



Frontline

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RESULTS OF AERIAL SEEDING BLACK SPRUCE ON COARSE-TEXTURED SOILS

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CATEGORY: Regeneration

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INTRODUCTION

Aerial seeding is a low-cost option for reforesting extensive areas of black spruce (*Picea mariana* [Mill.] B.S.P.) forest. However, most past attempts to direct seed this species on upland sites have failed, largely as a result of poor site selection, inadequate site preparation, or inappropriate seeding regimes (Fraser 1981a,b).

Over the past two decades the Canadian Forest Service—Ontario has investigated site, seedbed, and microsite requirements, as well as seeding regimes for black spruce on coarse-textured upland sites. This technical note summarizes the results of several scarification and direct seeding trials conducted near Thunder Bay, Ontario. Also discussed are seed distribution with the Brohm aerial seeder and black spruce seed release from logging slash.

APPROACH

The methods employed and results obtained are described in detail by Fleming et al. (1985, 1987) and Fleming and Mossa (1989, 1994, 1995a,b¹). All trials were conducted on fine sandy to coarse loamy upland soils of varying thickness over bedrock. Prior to harvest these sites supported mature, well-stocked upland black spruce or black spruce–jack pine (*Pinus banksiana* Lamb.) stands.

Treatment blocks 10–35 ha in size were scarified and then aerial seeded (Fig. 1) to black spruce in April or May at one of four prescribed rates (0; 50,000; 100,000; or 150,000 viable seeds/ha) both the first and third year after scarification. Portions of some blocks were also sown at the rate of 25,000 viable jack pine seeds/ha the first spring after scarification. Within each block, seedling establishment was related to site type (Sims et al. 1989) and seedbed coverage (Fleming and Mossa 1989). Prior to seeding, scarification trials were conducted on these blocks to determine the suitability of different implements for creating black spruce seedbed (Fleming and Mossa 1987). In total, five different scarification–seeding trials were carried out.



Figure 1. Aerial seeding a scarified, upland black spruce cutover.

¹ Fleming, R.L.; Mossa, D.S. 1995b. Dispersal and viability of black spruce seed from cones in logging slash (unpublished manuscript).



Studies of black spruce seed distribution with the Brohm seeder / Piper PA-18A aircraft combination were conducted on a level agricultural field using a rectangular array of 900 seed traps (Fleming et al. 1985). Seed distribution from cone-bearing slash was investigated using black spruce tops with all but the current year's cones removed. These were placed in different positions throughout the cutover (Fleming and Mossa 1995b).

FINDINGS

Scarification Trials

Of the equipment examined, a modified Cazes and Heppner (C&H) plow and disc trenchers showed the greatest potential for creating adequate quantities of upland black spruce seedbeds (Fleming et al. 1985). These seedbeds are located within 10 cm below and 5 cm above the mineral soil-humus interface (Fleming and Mossa 1994).

Seed Distribution

The Brohm seeder could be quickly and accurately calibrated to deliver black spruce seeds at rates from 25,000 to 300,000 seeds/ha.

The pattern of seed distribution across the flight path was consistent for a wide range of seeding rates. It peaked slightly to the left of centre. Seed distribution along the flight path exhibited a wave-like pattern as each revolution of the auger produced a pulse of seed to the slinger. Higher seeding rates produced a greater number of waves per unit distance traveled, but with decreasing amplitude. When distribution both across and along the flight path was considered, an interpass spacing of 15 m provided the best results (Fleming et al. 1985).

Operational Seeding Trials

After 5 years, mean black spruce stocking levels on scarified and seeded blocks were at least twice that of scarified but unseeded blocks (Fig. 2). An increase in the prescribed seeding rate per application from 50,000 to 150,000 viable black spruce seeds/ha increased mean stocking from 56 to 64% and increased seedling density from 6,000 to 12,000 stems/ha. Of the 14 blocks seeded, seven had >60% stocking, six had 40–60% stocking, and one had <40% stocking to black spruce.

Seeding the first spring following scarification produced mean black spruce stocking levels of 45–55% for the three seeding rates after 5 years. These levels were 10–15% higher than those resulting from seeding the third spring after scarification. This difference was attributed to the ingress of "naturals" soon after scarification (see below), and reductions in seedbed quality and quantity with time since scarification (Fleming and Mossa 1995a). There was little stocking (<15%) to black spruce advance growth in any of the blocks.

