INTER- AND INTRASPECIFIC GRAFTING AND BREEDING OF FIVE-NEEDLE PINES

Clifford E. Ahlgren
Director
Quetico-Superior Wilderness Research Center
Duluth, Minnesota

The forest tree improvement work at the Center was started in 1949 with the introduction of some of Dr. Riker's grafted eastern white pine selections. Subsequently a program of selecting, grafting, breeding and testing for resistance was begun. The work was initiated at Basswood Lake (15 miles NE of Ely, Minnesota) rather than elsewhere on a more accessible site for two main reasons. First, the high incidence of rust in the area along with large numbers of infected *Ribes* bushes affords good material for testing for resistance to blister rust. Secondly, the area is situated on a peninsula. The resultant cool, moist condition is conducive not only to graft survival but also to rust inoculation and infection.

In our first field grafting, Riker's white pine selections were grafted on 4- to 16-year-old native white pine rootstocks. The grafts produced conelets which were used in our breeding program. Many of the grafts have now grown beyond reach of ladders and are still too small for climbing for controlled pollination work. For these, a record of staminate and pistillate cone production is being kept, open-pollinated cones are gathered, and seeds are used in our resistance testing program.

An interspecific grafting program was begun involving all combinations of the rootstock species eastern white pine *(Pinus strobus* L.), red pine *(P. resinosa* Ait.), jack pine *(P. banksiana* Lamb.), mugho pine (P. *mugo* Turra) , and Scotch pine *(P. sylvestris* L.) ; with scion species eastern white pine, Swiss stone pine *(P. cembra* L.), Korean pine *(P. koraiensis* Sieb. and Zucc.), Macedonian white pine *(P. pence* Griseb.), and Himalayan pine *(P. graffithii* McClelland) . Over a period of 17 years, about 2,000 grafts have been made, with a good sample of each scion-rootstock combination and about 65 percent total survival. These combinations were set up to investigate the possibility of using interspecific grafting to stimulate cone and pollen production and to provide breeding material low to the ground on hardy rootstocks.

Both staminate and pistillate cones are produced on most graft combinations. However, a difference in scion species response to rootstock species exists in some cases. For example, Korean pine grafted on red pine rootstocks produces only staminate cones and the graft combination is not too compatible. On eastern white pine rootstocks, grafts of this species are very compatible and both male and female cones are produced. However, Swiss stone pine tends to produce more pistillate cones on red pine than on white pine. Conelet production on other rootstock-scion species combinations also differs, but the grafts are still quite young. Differences in survival on various rootstock species also exist. In addition, time of pollen production is influenced by rootstock. We find, for example, that Swiss stone pine grafted on red pine produces pollen first each year, followed by Swiss stone pine on Scotch pine, mugho pine, and finally on white pine rootstocks. Differences in primary growth and needle length also exist among the various graft combinations.

Mugho pine shows promise as a rootstock species. It has the advantages of being low and convenient for work and of having numerous terminals for grafting. Consequently, many grafts can be made on one tree. To date, survival of all of the 5-needle pine species with which we are working is good on mugho pine. The grafts produce viable pollen and pistillate conelets. Controlled pollination of these have produced viable seed. Furthermore, we find that the rootstock on which the graft is growing tends to thicken and grow more or less in pace with the scion. Thus, a firm base develops which will support the normally more rapidly growing graft for some time. If such results are consistently obtained, mugho pine could serve as a very useful rootstock for experimental pine seed orchard work.

As the grafts produce staminate and pistillate conelets, both inter- and intraspecific pollinations are made. Every combination is repeated 3 years before it is abandoned as incompatible. Reciprocal crosses are made whenever possible. Seeds produced are grown in our nursery for resistance testing and outplanting.

Pollen is collected and kept separate by scion and rootstock species for determination of the effect of rootstock species on pollen viability. Each sample is tested for viability as soon as collected. Pollen is frozen over silica gel in a dessicator and sealed in a vacuum equivalent of IL to 2 mm. mercury for one half hour. To date, we have been able to keep pollen viable for five years using this method.

The seeds are stratified and planted in nursery beds, grown for two summers and then inoculated. Best results have been obtained by wrapping the infected *Ribes* leaf around the needles of the seedling, thereby creating a miniature moisture chamber in which high infection results. If these *Ribes* leaves are too small — for example, when using *R. hirtellum* — a larger herbaceous leaf, such as one from *Rubus idaeus* is wrapped around the outside to provide pinning material and create the moist condition. Nursery boxes are covered with burlap and kept moist for 3 days. A consistent inoculation within each nursery box is indicated by the even distribution of yellow needle lesions found the next spring.

Some indication of variation in the rust is indicated by the differences in amount of infection obtained on identical samples of several white pine selections when inoculated separately using three different species of *Ribes* as inoculation sources. Also, a difference in lesion types is frequently observed. Both small discrete lesions and large coalescing lesions with some color differences are found.

Seedlings which survive inoculation in the nursery bed are transplanted into another bed for 1 year and then planted in the field test areas where rust infection is maintained at high levels by the cultivation of *Ribes* bushes.