RELEVANCE OF TREE IMPROVEMENT TO FOREST PEST MANAGEMENT

Report to the Canadian Forest Pest Control Forum

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INTRODUCTION

How can tree improvement programs contribute to Forest pest management? To answer this question we first need a reasonably clear perception of what we mean by pest management. It stands on its own as a field of knowledge and of advanced technology applied to pest identification, detection, evaluation, prediction and control. Control strategies include the use of chemical pesticides; in forestry this generally involves aerial application of insecticides, fungicides and herbicides over large forested areas. Use of biological control agents is another strategy involving aerial applications of entomopathogenic microorganisms and release of parasites to exercise long-term regulation of pest populations. Practicing good silviculture and stand management is another strategy. This involves, inter alia, use of high quality seed in forest regeneration; seed which is genetically superior and capable of producing planting stock well-adapted to site conditions and tolerant or resistant to insects and diseases. This is where tree improvement can make a significant contribution to pest management. Pest problems will not be eliminated but intelligent forest pest management does not aim to eliminate pests; its principal aim is to reduce losses to acceptable levels.

SEED PRODUCTION AREAS AND PLUS TREE SELECTION

Establishment of seed production areas (Lamontagne, 1978) and selection of plus trees for seed orchard development (Morgenstern et. al., 1975) are first steps in a tree improvement program. The susceptibility of growing stock can be influenced by applying basic principals of genetics, ecology, and pest biology during selection of stands for seed production, stand roguing and plus-tree selection. How can development of seed production areas and selection of plus trees, contribute to forest pest management?

Stands selected, should be relatively free of diseased and insect damaged trees and some effort should be made to determine if it has had a history of repeated insect outbreaks or disease epidemics. If the stand is growing vigorously in spite of repeated attacks it may be an excellent candidate because it contains genotypes well-adapted to or tolerant of pest outbreaks.

When a decision has been made to use a particular stand as a candidate SPA it should be rogued to remove insect- and disease-damaged trees. Such trees are probably genetically inferior and in addition they serve as infection centres for renewed outbreaks or epidemics when conditions become favorable.

In addition to form, growth and wood quality as a basis for plus-tree selection, consideration should be given to health of the tree. Only trees free of disease and damage due to insects should be selected. Intense outbreaks or epidemics should be used to select survivors which may be genetically superior and adapted to withstand or resist attacks or infection.

VARIATIONS IN SUSCEPTIBILITY

Variation in susceptibility among species, among related species, and within species does exist and serves as a base for producing vigorous trees which can withstand or resist insect outbreaks or disease epidemics. What evidence suggests that such variations in susceptibility of trees can contribute to forest pest management?

Variation in susceptibility among related species and natural hybridization between species provide us with important clues about the possibility for genetic manipulation of trees. For example the spruce budworm has a fairly wide host range including balsam fir, white spruce, red spruce, black spruce and other conifers. Red spruce is highly susceptible and black spruce is relatively resistant. These two species produce hybrids where their ranges overlap (Morgenstern and Farrar, 1964) and progeny of these natural crosses show a high degree of variation in susceptibility to damage by spruce budworm (Manley and Fowler, 1969). Some of the progeny retain many of the characteristics of red spruce but display a high degree of resistance to budworm typical of black spruce. This suggests that trees can be manipulated by hybridization to produce types which are tolerant or resistant.

Provenance studies on geographic variation and adaptability to site within native species provide us with important information which can be used in pest management. For example, studies in jack pine indicate that there are definite limits for the transfer of seed from one part of the range of the species to another. Certain seed sources are highly susceptible to late frost and to infection by scleroderris canker; infection and mortality is greatest for sources from latitudes south of planting sites (Yeatman, 1976). Seed can be moved over fairly wide distances east to west or vice versa but transfer from south to north over a short distance of only 80 miles is questionable. Similar studies with lodgepole pine have demonstrated that it is highly susceptible to sweet fern blister rust when planted in Ontario (Yeatman, 1974).

Provenance studies of exotic trees point to possibilities for replacing native species which are very susceptible to introduced pests. For example exotic larches may be utilized in the place of tamarack to take advantage of their high growth rate and ability of some seed sources to tolerate or resist attack by larch sawfly. Experiments established at Petawawa in 1960 and 1961 to compare silvicultural potential of exotic larches for selection of superior phenotypes provide such information. A severe outbreak of sawfly in 1977 in these plantations provided an opportunity to rate seed sources for defoliation. There were significant differences in defoliation, height and volume among seed sources; combinations of low susceptibility and high yield are rare but can be found.

Studies on intensive selection of Norway spruce for hardiness and weevil resistance indicate that it is feasible to produce exotic trees which are tolerant to our native pests and harsh conditions. In 1924, sixteen hundred Norway spruce, produced from seed, from a plantation of unknown origin in Quebec, were planted at Petawawa. Trees were subjected to intensive selection for weevil resistance and frost hardiness by Dr. Carl Heimburger so that only thirty trees remained. Progeny from these trees were planted at Petawawa along with several other seed sources from the International Norway Spruce Trial of 1938. Observations on weeviling were made from 1963 to 1972 in this plantation. Four provenances from Northern Europe confirmed Holst's (1955) observation that narrow-crowned phenotypes are less prone than others to weevil attack and have a higher recovery rate; the best seed source was the selected population from Petawawa.

CONCLUSIONS

Awareness of pest problems and consideration of variations in susceptibility have been an integral part of the tree improvement program at Petawawa since its inception in 1924. Studies to date indicate that breeding for resistance is possible because there are significant variations in susceptibility to insects and diseases among related host species, geographic strains of a particular host species and among interspecific hybrids. In addition, trees can be selected for resistance to pests and for hardiness. Breeding for resistance is possible but it takes time; for example, progeny from a plus-tree selection program need to be assessed for the period of time required for a plantation to reach maturity. In the meantime, small improvements can be made by careful selection and roguing of seed production areas and by selection of resistant or tolerant plus-trees as parents for seed orchards. Use of resistant trees and information from tree improvement programs should be part of long-range pest management strategies, especially when chemical control, biological control or other silvicultural prescriptions fail or are not appropriate.

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