Seeding results with black spruce were much better on wetter than on drier sites. For instance, fifth-year black spruce

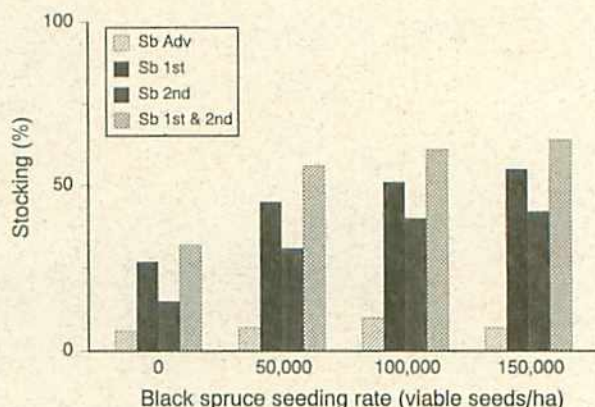


Figure 2. Mean fifth-year stocking results, on a 4-m² quadrat basis, from five aerial seeding trials in the Thunder Bay District. All areas were seeded twice at the same rate the first and third spring following summer scarification. Black spruce stocking resulting from advance growth (Sb Adv), and over the period of the first (Sb 1st) and second (Sb 2nd) seeding, as well as total black spruce (Sb 1st and 2nd) stocking, are shown.

stocking for the largest trial (120 ha), for all seeding rates combined, ranged from 35% on Moderately Fresh Soil Moisture Regimes to 85% on Moist Soil Moisture Regimes (Fig. 3).

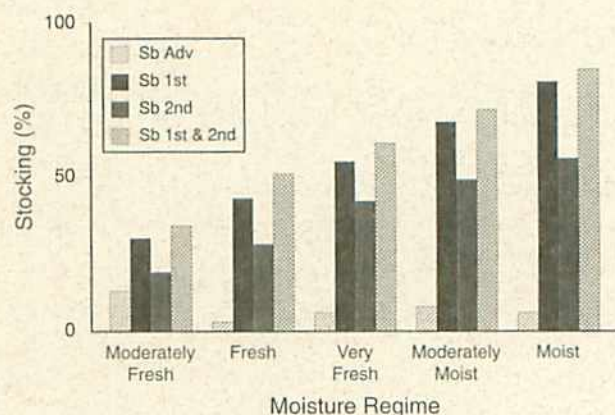


Figure 3. Mean fifth-year stocking results (4-m² basis) by Soil Moisture Regime, all seeding rates combined, for the aerial seeding trial at Madden Lake Road. Black spruce stocking resulting from advance growth (Sb Adv), the first seeding (Sb 1st) and the second seeding (Sb 2nd), as well as total black spruce (Sb 1st and 2nd) stocking, are shown.

Mean jack pine stocking on the blocks seeded to black spruce was 55%. Seeding 25,000 viable jack pine seeds/ha concurrently with the first spruce seeding improved pine stocking by up to 30%. Combined stocking to both species on the seeded blocks averaged 80%. Only one of the 14 seeded blocks had a combined stocking of <60%. Total seedling densities (jack pine and black spruce) averaged 17,000 seedlings/ha (Fleming and Mossa 1989).

Ingress of Naturals

Seeds from cone-bearing logging slash and nearby residual stands can provide for substantial "natural" black spruce

stocking on clear-cut sites. Stocking levels of up to 40% were obtained on scarified but unseeded blocks, largely as a result of seed release from cone-bearing logging slash. Most seeds in cones elevated above the ground surface were released within 1 year of harvesting, and virtually all seeds were released within 2 years after harvest (Fig. 4). Seed release from cones on the ground occurred more slowly, but was largely completed by the third year after harvesting. Seed viability in elevated cones remained high for at least 3 years, but viability in cones in contact with the ground decreased substantially by the second year.

