

A JACK PINE SEEDLING SEED ORCHARD PLANTATION
OF UNUSUAL DESIGN

J. I. Klein¹

SUMMARY

An experimental seedling seed orchard was planted in June, 1972, using open-pollinated families. Each of 24 blocks contains one tree from each of 220 families, divided into 11 plots of 20 trees. Initial spacing was 2 by 2 feet, with a 4-foot space between plots. The 20 families represented in each plot are from one source area. A series of selection thinnings will reduce the 20 trees in each plot to 1 tree. Selection will thus be exercised among trees having little or no co-ancestry, but having a common geographic source. Because each source area is represented in only one plot of each block, mating will be predominantly between sources. Seedlings were assigned to blocks according to size ranking within families, in the expectation of reducing the influence of nursery environment variation on the selection outcome.

INTRODUCTION

The seed orchard plantation to be discussed here is part of a program for genetic improvement of jack pine planting stock used in Manitoba and Saskatchewan. The principal activity of the program's first selection cycle involves testing at two or more locations, of open-pollinated families from more than 200 mildly selected parent trees. Parent-tree selection and family testing are being done separately in three breeding districts. About ten years after test plantation establishment, it is anticipated that an initial selection of superior parental or progeny genotypes will be carried out, on the basis of test plantation family performance. Seed orchards will then be established, using seed or scions of the selected genotypes. In the hope of achieving some tangible output from the program before the seed orchards of tested genotypes become productive, a seedling seed orchard relying upon phenotypic selection among neighboring plants was established.

All but a few of the 220 families in the seed orchard plantation are also included in the family test for the eastern breeding district, an area in eastern Manitoba about 115 miles north to south and 50 miles east to west. Both the seed orchard and family test were planted in spring, 1972. The seed orchard plantation is located near Winnipeg, Manitoba, and is roughly 30 miles west of the main belt of pine forests in eastern Manitoba. Soil on the planting site is a medium sand, low in nutrient status, and roughly equivalent to soils supporting jack pine in eastern Manitoba.

¹Canada Department of the Environment, Northern Forest Research Centre, Edmonton, Alberta.

DESIGN OF THE PLANTATION

A key feature of this plantation is the genetic relationship among the trees planted on the space that will ultimately be occupied by one selected tree. The 220 families were divided into 11 groups of 20 families on the basis of geographic proximity of the parent trees; hence, source groups. Assignment of families to source groups was accomplished by plotting parent tree locations on a map of eastern Manitoba, then drawing boundaries to form 11 compact areas each containing 20 parent-tree locations. Selection will be done within plots on which 20 trees were planted; one tree from each family of one source group.

Spacing is 2 feet square within plots. A 4-foot margin separates each plot from surrounding plots. A series of selection thinnings, at intervals of 2 to 4 years, will reduce the stocking on each plot to a single tree. That tree will occupy a space, including its share of the margin, of 10 by 12 feet.

Eleven plots, containing trees of the eleven source groups, constitute one block in the plantation. Source groups were assigned randomly to plot positions within each block. Following completion of selection thinning, each block will contain eleven trees. The sources of the eleven selected trees in any block will be distributed fairly evenly over the eastern breeding district. Pollinations will thus be predominantly wide crossing, relative to open-pollination under natural conditions.

There are 24 blocks in the plantation. For each family, seedlings were distributed to blocks according to size ranking within the family; that is, one block has the largest seedling of every family, another the tenth largest seedling of every family. Blocks are identified in the plantation records according to the size ranking of their seedlings.

Planting stock for ten source groups was of 3 + 0 age class, and the eleventh was 2 + 0. All seedlings were labeled with their family accession number.

PLANTATION DESIGN IN RELATION TO OBJECTIVES

One objective of this plantation was alluded to in the Introduction. There are actually three objectives, which are listed here as a frame of reference for the discussion which follows.

The seedling seed orchard plantation is expected to provide:

1. a productive seed orchard, having a reasonable likelihood of genetic gain, at an early date;
2. experience with phenotypic selection under controlled conditions;
3. a suitable material for local trials and experience on seed orchard management.

Early Genetic Gain - The first seed orchards established on the basis of family test results are expected to start producing seed at a useful rate roughly 18 years after planting of the family test. This plantation is expected to be in production about 5 years earlier. A five-year reduction in the waiting period to seed production from a breeding program may well be appreciated by the program's clients, provided there is a plausible likelihood that the seed is genetically improved.

The likelihood of genetic gain is perceived on the assumption that there will be a positive genetic response to phenotypic selection among young planted trees of equal age from a genetically variable population. Genetic variability among the trees on each selection plot should be enhanced by the fact that each tree has a different seed parent. Sharing of a pollen parent among two or three trees on a plot from the same source stand is unlikely although not impossible. Site-related environmental variation should be quite low among 20 trees planted in a rectangle 6 by 8 feet. Stratification of seedlings among blocks according to size ranking within families was done in the belief that most of the size variation within families at the time of planting was due to environmental variation in the nursery. If this belief is correct, the stratification procedure will enhance genetic gain in the seed orchard. If it is not, nothing would have been gained by not stratifying. The correct procedure in that case would be to discard the small seedlings.

Genetic variability among the trees on each plot could have been further increased by eliminating the source-grouping. Genetic improvement of the seed orchard output might not increase proportionately, however, owing the likelihood of a larger genotype-by-environment interaction effect, where the trees being compared are of widely separated source. Exploitation of geographic variation in this plantation would, furthermore, be redundant, because variation among source areas can be identified from the family test results and can then be exploited by seed collections from the best source populations.

Phenotypic Selection Experience - Within the total tree improvement program of the Northern Forest Research Centre, there are a number of specific programs being contemplated that would employ, as one means of improvement, phenotypic selection among trees planted at close spacing. Selection within wide-cross full-sib families, or within exotic stand-progenies, are possible uses. The selection process at each thinning would involve comparison of the trees within plots by pairs, and removal of the poorer tree of each pair. The comparison would be based on growth measurement and visual judgment of stem quality. Establishment of this seed orchard plantation provides an opportunity to gain experience in the application of this technique. It was partly for the sake of this objective that families were grouped into plots on the basis of source proximity. If trees from different source areas had been mixed, the response to phenotypic selection would have been entirely unrepresentative of future applications of the technique. Labeling of each seedling with its family number was done to provide information about the distribution of selected and discarded trees among the families used in the plantation. There is no specific treatment planned for this information.

Seed Orchard Management - Despite the abundant literature on seed orchard management, and jack pine's reputation for fecundity, there is a need for local data on seed production in young trees, and the response of seed production to cultural manipulation. This plantation can be used to meet that need, at least for seed-grown trees. During the selection thinning period, reproductive behavior of the trees will be observed. Treatments intended to stimulate pollen and seed production will be applied upon completion of selection. It may prove convenient to use the 24 blocks of 11 selected trees as experimental units. Information so obtained is expected to be timely, as establishment of the first family-tested seed orchards will commence a few years before completion of selection thinning in this seedling seed orchard.