Grading seed by weight in white spruce

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In white spruce, sorting seed by weight for container seedling production is biased in favor of trees that produce a narrow range of heavy seeds. Recommendation: do not sort by weight until more is known about the genetic implications of this practice.

Over 100 pounds of white spruce (*Picea glauca* (Moench) Voss) seeds are used annually in Alberta for growing containerized tree seedlings for reforestation. These seeds are drawn from large bulk seedlots col. lected from many trees per collection site in good seed years when collection is possible.

Only the very best seed is used for container seedling production. Seedlots with germination percentages below 75 percent are not used, if at all possible, and seeds are sorted by weight within seedlots to remove smaller and empty seeds. This minimizes labour costs resulting from overseeding, subsequent thinning, and from incomplete or partial germination.

It has been the practice in Alberta, as in other provinces, to grade seed by weight within good seedlots. No more than the top 5 percent to 20 percent of the heaviest seeds are used for the seeding of containers.

Burgar (2) showed that there was a positive correlation between seed weight and seedling size in white spruce. This knowledge indicated that sorting by weight would not only reduce labour costs when rearing container seedlings but the stock would also be taller than if unsorted seeds were used. However, these are short-term advantages.

The influence of seed weight on seedling size is only temporary (3), disappearing almost completely in 5 years. In addition, seed weight is highly specific to the tree. Sorting by seed weight from bulk seedlots might therefore lead to a serious reduction in genetic variability in resulting seedling populations.

Little or nothing is really known about correlations between seed weight and such characteristics as germination behavior, tree form, survival, growth rates, etc. However, some preliminary data developed by the author show that the heaviest seeds in white spruce may germinate more slowly than seeds of average weight.

The opinion is therefore presented that seeds should *not* be sorted by weight but that all viable seeds from bulk lots should be used in reforestation until more is known about the resulting effects of weight sorting on subsequent stand quality. It is the purpose of this paper to illustrate this by way of some examples.

Methods

Seeds were hand collected from nine standing white spruce trees in central and southern Alberta in 1968 and 1969.[1] The trees were selected at random in 1968 with no special attention paid to size of seed crop, form, or to vigour of tree. All samples were collected from trees over 100 years old.

In 1969 seeds were collected from the same trees and in the same manner as the previous year. Collections were made from five trees west of Calgary and from four trees 100 miles north of Edmonton.

Some of the larger spruce trees from central Alberta bore more than 4 bushels of cones in 1968 or the equivalent of 1 million seeds per tree. However, the average seed yield per tree was only 1 bushel of cones (or the equivalent of 250 thousand seeds.) Cone crops were barely one-fifth as large in 1969 as in 1968 for given trees. Only four of the nine trees produced cones in 1969.

The cones were air dried, the seeds extracted by hand tumbling and stored in a refrigerator at 32° to 36°F (0° to +3°C) before weighing. All seeds were stored in sealed glass jars.

The seeds were X-rayed before weighing to remove all empty seeds, partly filled seed or seeds damaged by insects or fungi. Each sound seed was then weighed with a CAHN electro balance to the nearest tenth of a milligram and grouped into weight classes ranging from 0.65 to 1.04 mg (class 1) to 3.85 to 4.24 mg (class 9).

A total of 250 individual seeds were weighed per tree in 1968 and 1969. These samples were assumed to be representative of seed weights for the given trees. Moisture contents of all seed lots varied from 5 percent to 7 percent at time of weighing.

[1] These seeds were collected while the author was in the employ of the Canadian Forestry Service, Canada Environment, Calgary, Alberta.