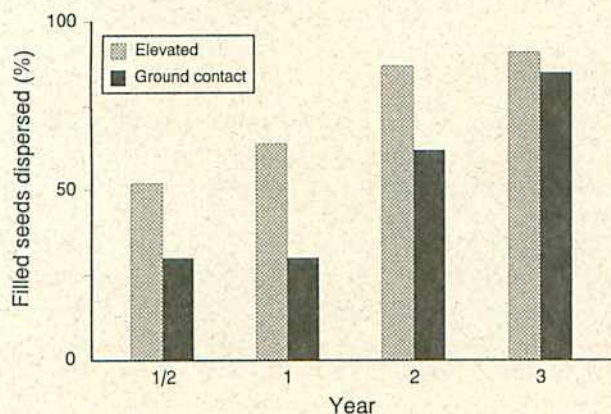


Figure 4. Temporal pattern of seed dispersal from cones in logging slash, for cones elevated above the ground surface and in contact with the ground.

SILVICULTURAL IMPLICATIONS

Scarification Equipment

Disc trenchers or similar machines with powered scarifying heads and hydraulic down pressure are effective in exposing good quality black spruce seedbeds. The resulting continuous, scarified furrows produce reasonable seedbed coverage, while ready control of scarification depth helps to maintain seedbed quality. In some cases, double passes may be necessary to achieve adequate seedbed exposure for broadcast seeding. Front-mounted V-plows, such as a modified C&H plow or various Fesco reforestation plows, can also give good results. Regardless of the type of scarifier, each must be carefully used to produce the required seedbeds (Fleming et al. 1987).

Large quantities of logging slash reduce scarification effectiveness and can greatly limit seedbed exposure. Full-tree logging concentrates most branches and cone-bearing tops at roadside. This can result in increased seedbed exposure, but also removes an important supplementary seed supply.

Broadcast Seeding Procedures

Each broadcast seeding device produces a deposition pattern unique to the specific combination of seeder, aircraft, and species of seed. When black spruce is sown with the Brohm seeder / Piper PA-18A aircraft combination, seeding rates of $\geq 100,000$ seeds/ha and an interpass spacing of 15 m should

produce good seed deposition results. Ground guidance during seeding and monitoring of seed deposition with seed traps are recommended. Whenever possible, seeding should be carried out under calm conditions.

Seeding Prescriptions

Aerial seeding should be carried out in late winter or early spring following site preparation the previous growing season. To compensate for inhospitable weather and other random events, multiple seeding (seeding the same area in 2 or 3 consecutive years) is recommended over seeding only once. Total seeding rates of 100,000 to 200,000 viable black spruce seeds/ha (i.e., two applications of 50,000–100,000 seeds/ha) have often resulted in adequately stocked stands on Very Fresh to Moist Soil Moisture Regimes (Sims et al. 1989) that were well site-prepared (i.e., $\geq 10\%$ gross receptive seedbed exposure, well distributed over the cutover). In contrast, seeding has largely failed on well site-prepared, Dry to Moderately Fresh Soil Moisture Regimes, at seeding rates of up to 300,000 viable seeds/ha. Thus, careful site selection and adequate site preparation are requisites. High seeding rates can rarely compensate for poor site selection or inadequate site preparation. It is also best to select seeding rates after considering the distribution and receptivity of seedbed on the target area (e.g., by using a seeding model [Régnière 1982, Groot 1988]). Direct seeding should be viewed as a way to increase stocking levels resulting from natural sources so as to achieve some desired level, rather than as the only means of regeneration, per se. In this context, the choice of harvesting method is an important consideration.

On coarse-textured soils, simultaneous seeding of jack pine and black spruce should be considered. These two species naturally coexist on these sites and appear to have contrasting micro-niche preferences; jack pine establishment and development is better than that of black spruce on drier microsites, while black spruce does well on moister sites. Many coarse-textured upland areas are composed of a mosaic of different Soil Moisture Regimes and site types that are too small to aerial seed individually. Seeding of both species will help ensure that adequate stocking to desirable conifers is achieved over the entire area. Black spruce growth will be substantially slower when overtopped by jack pine, but this approach offers the potential for dual-cropping. The jack pine could be harvested first, using careful logging methods (e.g., single-grip harvesters), while the black spruce is left to develop for an additional period.

Natural Regeneration

Seeds from cone-bearing logging slash can make a substantial contribution to subsequent stocking levels. To take advantage of this, scarification should be conducted as soon as possible after harvesting. If scarification is delayed for more than a year after harvesting, much of this seed supply will already have been dispersed, falling for the most part on unreceptive seedbeds. Harvesting procedures that leave cone-bearing tops on the cutover could considerably augment this seed supply.

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