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BLACK SPRUCE SEEDS SHORT-LIVED ON BOREAL FOREST SEEDBEDS

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CATEGORY: Cone and seed
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INTRODUCTION

Viability of black spruce (*Picea mariana* [Mill.] B.S.P.) seeds after dispersal in nature or by man may be a crucial factor affecting regeneration of the species on boreal forest seedbeds. Some authors maintain that black spruce seeds remain viable for extended periods, while others take the position that viability is lost quickly. Several experiments carried out by the Canadian Forest Service–Ontario were designed to investigate this issue. They are reviewed here and their management implications discussed.

Typical black spruce stands of northern Ontario produce an annual seedfall ranging from 1.0 to 12.6 million seeds per hectare (Losee 1961). Good seed years occur at 2- to 6-year intervals (Vincent 1965). Thus, an intact stand generates an abundance of seed, much of which falls on or settles into the forest floor. Should seed viability prove to be prolonged, it has been postulated that such seed could contribute significantly to the restocking of cutovers.

KENNEDY TOWNSHIP EXPERIMENT

In 1969 an experiment was conducted in the Kennedy Black Spruce Area, 18 km northeast of Cochrane, Ontario, in the Northern Clay Section, B.4 (Rowe 1972) of the Boreal Forest Region. The purpose of the investigation was to determine the number and viability of black spruce seeds that had been deposited through normal seed dispersal and remained stored in the surface horizons of a typical peatland soil (OG 9, conifer–herb/moss rich) (Jones et al. 1983).

Sampling was done in three conditions: (1) an overmature, uncut black spruce stand, (2) an adjacent clear-cut area, and (3) a part of the same clear-cut that had subsequently been burned (Fig. 1). Seed collection during the preceding 5-year period (1965–1969) revealed that in the three sampling locations about 12.67, 1.25, and 1.75 million seeds per hectare, respectively, were dispersed. Annual seedfall on the specific locations ranged from nil to almost 6 million seeds per hectare. As expected, the harvest substantially reduced the number of seeds being dispersed. Even though the combination of harvesting and subsequent burning would have reduced the seedfall to an amount similar to that in the adjacent cutover, seed released from heat-induced opened cones in the standing dead unmerchantable stems accounted for the greater number caught in seedtraps.

Figure 1. The burned seedbed in Kennedy Township from which samples were taken.

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The number of naturally dispersed seeds found in 2.5-cm thick layers in the top 12.7 cm of the peat soils are shown in Table 1. The majority of seeds were found in the upper 5 cm of the soil. More seeds were found in the samples from the uncut site than from either the cutover or the burned cutover. Less than 1% germination was obtained from seeds recovered from the two surface-most layers. Seeds from the deeper layers failed to germinate. This suggests that the viability of black spruce seeds in or on peatland seedbeds is short-lived.

sown seeds had germinated. Only a few of the buried seeds had germinated and some seed had been destroyed by insects. At least 95% of all seeds that had not germinated were recovered and immediately subjected to viability testing under laboratory conditions. A sample of control seeds, stored in ideal conditions, was tested on each occasion.

Table 1. Percent and number (millions/ha) of black spruce seeds at five depths and under three stand conditions.

Sample depth	Percent and number of seeds per hectare					
	Overmature, uncut		Clear-cut		Clear-cut, burned	
(cm)	Percent	Number	Percent	Number	Percent	Number
0.0 – 2.5	28	40.1	81	47.9	43	40.3
2.5 – 5.0	40	55.8	4	2.2	39	36.8
5.1 – 7.5	11	15.6	2	1.0	9	8.9
7.6 – 10.0	12	16.8	13	7.9	5	4.4
10.1 – 12.7	9	13.3	0	0.0	4	3.5
Total	100	141.6	100	59.0	100	93.9

MANITOUWADGE EXPERIMENT

In 1972, an experiment was established on the licence area of the QUNO Corporation (formerly the Ontario Paper Company) in the Central Plateau Section, B.8 (Rowe 1972) of the Boreal Forest Region (Fig. 2). According to Fraser (1976), cleaned black spruce seeds (seed zone 3200) were carefully placed on the surface and at 1.0, 3.0, and 6.0 cm below the surface of a site-prepared, sandy podzolic soil (V31, black spruce–jack pine/tall shrub/feathermoss) (Sims et al. 1989). The surface seedbed was at the mineral soil/humus interface, which served as the datum for determining depth of the buried seed. Seven plots were established for each of the four depth treatments so as to enable the testing of seed viability in the spring and fall over 3 consecutive years.