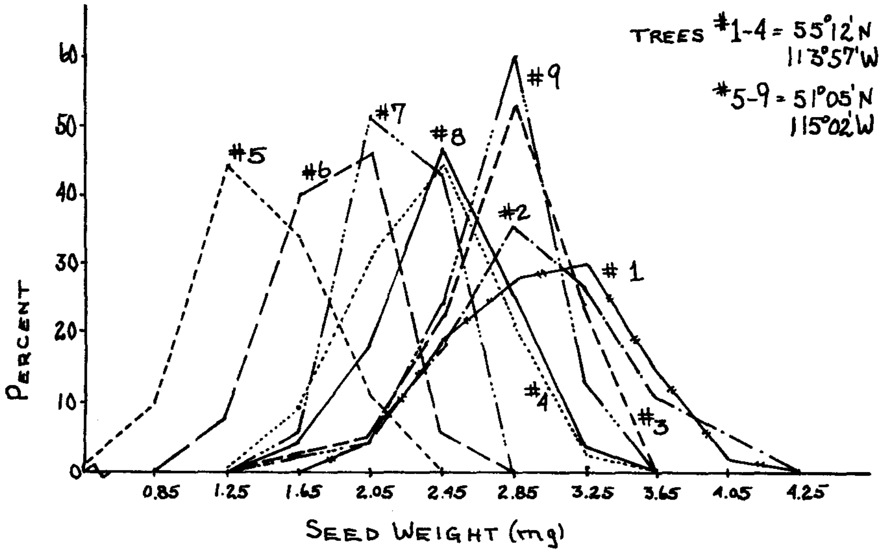
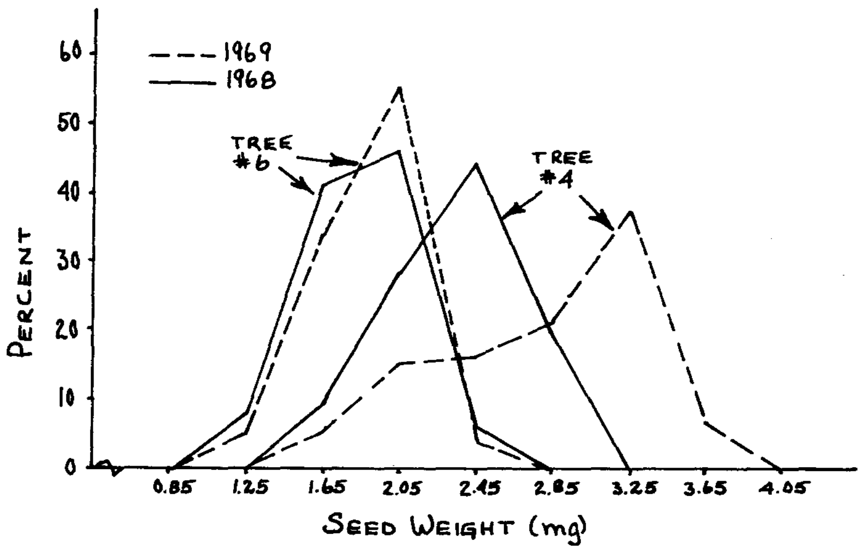


Figure 1.—Distribution of seed weights within nine trees of white spruce from Southern and Central Alberta.



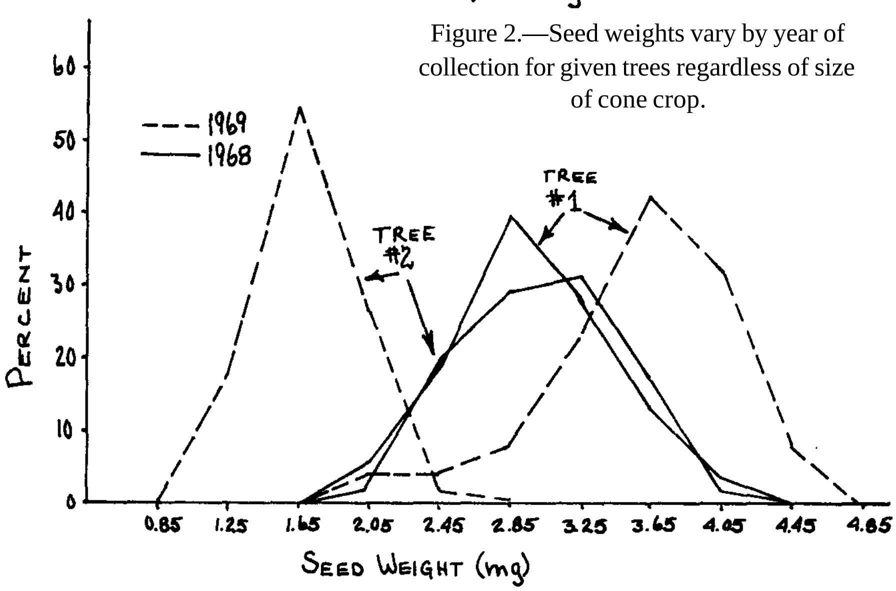


Figure 2.—Seed weights vary by year of collection for given trees regardless of size of cone crop.

