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SEED SHELTERS IMPROVE BLACK SPRUCE ESTABLISHMENT AND SURVIVAL ON UPLAND CUTOVERS

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INTRODUCTION

Direct seeding black spruce (*Picea mariana* [Mill.] B.S.P.) has long been considered an alternative reforestation technique to planting. Among the advantages in favor of seeding are the reduction in overall cost, the elimination of storage and transportation problems associated with nursery stock, the ability to regenerate shallow soil sites, and the promotion of a naturally developed root system (Cayford et al. 1974).

Aerial broadcast seeding provides a quick, low-cost method of regenerating large and/or inaccessible areas. For black spruce this method has been inconsistent in producing adequately stocked stands, particularly on upland sites. Row seeding reduces the quantity of seed required, but precision seeders for black spruce have not yet proven effective. Seed spotting (Fig. 1) best utilizes the seed resource and enables greater control over spacing and density. Regardless of the method of distribution, all seed is subjected to similar, potentially hostile environmental conditions once in contact with the seedbed. Extreme temperature variation, flooding, drought, and seed predation from a variety of sources are some of the factors that limit the success of direct seeding efforts.

In an attempt to offset these less-than-optimum conditions, a number of seed treatment initiatives were developed to accelerate germination speed and enhance early seedling development. Experiments designed to evaluate the field performance of various seed pretreatments, such as osmotic priming (a form of pregermination), micro nutrient presoaking, and seed encapsulation, were conducted on both

Figure 1. Successfully stocked Cerkon sheltered seed spot following two growing seasons.

upland and lowland sites. Seed shelters were routinely incorporated into these trials, not specifically as a treatment, but more to provide a controlled environment for accurately assessing the relative performance of specific treatments. It soon became evident that the gain achieved through the use of the seed shelter far outweighed any advantage that the seed pretreatment itself may have had.

This note presents fifth-year stocking, density, and height growth results for three lowland and three upland seed spot experiments that compare untreated/unsheltered black spruce seed spots with untreated/sheltered seed spots.

STUDY AREA

Study area attributes are summarized in Table 1. Sites 1, 2, and 3 are lowland black spruce areas with organic matter depths greater than 40 cm. Sites 2 and 3 are classified as a Clay Belt Forest Ecosystem Classification (FEC), Operational Group (OG) 11 *Ledum* (wet, moderately decomposed organic soil with a thick surface fibric horizon) (Jones et al. 1983). Site 1 had a mix of OG 11 and OG 12 *Alnus*-herb poor (herb poor on wet, moderately decomposed organic soil with surface fibric horizon). Sites were clear-cut; Site 1 by tree-length logging and Sites 2 and 3 using full-tree methods. All lowland sites were shearbladed during the winter prior to seeding.

Sites 4, 5, and 6 are black spruce upland sites. Sites 4 and 5 were classified as Clay Belt FEC OG 5 Feathermoss–Fine Soil (feathermoss on fresh to moist, fine, loamy–clayey soil). Site 6 was classified as Northwestern Ontario (NWO) FEC black spruce/Labrador tea/feathermoss (*Sphagnum*) with shallow to moderately deep sandy soils (Sims et al. 1989). Sites 4 and 5 were harvested in 1977 using a conventional full-tree, cut and skid harvesting system and site prepared in 1981 and 1982, respectively. Site 6 was harvested in 1982 using a full-tree harvesting system and scarified in 1984.

APPROACH

Seed was obtained from general collections in seed zones 3E and 3W. For all trials seed viability exceeded 95%. All seeding took place from early to late spring (mid-May to early June).

For both upland and lowland trials a minimum of three replicates of 50 seed spots, each consisting of five seeds, were established and seeded by hand. Normally, Cerkon-type seed shelters are installed and seeded using a trigger-operated dispensing tool.

On all lowland trials, great care was taken to ensure consistent microsite selection. Only poorly decomposed *Sphagnum* peat seedbeds that were sheared during logging or by using site preparation equipment were chosen. These are regarded as very receptive to seed germination because of the unbroken capillarity that provides constant moisture to the seedbed surface. In turn, this has a moderating effect on surface temperatures. For unsheltered seed spots, black spruce seed

Table 1. Summary of study area attributes.

Site no.	Location	FEC site type	Site preparation	Seedbed selected	Seeding date
1	Adanac Township Cochrane District (49°34'N, 81°35'W)	OG 11 and OG 12	winter shearblade	*sphagnum* peat	May 31, 1983
2	Sangster Township Cochrane District (49°26'N, 8O°3O'W)	OG 11	winter shearblade	*sphagnum* peat	May 13, 1984
3	Tweed Township Cochrane District (49°28'N, 80°35'W)	OG 11	winter shearblade	*sphagnum* peat	June 8, 1985
4	Sheldon Township Cochrane District (49°50'N, 81°35'W)	OG 5	backscratcher	exposed, fine mineral	May 18, 1982
5	Sheldon Township Cochrane District (49°50'N, 81°35'W)	OG 5	bräcke, backscratcher	exposed, fine mineral	May 12, 1983
6	Abitibi Camp 11 Thunder Bay District (48°56'N, 89°Ol'W)	SS6, SS8 V34	TTS disc trencher	shallow, coarse mineral	April 27, 1988

was sown directly onto the seedbed surface, usually into a shallow depression made by compacting the *Sphagnum*. Seed shelters were secured by removing loose *Sphagnum* from the surrounding area and mounding it around the lip on the shelter's base.

