Frontline

Forestry Research Applications

Canadian Forest Service–Ontario

Technical Note No. 30

LARGER BLACK SPRUCE CONES PRODUCE MORE AND HEAVIER SEEDS

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CATEGORY: Cone and seed
KEY WORDS: Black spruce, seed yields, cone yields, size classes

INTRODUCTION

Beginning with seeds and culminating with mature trees, development of a forest is commonly considered a linear process. More realistically, this process is cyclical, as each stage is influenced by those preceding it. Tree vigor regulates cone development; in turn, cone traits affect seed quality. Seed characteristics influence seedling vigor, and vigorous regeneration ensures the establishment of a healthy forest. Since the most competitive trees are favored as the stand ages, the most developed trees will comprise the mature forest. The quality of the mature forest subseqently governs cone and seed production, thereby completing the cycle.

Cone pickers who work on a piecework basis may consider only those factors that influence work efficiency and remuneration (Fig. 1). For instance, collecting large cones will fill a container faster and with less effort than picking small ones. Mechanical cone harvesting from logging slash does not discriminate; all sizes of cones are processed.

Cone size choices made in the field could have a significant influence on forest establishment and subsequent development. This technical note describes some of the results of investigations into black spruce (*Picea mariana* [Mill.] B.S.P.) cone and seed production related to stand parameters (Skeates and Haavisto 1987). The information should help forest managers to develop prescriptions that will increase both the yield and quality of seeds from reproductive structures.

APPROACH

A good black spruce cone year occurred in northern Ontario in 1979. Total tree collections were made from four registered seed production areas (SPAs) and three mature natural

Figure 1. A cone picker decides which cones to take.

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stands (Table 1). Candidate trees in the Limestone Lake, Jean Lake, and Bonner Centre Seed Production Areas were also sampled in 1984. These latter sites included crowns that obviously had smaller cones.

Table 1. Stand information for the cone collection areas.

Collection area	Stand type	Stand age (years)	Number of trees
Limestone Lake SPA	Plantation	23	31
Jean Lake SPA	Natural regeneration	23–26	30
Lydia Lake SPA	Natural stand	60	7
Bonner Centre SPA	Plantation	27	15
Red Lake District	Natural stand	80	10
Sioux Lookout District	Natural stand	80	10
Ignace District	Natural stand	80	10

Screens were used to separate cones into six diameter (size) classes in 0.159-cm (1/16th inch) increments from largest to smallest, as follows: (1) >1.75 cm, (2) 1.59–1.75 cm, (3) 1.43–1.59 cm, (4) 1.27–1.43 cm, (5) 1.11–1.27 cm, and (6) <1.11 cm. Cone lots were sized separately for each tree. The number of cones in each size class was ascertained and their volume was measured.

Seeds were extracted by tree and by cone size class per tree using three cycles of wetting and drying. Seeds were processed using a small-scale extractory (Irving et al. 1987). Subsequently, the seeds were weighed and counted to determine mean weight and number per cone. Analysis of variance was performed on the data and regressions were developed for seed yields per cone and mean seed weight related to cone size classes.

RESULTS

The range in cone size was observed to be characteristic of a particular tree. Some trees produced predominantly large cones; others had a higher proportion of small ones. Few trees bore more than three size classes of cones. Young stands had a higher proportion of trees bearing cones in Classes 1 and 2. Forty-six percent of the trees from which cones were collected at Limestone Lake, 23% of those at Jean Lake, and 40% of those at Bonner Centre produced cones only in the two largest size classes. No trees in the older stands produced Class 1 or Class 2 cones, with the exception of one tree from the Ignace collection that produced some in Class 2.

Mean seed weight varied directly with cone size class (Fig. 2). In particular, the Lydia Lake stand produced much lighter seeds in all cone size classes ranging from 0.69 to 0.86 mg. The highest mean seed weight (1.3 mg) was from Class 1 cones in the young, naturally regenerated stand at Jean Lake. Variability in mean seed weight was also apparent among trees within stands and among crop years for the same location.

Mean seed yield per cone varied directly with the cone diameter, i.e., cone size, in each collection (Fig. 3). The trends were similar regardless of location, and substantiated

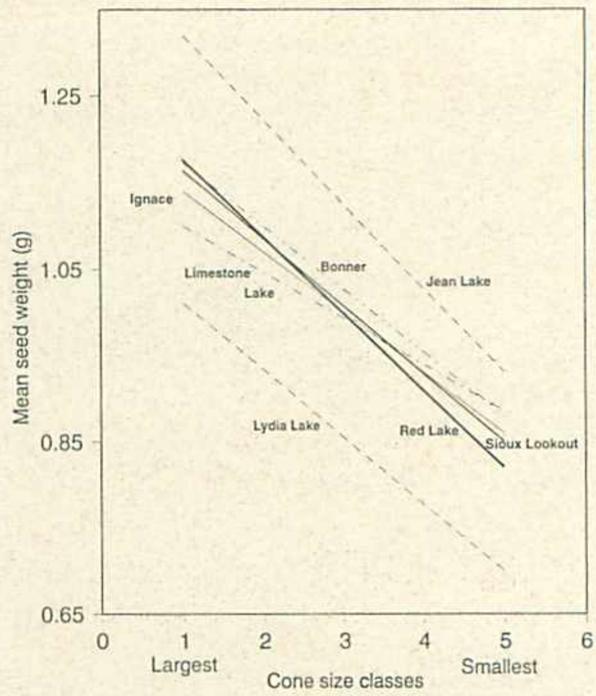

Figure 2. Linear regression of mean seed weights (g) by cone size class for seven locations in northern Ontario.

the findings of Haavisto et al. (1988). However, actual per cone seed yields within size classes differed considerably among the locations. For example, Class 3 cones from Limestone Lake and from Red Lake yielded means of 52 and 25 seeds per cone, respectively.

