Seedbed Coverings Affect Germination, Growth, and Frost Heaving in Bareroot Nurseries

David G. Simpson

Research scientist, British Columbia Forest Service, Kalamalka Research Station, Vernon, BC, Canada

At a bareroot nursery in central British Columbia, seedbed coverings-including a bedhouse and clear, white, black, or porous clear polyethylene- were evaluated on seedbeds of white spruce (Picea glauca (Moench) Voss] and lodgepole pine (Pinus contorta Dougl. ex Loud). The bedhouse treatment resulted in the most consistent germination and seedling growth improvement, and the clear polyethylene resulted in substantially reduced germination. The other treatments had small and inconsistent effects on germination; however, the porous clear bedcovering increased seedling growth. Lower frost heaving losses in bedhouse-grown spruce seedlings could be due to the greater root weight (size) of those seedlings. Tree Planters' Notes 41(4):13-16; 1990.

In bareroot forest nurseries in the Pacific Northwest, much of the seed sown does not produce planting stock. Most losses occur during-the first year in the nursery and are associated with failure of seed to germinate. These losses occur for various reasons, including low seed vigor, poor germination, disease and insects, environmental damage, and failure to meet culling standards. The failure of seed to germinate in the nursery bed not only wastes seed but also causes irregular bed spacing, further reducing production of acceptable seedlings.

These studies were undertaken to identify some nursery bed coverings that would give improved seed germination and better seedling growth with white spruce and lodgepole pine in bareroot nursery beds.

Methods

In 1979, 1980, and 1983, experiments were undertaken at the Red Rock Forest Nursery near Prince George, British Columbia (53° 41' N, 122° 40' W). In 1979 the treatments included: a bedhouse that was 3 m wide, 10 m long, and 1.2 m high covered with clear polyethylene as well as an uncovered control treatment.

In 1980, in addition to the bedhouse treatment, clear, white and black polyethylene bedcoverings were applied directly on the seedbed. In 1983, a porous clear polyethylene that is used in disposable infant diapers and had shown potential after testing at Weyerhaeuser Canada's Grandview Nursery was evaluated along with uncovered areas. The polyethylene bedcoverings were applied over 10-m sections of 1.2-m-wide nursery beds immediately after sowing and left in place for approximately 6 weeks. The edges of the polyethylene were secured with soil, and small ridges of soil between the drill rows kept the polyethylene slightly above the soil surface.

Germination counts after 6 weeks and measurements of seedling morphology after the first growing season were made on several plots in each treatment. In the 1980 experiment, substantial numbers of seedlings suffered from frost heaving due to unusual winter weather. Early in 1981, frost heaving losses were assessed on randomly located plots in each treatment.

Data from each experiment were subject to analysis of variance, and when treatment effects were significant, differences between means were tested with Duncan's multiple range test. SAS/STAT7" computer programmes (SAS Institute, Inc., Cary, NC) were used for the preceding analysis.

Results and Discussion

Seed germination. The viability of white spruce and lodgepole pine seedlots in laboratory tests (data supplied by the British Columbia Ministry of Forests Seed Centre) ranged from 49 to 86% and 37 to 92%, respectively (table 1). In most cases, field germination rates in the control plots were lower than laboratory germination rates, the

The author thanks W. Taylor, S. Andersen, and K. Odlum, all formerly of the British Columbia Forest Service, Research Branch, for technical assistance, and Weyerhaeuser Canada, Grandview Forest Nursery, Armstrong, BC, for providing the porous clear polyethylene.

reduction ranging from 1 to 41%. In the 1979 experiment, germination in the bedhouse treatment was as good as germination in the laboratory, indicating that all the viable seeds in the two seedlots (1839 and 2835) had germinated.

Likewise, in the 1980 experiment, the bedhouse treatment caused all viable seed of seedlot 1931 to germinate; however, in seedlot 2658 germination was poor and not affected by the bedhouse treatment. Also, in the 1980 experiment, white and black polyethylene bedcoverings slightly improved germination of seedlot 1931 but had little effect on seedlot 2658.

Clear polyethylene bedcovering had a definite negative effect on germination, with only 15% of seed germinating in seedlot 1931. In the 1983 experiment, 3 of 4 spruce seedlots covered with the porous clear polyethylene germinated better (2 to 17%) than the controls. However, in lodgepole pine, 2 of 3 seedlots had lower germination (21 and 23%) than the control treatments.

Considered together, the results from these experiments suggest that the bedhouse treatment resulted in the most consistent improvement in germination rates; clear polyethylene substantially reduced germination; and white, black, and porous clear polyethylene had little, if any, consistent effects on seed germination.