Results

The distribution curves for each tree are presented in figure 1. This figure shows that seed weight within trees is quite distinct and rarely spans the full range of weight found for white spruce as a whole in this study. Only data from the 1968 collections are presented in figure 1.

Figure 2 shows that seed weight also varies by year for individual trees. The size of cone crop for a given tree for a given year was not positively correlated with individual seed weight (figure 2).

The individual distribution patterns for seeds from the nine trees plotted in figure 1 were replotted cumulatively in figure 3 to illustrate more clearly that sampling for seed weight is really the same as sampling for "genotype" rather than for seed "quality" *per se.*

For example, if the nine trees used here are taken to represent an average bulk sample of seed, and if the heaviest 17 percent of the seeds of this bulk sample are to be used for the growing of container seedlings, then only about 44 percent of the trees would be represented. Furthermore, if the heaviest 5 percent of the seed are to be used, then only about 22 percent of the trees would be represented. This implies, of course, that seed from 56 percent and 78 percent respectively of the trees might as well not have been collected. That could imply a waste of between $13 and $18 on each pound of seed collected and cleaned, assuming that it costs $20 to collect a bushel of cones and $3 to ship, extract, and clean the seed.

A sort for the heaviest seeds therefore automatically means that the seedling population arising from direct seeding in the field is genetically different from the population of seedlings reared in the nursery. This sorting is not important if planted

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stock is used to supplement stocking on areas previously seeded with the lighter seed from the same seedlot. In all other situations, where the different seed fractions are used for reforestation of different areas, the sort has had an unknown effect on the stand makeup for future years.

Discussion

The short term benefit of using heavy seed for obtaining larger tree seedlings (3) gives an added advantage to the saving in labour and time when, using fully viable and clean seed for the production of container seedlings. Over-seeding, to compensate for lack of dependable germina. tion in unsorted seedlots, leads to high weeding costs. Over-seeding also wastes precious seed. Under-seeding leads to further need for seeding of duds (empty containers).

The goal with seed sorting should be to remove useless seed from the seed with germination potential. This kind of sorting can be done on a production scale (1) and should aim to remove no more than the lightest 1-2 percent of the sound seed together with the trash and useless seeds.

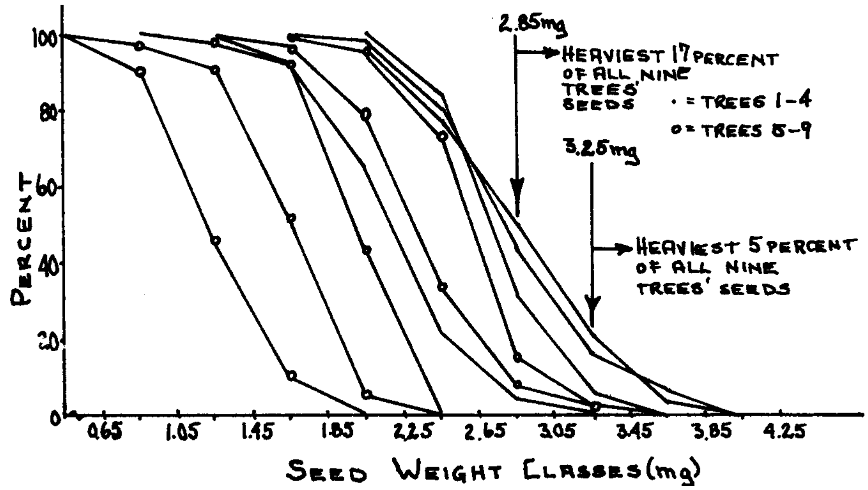

Figure 3.—Cumulative curves for seed weights for the nine white spruce trees from figure 1.

In addition, seed weight may not be positively related to germinability, to tree form, to drought (hardiness avoidance), or to any other tree characteristic. Seed sorting by weight could therefore lead to the removal of the best adapted trees from a

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given site. Because seed weight varies by tree from year-to-year, it is not even a stable criterion for sorting seed for individual trees in seed collection areas or seed orchards, judging by the data presented here. Seed should be sorted by tree genotype and phenotype and not by seed weight.

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