Seeds from all depths were collected from randomly selected plots at the end of 4, 10, 16, and 22 months after placement. Four months after placement, more than 50% of the surface-sown seeds had germinated. Only a few of the buried seeds had germinated and some seed had been destroyed by insects. At least 95% of all seeds that had not germinated were recovered and immediately subjected to viability testing under laboratory conditions. A sample of control seeds, stored in ideal conditions, was tested on each occasion.

Figure 2. Black spruce test site near Manitouwadge, Ontario.

Four months after placement, only 38% of the recovered surface-sown seeds had germinated (Fig. 3). Buried seeds had higher viability than did seeds placed on the surface. Ten months after placement, viability tests yielded similar results. At the end of 16 and 22 months after placement, none of the recovered seeds had germinated.

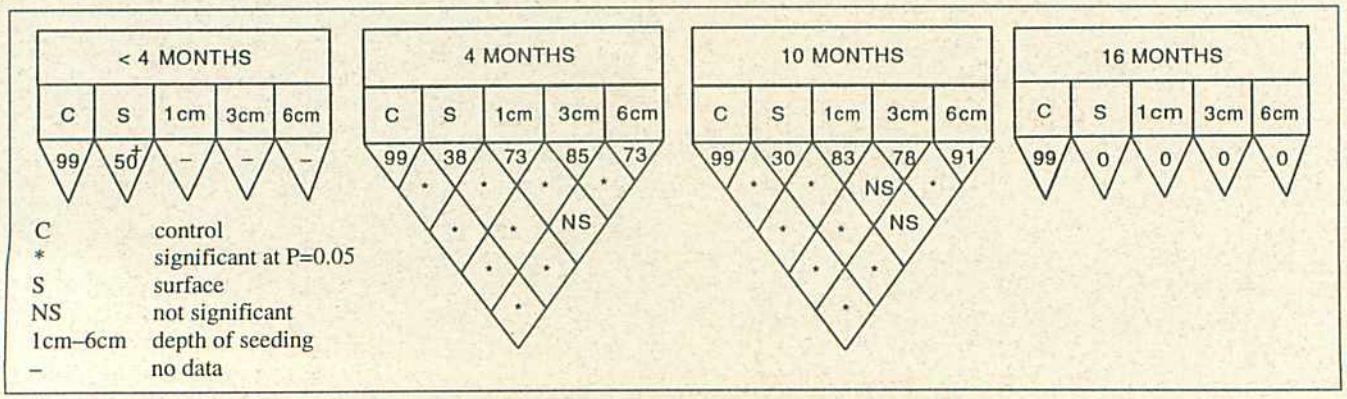

Figure 3. Germination of seeds expressed as a percentage of sound seeds presumed capable of germinating on or in an inorganic soil seedbed (from *Fraser 1976*).

HAUGHTON TOWNSHIP EXPERIMENT

Similar in design and purpose to the Manitouwadge experiment, this investigation was conducted in 1977, but in a black spruce peatland stand (V33, black spruce/feathermoss) (Sims et al. 1989) in the Kirkwood Forest (Fraser 1980). The surface datum was created by scalping off the living moss (*Sphagnum* spp.) to expose a slightly decomposed organic layer (Fig. 4). Seeds were carefully placed on this surface and at depths of 1.0 and 6.0 cm below this surface. Five such plots were established to permit recovery of seeds for viability testing at the end of 4, 10, 16, and 22 months. Control seeds and those recovered were subjected to laboratory viability testing.

Figure 4. Seedbed in Haughton Township tial prior to removing the Sphagnum *moss layer.*

During the initial 4-month period, 17% of the surface-sown seeds had germinated on the decomposed organic layer. Of the ungerminated seeds, 97% were successfully recovered at the end of 4 months. No seeds had been lost to depredation by rodents or birds, but 9% had been damaged by wire worms (*Elateridae* spp.).