Recent upland scarification trials and direct seeding experiments (Fleming et al. 1987) indicate that well decomposed organic matter (H-Hi horizons, <5 cm thick, just above the humus/mineral soil interface) provides the best seedbed. Sites 4 and 5 had a very thin humus layer and an unusually deep Ae horizon. Consequently, a microsite nearer the B horizon was selected for this trial. Site 6 was generally much shallower, thus seedbeds were located closer to the preferred humus/mineral soil interface. On all upland sites the seed spots were placed on the bottom of shallow furrows, or mid-slope in the case of deep furrows. As on the lowland sites, seeds were sown into a shallow depression made on the seedbed surface and seed shelters were secured by mounding mineral soil around the lip of the shelter.

Two types of seed shelters were used during the trial. The Hakmet TT shelter (a Finnish design) was used for both upland and lowland trials in 1983. The Cerbo Cerkon (a Swedish design) was used for all other trials. Both these shelters have the traditional conical shape (the Hakmet being slightly larger with thinner walls) and both are photodegradable. Decomposition rates range from 2 to 5 years, but the base of the shelter may persist under the soil surface for up to 10 years or more. Seed spot stocking and density were assessed following the first, second, and fifth growing seasons. The height growth of all seedlings was measured following the fifth growing season.

RESULTS AND DISCUSSION

Figure 2 summarizes fifth year stocking and establishment ratio results of sheltered and nonsheltered seed spots for all sites. Stocking values for both sheltered and nonsheltered spots on lowland sites 1, 2, and 3 range from 86 to 97 %. The lack of a noticeable difference in stocking between sheltered and nonsheltered seed spots on lowland sites, and the absence

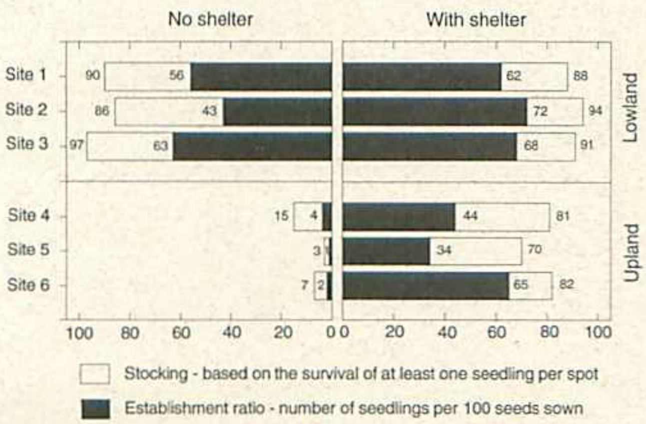

Figure 2. Summary of fifth-year stocking and establishment ratio of sheltered and nonsheltered black spruce seed spots.

of significant mortality over a 5-year period, can be attributed to the receptive nature of *Sphagnum* peat seedbeds, which are very conducive to both seed germination and seedling establishment. However, the fact that these high stocking levels were maintained over a 5-year period without the aid of seed shelters is somewhat surprising. Only Site 2 shows a noticeable decrease in the actual establishment ratio of seedlings on unsheltered spots following the fifth-year assessment. Conversely, both stocking and establishment ratios for sheltered seed spots on all upland sites are significantly higher than for unsheltered seed spots.

The seed shelters effectively ameliorate germination conditions on upland sites by increasing relative humidity and moderating the temperature within the shelter. These conditions are maintained throughout the critical mid-season growing period when heavy mortality due to seedling desiccation is a major limiting factor for unprotected seedlings. Just as important, however, is the shelter's stabilizing effect on the seedbed. It affords protection against excessive microsite erosion and dislocation, and subsequent burial of seeds or newly established seedlings during periods of excessive rainfall.

Figure 3 summarizes the average fifth year height growth of the largest seedling per seed spot of both sheltered and nonsheltered seed spots for all sites. Analysis indicates a

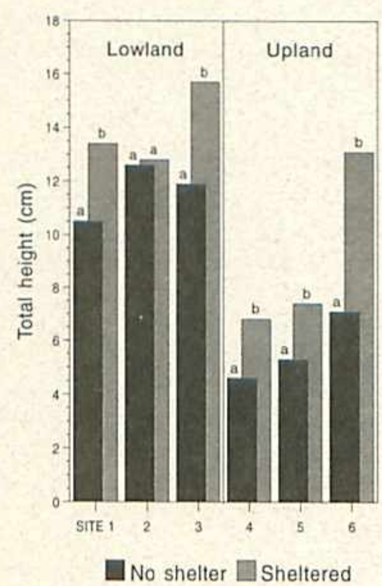

Figure 3. Summary of average total height of the largest seedling per spot after five growing seasons for both sheltered and nonsheltered black spruce seed spots. Differing letters within the same site indicate a significant difference at the $p \leq 0.05$ level.

significant difference in fifth year height growth of two of the three lowland sites and for all of the upland sites. Again, the ability of the shelter to promote early seedling establishment and maintain ideal growing conditions is cited for this difference. Overall height growth is considered poor, especially on upland sites (Sites 4 and 5). This can be attributed to overall poor site productivity, persistent attack by needle rust, and repeated exposure to late spring frost.

SILVICULTURAL IMPLICATIONS

This study suggests that the use of seed shelters appears to have no real advantage for the survival of black spruce if used on *Sphagnum* peat sites. However, a significant increase in both survival and height growth can be realized on upland sites when seed shelters are employed.

Refinements to improve the tools used to deposit the shelter and dispense seed are being undertaken, and preseeded shelters are also being tried.

As intensive regeneration methods become a less attractive option due to budgetary limitations, seed-based regeneration methods may become a more widely used alternative. As direct seeding of upland black spruce sites increases, seed shelters can play a role in specific circumstances.

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