dead seedlings from both aspects and a reevaluation of site data, no reason could be identified. Though within-aspect survival rates differed by planting treatment, height, diameter, and shoot and root biomass were not significantly different (P = 0.05) after 2 years of growth (Table 2).

TABLE 2.

MEAN VALUES FOR DOUGLAS-FIR SEEDLING CHARACTERISTICS AT PLANTING AND AFTER 2 YEARS (1981), BY ASPECT AND PLANTING TREATMENT. STANDARD ERROR IS IN PARENTHESES.

| Aspect and treatment | Height (cm) | Diameter (mm) | Shoot biomass (g) | Root biomass (g) |
|---|---|---|---|---|
| Both aspects, at planting | 24.5(0.2) | 5.2(0.1) | 3.4(0.2) | 2.2(0.2) |
| South, 1981 | | | | |
| Auger | 45.5(1.2) | 10.4(0.3) | 27.6(3.8) | 18.4(3.2) |
| | ns | ns | ns | ns |
| Hoe | 45.7(1.3) | 10.4(0.3) | 25.9(3.9) | 15.8(2.4) |
| Southwest, 1981 | | | | |
| Auger | 41.5(1.0) | 8.5(0.2) | 17.4(2.5) | 13.5(1.8) |
| | ns | ns | ns | ns |
| Hoe | 40.8(1.3) | 8.1(0.3) | 18.3(5.3) | 16.8(6.9) |

[ns] Not significant.

## CONCLUSIONS

Under the test conditions described, auger-planted seedlings survived significantly better than hoe-planted seedlings on the southwest aspect. Planting quality was improved, though seedlings did not grow better on auger-planted than on hoe-planted sites in the 2-year observation period.

Although power augers were not difficult to operate in this study, different soil conditions might prohibit their use. Increased size and content of coarse fragments could prevent penetration of soil to adequate depth, and case-hardening of the holes might prevent lateral root extension in clay soils. The use of augers might also be limited in sandy soils if holes collapse before seedlings can be properly placed. This planting method should therefore be recommended only on a site-specific basis after field trials have established probable seedling response to local conditions.

## LITERATURE CITED

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