Only 9% of the seeds placed on the surface and that had not germinated were viable at the end of 4 months. The viability of seeds from the 1.0-cm depth was much lower (42%) than for controls (98%), but considerably better than for seeds from the 6.0-cm depth (10%) (Fig. 5). By the end of 10 months, all surface-sown seeds had germinated. This suggests that seed viability had been retained over the winter and the subsequent growing season. Seeds recovered from the 1.0- and 6.0-cm depths had significantly lower viabilities than did the controls. By the end of 16 and 22 months after placement, none of the recovered seeds germinated under test conditions.

DISCUSSION

One of the factors that may contribute to the sporadic success achieved in regenerating black spruce cutovers using seeding (natural or artificial) may be the short duration of seed viability on or in seedbeds. Even though the "seed rain" has been shown to approach 6 million seeds annually under stand conditions, less than 1% of this naturally dispersed seed was viable (Kennedy Black Spruce Area Experiment). Fraser's (1980) Haughton Township experiment showed that seeds could remain viable on the surface for up to 10 months (i.e., from one growing season to the next). Furthermore, the latter study substantiated the earlier work by showing that seed viability may only be poorly retained once seeds become embedded, but not exceeding 1 year in wet peat soils. Even in upland conditions, black spruce seed viability on or in mineral soil was lost after 10–16 months (Fraser 1976). Some of the loss in viability was due to soil fauna. Loss of black spruce seed viability is postulated to be due to the lack of protection afforded by the thin seed coats from the wide fluctuations in temperature and moisture on or in seedbeds.

SILVICULTURAL RECOMMENDATIONS

These investigations have critical implications for successfully regenerating black spruce in the boreal forest of northern Ontario. Forest managers should not depend on soil-borne seed banks to significantly contribute to the restocking of cutovers. Furthermore, the importance of ensuring a continuous supply of seeds after harvest and/or site preparation, until the site becomes adequately regenerated, is emphasized for modified harvest operations. Unless germination and early survival can be assured during the first growing season following direct seeding, repeated sowings may be necessary to ensure successful restocking.

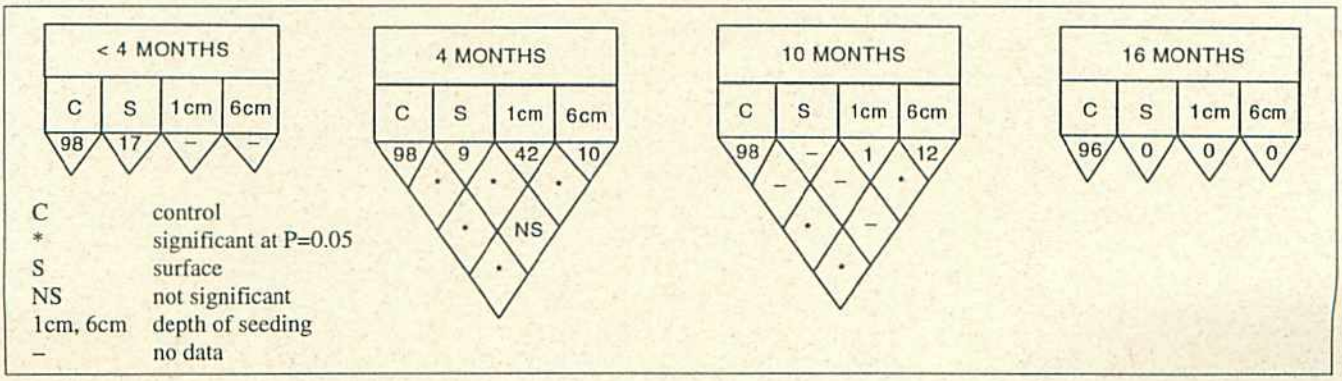

*Figure 5. Germination of seeds expressed as a percentage of sound seeds presumed capable of germination on or in an organic soil seedbed (*from *Fraser 1980).*

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