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Effects of Site Preparation on Survival and Moisture Stress of Interior Douglas-Fir Seedlings Planted in Grass

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Survival of planted Douglas-fir seedlings, *Pseudotsuga menziesii* (Mirb.) Franco, was improved by several types of site preparation, especially herbicide treatment. Survival patterns closely followed levels of internal moisture stress. The results demonstrate the effect of grass on survival and internal moisture stress of planted Douglas-fir seedlings, as well as the benefits of grass controlling by spot treating with an herbicide.

Twenty years of research and field observations have established the connection between competition and improved survival and growth of tree seedlings. Where soil moisture is severely limiting, even minor amounts of competing vegetation are important. Grasses are especially strong competitors because their often massive root systems rapidly occupy the soil and deplete soil moisture. At best this shortens the effective growing season and reduces the growth of tree seedlings; at worst it leads to their death (1, 2, 4, 5, 7, 8, 9).

One objective of this study was to compare two site preparation methods: scalping and spot treating with atrazine. Selected treatments were compared on the basis of predrawn moisture stress (PMS) and survival of 2-0 Douglas-fir seedlings. A second objective of the study was to test the possibility of applying a mixture of paint and atrazine in autumn to provide on overwintering marker that would help planting crews relocate treated spots at planting time-6 months later. If planting crews can identify spots treated the previous fall, they will be able to plant seedlings directly in the centers of the spots, where minimum competition occurs.

Methods

The study site is located near Cle Elum, Washington, on a gentle northerly slope at 880 meters (2900 ft) elevation. The soil, formed in old alluvium, is a moderately well-drained inclusion in the Quicksell series. Surrounding forest vegetation is dominated by ponderosa pine (*Pinus ponderosa* Dougl. ex Laws.) and Douglas-fir, but the site itself is a grassy meadow measuring approximately 6 hectares (15 ac).

Locations at which trees would be planted were staked in the summer of 1981 to insure relocation and ready identification of treatments. Treatments were assigned at random, in four blocks. One-meter squares were sprayed around each stake in September 1981, using either AAtrex 4-L in water or AAtrex 80-W in diesel, and paint as indicated in table 1. Each load was mixed individually and applied from a backpack sprayer.

Two-year-old Douglas-fir seedlings were planted in the centers of the treated spots in April 1982, using a planting hoe or auger. Where a hoe was used, a slight scalp removed surface litter, but not topsoil or roots, except as noted for treatment 1 B. Scalps were approximately 35 to 40 centimeters (15 in) square.

Planting weather was cool, with some snow. Seedlings were small, but appeared to be in good condition. PMS at the time of planting averaged 2.5 bars, well below the limit of 5 bars recommended for planting stock by Cleary and Zaerr (3). Buds were dormant and tops had a healthy green color.

Survivors were counted in mid-August 1982. A pressure bomb (11) was used to determine predawn (4 a.m. Pacific Standard Time) PMS for a random sample of survivors from treatments representing a range of site preparation treatments (table 1). PMS was determined according to general recommendations given by Ritchie and Hinckley (10). The whole top of each seedling was removed because seedlings were too small to take branch samples. Each top was cut off with a razor and placed in a plastic bag to retard transpiration; no more than 10 minutes elapsed between cutting and stress determination. Rate of pressure increase was standardized at 10 psi/sec. Since the limit of safe operation for the instrument used was 40 bars, any sample exceeding a PMS of 40 bars was arbitrarily recorded as 41 bars.

***Table 1**—Summary of treatments, indicating (x) those on which PMS were determined*

Treatment	Seedlings per treatment	PMS
1. Unsprayed controls		
A. No scalp; auger-planted	30	x
B. Thorough scalp with hoe, removing vegetation, roots, and about 1 cm of topsoil; hoe-planted	30	x
C. Slight scalp with hoe, removing surface litter only; hoe-planted	30	x
2. Atrazine in water, with red latex paint, at the rate of 23.5 ml paint/liter of water (3 oz/gal)		
A. Auger-planted	30	x
B. Hoe-planted	30	
3. Atrazine in water, without paint		
A. Auger-planted	30	
B. Hoe-planted	30	
4. Atrazine in diesel, with orange tree-marking paint, at the rate of 125 ml paint/liter diesel (16 oz/gal); hoe-planted	60	

Differences in survival were analyzed by chi-square; PMS differences between treatments were analyzed by analysis of variance.