Nursery growth. In the 1979 and 1980 experiments, at the end of the first nursery year, the seedlings from the bedhouse treatment were larger, except in height, compared to the control seedlings (table 2). In the 1980 experiment, the seedlings from the clear polyethylene treatment were smaller than the controls, while the seedlings from the white and black polyethylene treatments were generally of similar size to the controls. In the 1983 experiment, both spruce and pine seedlings from the porous clear polyethylene treatment were larger than the noncovered controls.

Although there were some differences between the seedlots treated in each of these experiments and in some cases there were treatment seedlot interactions, there was substantial variance associated with the treatments in all three experiments. It seems reasonable, therefore, to assume that the results observed here would be generally applicable to white spruce and lodgepole pine grown in similar environments.

Although the bedhouse resulted in better germination and larger seedlings at the end of the first growing season, it is not clear why this occurred. Soil temperature measurements made at 8:30 am each day on 10 days in June during 1979 indicate that the soil was slightly (1 .4 °C) warmer in the bedhouse (fig. 1).

Measurement of other environmental parameters were not made; however, it can be assumed that air temperature and humidity in the bedhouse were higher and windspeed was lower; all these factors influence moisture stress and thus germination and growth. The porous clear polyethylene bedcovering applied in 1983 similarly increased morning soil temperatures (1.7 °C)

Table 1—*Percentage germination of white spruce and lodgepole pine seed under various bedcovering treatments, by seedlot*

	White spruce								Lodgepole pine		
	1979		1980		1983				1983		
Treatments	1839	2835	1931	2658	2871	3121	4205	4286	1950	2099	8532
Laboratory viability*	80	49	80	64	65	81	80	86	37	66	92
Control	52	27	65	23	62	61	50	77	36	63	80
Bedhouse	83	48	85	23	–	–	–	–	–	–	–
Polyethylene											
Black	–	–	70	26	–	–	–	–	–	–	–
Clear	–	–	15	20	–	–	–	–	–	–	–
White	–	–	70	21	–	–	–	–	–	–	–
Porous clear	–	–	–	–	64	79	66	70	45	38	59

*Supplied by the British Columbia Ministry of Forests Seed Centre.

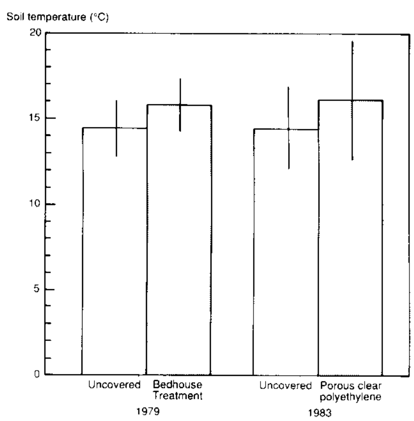

Figure 1—*Mean soil temperature 1 cm below the surface, measured on uncovered and bedhouse (1979) and uncovered and porous clear polyethylene-covered (1983) plots at 8:30 am on 10 days between June 15 and 28, 1979, and on 4 days between May 23 and June 20, 1983. Standard deviation is indicated around mean temperatures.*

relative to the beds that were not covered (fig. 1). The air temperature and humidity under the porous clear polyethylene would also be expected to increase relative to the control. Because the bedhouse and porous clear polyethylene treatments were not evaluated in the same year, it is not possible to contrast their relative effects on seedbed microclimate. Further study of the treatment effects on microclimate and seedling physiology is required to determine how the bedhouse and porous clear polyethylene affect conifer seedling growth. Of particular interest would be how the pattern and rate of growth throughout the growing season can be influenced by treatments applied for only 6 weeks.

Frost heaving losses. In many forest nurseries, seedlings can be lost during their first winter due to frost heaving. Seedlings are uprooted by ice that forms during repeated freezing-thawing of the nursery beds. Usually an insulating blanket of snow prevents frost heaving; however, in the winter of 1980-1981, the nursery beds were not covered by snow for much of the winter. Repeated freezing-thawing in the early spring resulted insubstantial frost heaving at Red Rock Forest Nursery that year. An examination of the seedlings sown in 1980 indicated that there were substantial treatment effects on frost heaving. Approximately 17% of bedhouse-treated seedlings were frost-heaved, whereas seedlings in the control plots had between 3 and 4 times more frost heaving. Reduced frost heaving in the bedhouse-grown seedlings may be due to the larger (heavier) root systems in those seedlings; there was a significant ($P < 0.05$) correlation between root weight and frost heaving (fig. 2). That reductions in frost heaving are due to larger root weights is also suggested by the observation that more frost heaving occurs in white spruce than in

Table 2—*Seedbed covering effects on first-year nursery growth of white spruce and lodgepole pine*