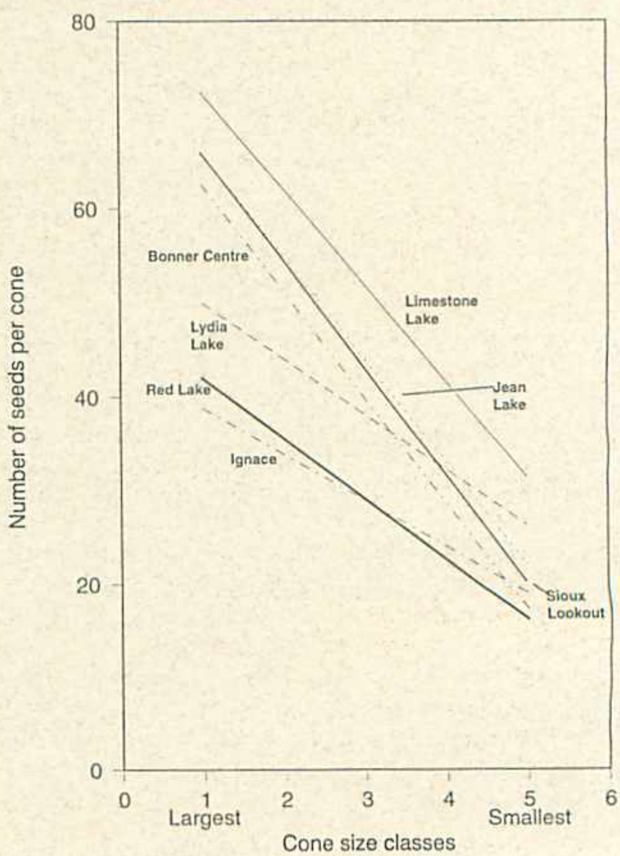

Figure 3. Linear regression of the number of seeds per cone by cone size class for seven locations in northern Ontario.

Seed yield variability within cone size classes was also influenced by stand age and tree-to-tree differences. For example, Class 3 cones from young stands yielded 44–52 cleaned seeds per cone; trees from older stands yielded 25–44. Only one tree from all of the older stands produced cones in Class 2. It yielded an average of 24 seeds per cone. Class 2 cones from younger stands yielded 49–64 seeds per cone.

MANAGEMENT IMPLICATIONS

While correlations derived from the data for each of the ten black spruce collections tended to be low, it is apparent that larger cones yield more and heavier seeds. As heavier seeds produce more vigorous germinants and seedlings (Skeates and Haavisto 1995a), cone collections should perhaps be made from trees that bear large cones (Fig. 4). Pickers, unless directed otherwise, will normally select trees with larger cones, since the time and effort required to pick a cone is similar, regardless of its size. Picking 20,000 large cones to fill a 1-hectolitre container will reward the worker with remuneration similar to picking 50,000 small ones, but with more than double the productivity in half the time. Both containers of cones will yield approximately the same number of seeds (Haavisto et al. 1988).

Large cones tend to occur on younger trees. To prevent physical damage to the standing trees, picking must be done carefully. Older trees have been shown to have smaller cones and to yield poorer quality seeds. Therefore, it may not be prudent to harvest cones in cutover areas where mature and overmature trees have been felled, and where cone processing can be done mechanically.

Reducing the number of small black spruce cones is best achieved at the collection stage. If this is not feasible, it may be beneficial to screen cone lots prior to shipping or processing to remove the smaller ones. Higher seed yields per unit volume would be realized upon conventional extraction for two reasons: larger cones contain more seeds (Haavisto et al. 1988), and seed is more difficult to extract from smaller cones (Fleming and Haavisto 1986). Therefore, if it is necessary to process small cones, extraction procedures should be modified to maximize potential seed yields.

Figure 4. Typical black spruce cones. Collection must be done before cone opening begins.

Many factors, and especially climate, affect cone and seed production. Wet weather during the time of pollination can detrimentally affect pollen dispersal from staminate to pistillate flowers, thereby influencing fertilization and seed set. Dry conditions during the growing season can seriously retard, or even curtail, normal metabolic processes and negatively affect cone and seed development. The size of the crop and the location of cones within the crown influence their size. The quality of a seed can be dependent on its position within the cone.

Undoubtedly, cone size and seed weight are genetically controlled. Based on black spruce cone collections over several years in the James Angus McPherson Seed Orchard near Longlac, Ontario, the authors found that these are clonal characteristics. Because seed weight is a maternal characteristic influenced by tree nutrition, variations in cone and seed attributes are also influenced by site conditions.

Any treatment that will improve tree growth and encourage the development of vigorous crowns will affect cone and seed production positively. For example, fertilizer treatment can result in more and larger reproductive structures on a tree (Skeates and Haavisto 1995b). The establishment of black spruce seed orchards will facilitate the application of techniques to enhance cone size. Furthermore, both cone and crop size should perhaps be factors to consider when roguing seed orchards.

Many silvicultural interventions during the continuum of events from regeneration to mature forest could contribute to making available a higher proportion of heavy seeds. Some of these have been discussed in light of artificial regeneration programs. If trees are to be left for seed sources as part of the regeneration plan, both cone and crop size should be considered and seed trees should be chosen accordingly. For natural regeneration systems, such as strip cutting in black spruce, fertilization of the leave strips prior to harvest may improve the quality of regeneration by increasing the average size of cones and seeds.

REFERENCES AND FURTHER READING

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The preparation of this note was funded under the Northern Ontario Development Agreement's Northern Forestry Program.

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Catalogue No. Fo 29–29/30E
ISBN 0–662–23071–X
ISSN 1183–2762

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