Results and Discussion

The highly visible red latex paint showed where coverage had been insufficient, allowing crews to immediately re-treat skips. By contrast, the orange tree-marking paint in diesel carrier was not much more visible than atrazine in water. Because this treatment was four times as expensive as treatments employing latex paint, it was considered uneconomical to increase its concentration to improve visibility. Besides, the combination of treemarking paint and atrazine-diesel mixture formed a precipitate that clogged the sprayers, making them unusable within 15 minutes.

Neither paint survived the winter. The site was inspected several times in early spring 1982, before planting, and before any grass had turned green. Neither of the paints were visible. Increasing the concentration of latex paint to 94 milliliters/liter (12 oz/gal) produced a spot that overwintered well, but was again prohibitively expensive. Fortunately, since treated spots were also marked by stakes, seedlings were still planted at the centers of the spots.

Both formulations of atrazine controlled grasses well. There appeared to be no benefit to using expensive diesel instead of water as a carrier. There was no indication that the latex paint had formed a "skin" around atrazine granules, or inhibited herbicidal action in any way.

Some reinvasion of treated spots was evident in all treatments by August 1982, and was most serious in treatment 1C. Percent coverage was not estimated, but reinvasion seemed to be greatest in treatments where a hoe had been used. This might be due to soil and litter disturbance caused by the minimal scalp of the hoe-planting technique. In contrast, auger-planting left the surface soil and dead thatch undisturbed, presenting invaders with an unfavorable seedbed.

Analysis of PMS data revealed a progression of stress levels which corresponded to the intensity of site preparation (table 2). The values in table 2 probably underestimate the stresses for entire treatments, since they are derived from survivors only. The underestimation would be most pronounced on treatments with the greatest mortalities.

Table 2—*Predawn moisture stress in selected treatments*

Treatment	PMS (bars)
1A. Control, no scalp	41.0a[1]
1B. Control, thorough scalp	29.9b
1C. Control, minimal scalp	26.5b
2A. Atrazine in water, with red latex	9.1c

[1]PMS's followed by the same letter are not significantly different from each other (p = .05).

Atrazine reduced moisture stress of planted stock better than manual control of competing vegetation. The greatest stresses occurred in seedlings that received no site preparation. There was no significant difference between effects of deep and shallow scalps, and seedlings on sprayed spots experienced minimal predawn stress.

Lopushinsky (6) has shown that stomates of interior Douglas-fir seedlings are virtually closed at 20 to 22 bars. Thus, stomates of the seedlings in the control treatments remained closed all day during the later part of the growing season. This conserves plant moisture but also reduces gas exchange needed for photosynthesis. A decrease in photosynthesis lowers vigor and lessens a seedling's ability to grow and compete with surrounding vegetation. By contrast, seedlings on herbicide-treated spots would be able to photosynthesize for at least part of the day.

Analysis of survival data confirmed the obvious and significant (.01 level) benefit of some form of site preparation (fig. 1). Trees planted in grass (treatment 1A) suffered 87 percent mortality because of competition for soil moisture. This mortality rate corresponds to the high PMS values obtained on these seedlings (table 2).

Relative effectiveness of the two site preparation methods on first-year survival was also evaluated. Seedlings planted on sites prepared with atrazine survived at approximately the same rate as those on scalped sites. However, seedlings planted on deep scalps tended to be chlorotic, which might be a result of topsoil removal and consequent nutrient deficiency. If this is true, an atrazine treatment would be preferable from the standpoint of nutrition, if not survival, especially since atrazine also minimized moisture stress and reinvasion of competing vegetation. Herbicides are also preferable to manual treatments from the standpoint of ease of application and operator safety.