			Dry weight (mg)	
	Height (cm)	Root collar (mm)	Shoot	Root
White spruce				
1979				
Bedhouse	2.8 a	0.94 a	83 a	28 a
Control	2.7 a	0.85 b	64 b	21 b
1980				
Bedhouse	1.5 a	0.72 a	42 a	24 a
Black polyethylene	1.3 b	0.64 c,b	31 c	16 b,c
Clear polyethylene	1.2 b	0.61 c	30 c	14 c
White polyethylene	1.4 a	0.65 c,b	35 b,c	17 b
Control	1.4 a	0.67 b	37 b	16 b,c
1983				
Porous clear poly	3.3 a	1.01 a	109 a	48 a
Control	2.8 a	0.88 a	95 a	39 b
Lodgepole pine				
1983				
Porous clear poly	3.8 a	1.52 a	396 a	135 a
Control	2.7 b	1.27 b	254 b	86 b

Within-experiment means followed by similar letters do not differ significantly ($P \leq 0.05$) according to Duncan's multiple range test.

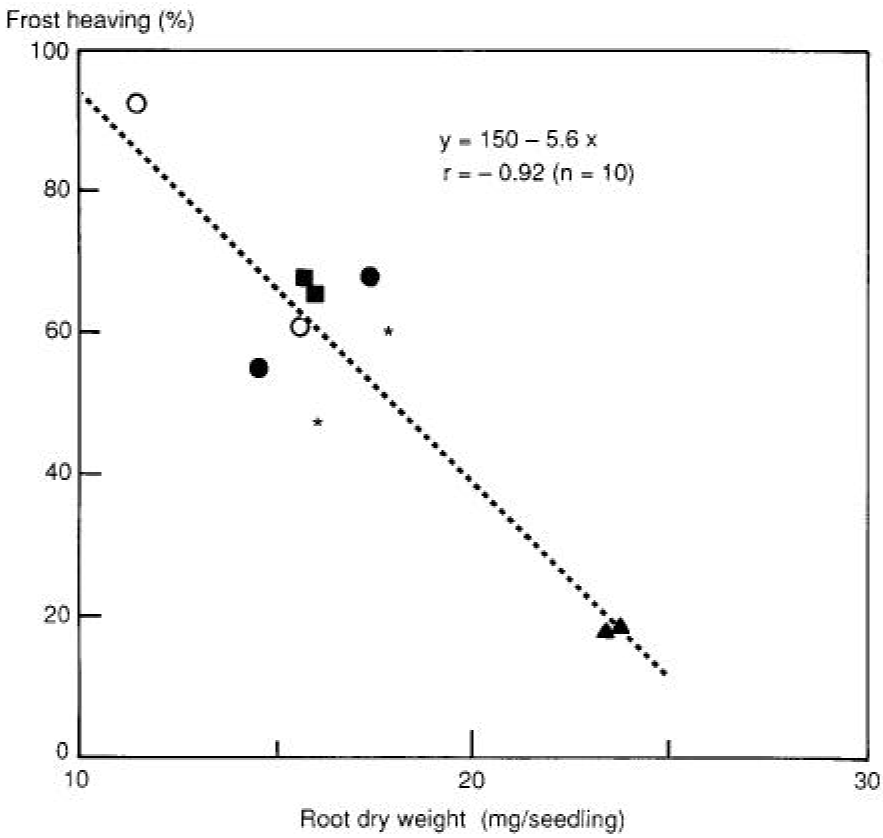

Figure 2—*Frost heaving in early spring 1981 of 1+0 white spruce seedlings as affected by root dry weight. Each point represents the average root weight of 100 seedlings randomly selected from 10 nurserybed plots measuring 0.5 by 1.2 meters. Plots received one of five treatments in the 1980 experiment: uncovered (controls,* ***solid circles****), black polyethylene (****solid squares****), clear polyethylene (****open circles****), white polyethylene (****asterisks****), or bedhouse (****solid triangles****).*

lodgepole pine. Lodgepole pine seedlings grown in experiment 3 had root weights 2 to 3 times those of white spruce (table 2).

Conclusions and Recommendations

Increases in seed germination and seedling size can be expected by using clear polyethylene bedhouses over white spruce and probably lodgepole pine bareroot nursery beds at northern nurseries such as Red Rock Forest Nursery (53° 40' N). Although the effects on seedling growth are small and due to factors as yet unclear, increased growth may be important in nurseries that experience frost heaving of 1-year-old seedlings. The use of bedhouses in the production of bareroot planting stock should not be considered until economic analysis and larger scale trials have been undertaken. Seedbed coverings, whether white, black, or porous clear polyethylene, may in some cases improve germination and growth. Clear polyethylene seedbed covering should not be used because they substantially reduce seed germination.