Conclusions

1. Some form of site preparation is essential to survival of

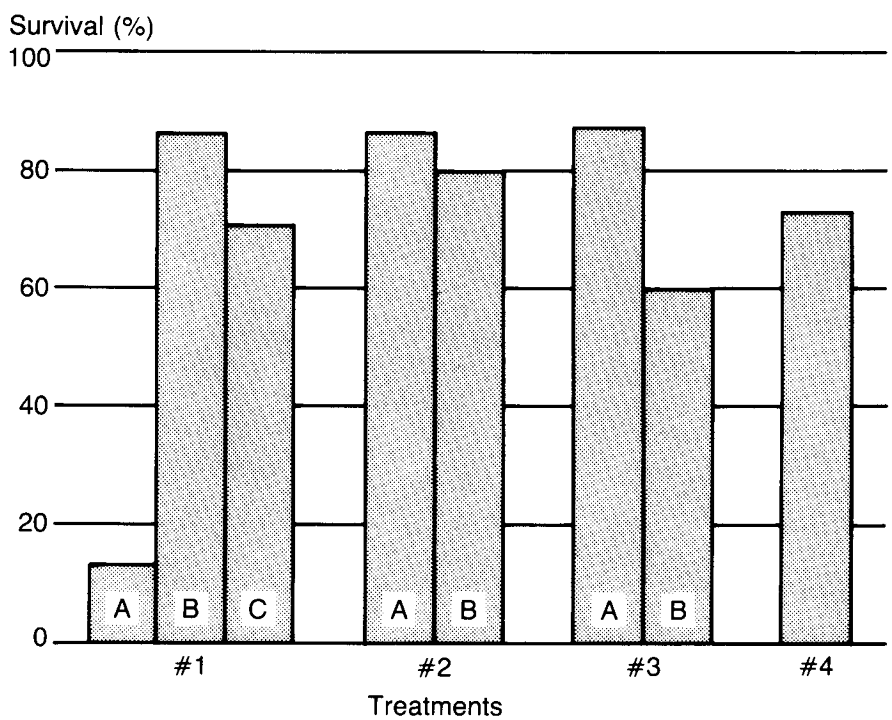

Figure 1—*Seedling survival after first growing season. Treatments are described in more detail in table 1.*

Douglas-fir planted in an established stand of grass.

2. Herbicide treatment is preferable to scalping because it minimizes reinvasion of competing species and improves water relations of seedlings. It may also improve seedling nutrition, insofar as nutrients are not displaced by scalping.

3. Neither latex nor tree-marking paint offers an economical solution to the problem of identifying herbicide-treated planting spots. An alternative is to mark each treated spot with a paint gun, but this requires a separate operation and usually involves an increase in workers needed.

Literature Cited

1. Baron, F.J. Effects of different grasses on ponderosa pine seedling establishment. Research Note PSW-199. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station; 1962. 8 p.
2. Cleary, B.D. Vegetation management and its importance to reforestation. Research Note 60. Corvallis, OR: Oregon State University, Forest Research Laboratory; 1978. 4 p.
3. Cleary, B.D.; Zaerr, J.B. Pressure chamber techniques for monitoring and evaluating seedling water status. New Zealand Journal of Forest Science 10(1): 133-141; 1980.
4. Eckert, R.E. Jr. Establishment of pine (*Pinus*, sp.) transplants in perennial grass stands with atrazine. Weed Science 27: 253-257; 1979.
5. Larson, M.M.; Schubert, G.H. Root competition between ponderosa pine seedlings and grass. Res. Pap. RM-54. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1969. 12 p.
6. Lopushinsky, W. Stomata] closure in conifer seedlings in response to leaf moisture stress. Botanical Gazette 130: 258-263;1969.
7. Newton, M. The influence of herbaceous vegetation on coniferous seedling habitat in old field plantations. Corvallis, OR: Oregon State University; 1964. 114 p. Ph.D. dissertation.
8. Newton, M. Seedling survival and vegetative competition. Western Reforestation: 39-41; 1964.
9. Phipps, H. M. Growth response of some shelterbelt species following sod removal-preliminary results. Research Note LS-21. St. Paul, MN: U.S. Department of Agriculture, Forest Service, Lake States Forest and Range Experiment Station; 1963. 3 p.
10. Ritchie, G.A.; Hinckley, T.M. The pressure chamber as an instrument for ecological research. Advances in Ecological Research 9: 165-254; 1975.
11. Scholander, P.F.; Hammel, H.T.; Bradstreet, E.D.; Hemmingson, E.A. Sap pressure in vascular plants. Science 148: 339-346; 1965.