SELECTING HYBRIDS AND SUPERIOR TREES FOR RECLAMATION PLANTING[1]

by

Walter H. Davidson[2]

Abstract. Tree species used in reclamation plantings should have the highest potential for survival and development on any given mine site. Selection criteria should include the ability to become established under adverse site conditions, rapid early growth, future market value, and freedom from insects and diseases. Results from field trials have identified several high potential hybrids and species for reclamation plantings. These include hybrid poplar (Populus sp), pitch x loblolly hybrid pine (Pinus rigida x P. taeda), Virginia pine (P. virginiana), Austrian pine (P. nigra), European black alder (Alnus glutinosa), and black locust (Robinia pseudoacacia). Recommended hybrid clones and seed sources are listed.

Additional Key Words: hybrid poplar, pitch x loblolly, hybrid pine, Virginia pine, Austrian pine, European black alder, black locust

Introduction

Great advances have been made in the science of genetics and tree improvement in recent years. Hybridization is commonplace, tissue culture is no longer a laboratory exercise, and tree breeding for specific attributes is a routine practice.

How do these programs affect our reclamation efforts? From the earliest days of planting trees for reclamation, foresters advocated using planting stock from local seed sources. This was a form of seed source selection. It seemed logical that trees adapted to the soils and climate of a region would perform well. This is true to a point. Progenies from local seed sources usually perform at least as well as the parents. However, other sources may perform better. Progeny testing of numerous seed sources may be necessary to determine the best one for the soil type or climate of the planting area.

Variations also occur within a seed source. To take advantage of these variations, tree breeders select parent trees with desirable characteristics and control pollination between these parents. The offspring must then be evaluated to ascertain if the desirable characteristics have carried through. Another means of taking advantage of the characteristics of a superior individual is through vegetative propagation or cloning. In cloning, all offspring are identical to the parent.

Hybridization is the process of crossing two different species to maximize desirable characteristics or minimize undesirable traits. Hybrids can be produced by open pollination; that is, a plantation or group of trees of one species is exposed to pollen from a second species. The resulting seed is a cross of the two parent species. Further testing is then necessary to determine if the desirable traits have been transmitted to the progeny. Once a desirable hybrid has been developed, it can be cloned through vegetative propagation to produce additional, identical offspring.

The procedures outlined above are, admittedly, more expensive than traditional means of producing seedlings or vegetative cuttings. However, improved survival, increased growth rate, or resistance to insects or disease may easily compensate for increased cost of seedlings or cuttings.

The value of using superior seedlings or selected seed sources has long been advocated. Limstrom (1960) stated, "A knowledge of seed source

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[2]Walter H. Davidson is a Research Forester with the USDA Forest Service, Princeton, W. Va.

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or the availability of superior varieties and hybrids of desired species is important in planning a reforestation project." His recommendations are just as valid now as they were 25 years ago. Unfortunately, the best planting stock, seed source, or hybrids often are not used in reclamation plantings. There are many reasons why superior seedlings or hybrids are not used.

Superior planting stock may not be available at the time a planting is scheduled. Advance planning and ordering of desired planting stock could help to alleviate this problem. Even if available, the cost of superior planting stock may influence the decision to use the best stock or the less expensive "bed run" seedlings. Some hybrids and superior species may require additional care (expense) after planting, discouraging their use. Another deterrent is the lack of knowledge on the part of coal operators and reclamation contractors concerning the value of using superior trees and hybrids.

On the positive side, many state nurseries are producing superior planting stock for use in their respective regions. Seed is collected from designated superior natural stands or seed orchards containing superior parent trees. The Penn Nursery located in Centre County, Pennsylvania, provides a typical example of current nursery practices (Schneck 1985). The 250-acre nursery has designated about 60 acres to seed orchards producing superior seed. White pine, Japanese larch, black cherry, and Norway spruce are the primary species in the Penn tree improvement program. Seedling prices reflect the additional costs incurred in producing the superior seedlings. In 1985, improved planting stock was $25 per 1,000 higher than "bed run" stock.

Research on seed sources (progeny testing) and hybrids on mine soils has been somewhat erratic over the years. Often the research has resulted from the personal interests of a scientist rather than from a documented request from the industry. Nevertheless, some of the research results have been put into practice. Following are reviews of several studies of progeny testing and hybrid species trials on mine soils.

Hybrid poplars. Testing of hybrid poplars for mine reclamation has been in progress since the early 1960's. A 1983 publication by Davidson and Vogel summarized the results of USDA Forest Service research to that date. The major deterrent to expanded use of hybrid poplar is its sensitivity to competition from herbaceous vegetation. If competition is controlled, there are many clones that can be recommended for reclamation planting. These and possibly others, depending on site conditions, have the potential for averaging 4 or more feet in height growth per year. Clone groups that have performed well over a wide range of site conditions in the Northeast include progeny from the following crosses:

1. P. maximowiczii x P. berolinensis
   NE clone numbers: 43, 44, 46, 47, 48, 49, 50

2. P. maximowiczii x P. trichocarpa
   NE clone numbers: 41, 42, 388

3. P. charkowiensis x P. caudina
   NE clone numbers: 17, 19, 20, 21, 310, 311, 312, 381

4. P. deltoides virginiana x P. caudina
   NE clone numbers: 222, 224, 225, 226, 228, 353, 359

5. P. maximowiczii x P. nigra plantierensis
   NE clone numbers: 51, 52

6. P. deltoides virginiana x P. trichocarpa
   NE clone numbers: 200, 204, 206, 207, 209, 212, 215, 220, 346

7. P. nigra x P. laurifolia
   NE clone numbers: 5, 8, 279, 283

Other published results on the performance of hybrid poplars show growth rates of 2 cords/acre per year in a 16-year-old plantation (Davidson 1979). Another report lists 10-year-old trees that have 9-inch diameters and are 60 feet tall (Czapowskyj 1978).

The potential of hybrid poplars for reclamation has been well described in these and other publications. However, the actual practice of using hybrid poplars is dependent on land use objectives that include provisions for intensive forest management practices.

Pitch x loblolly hybrid pine. Forest Service research using this hybrid on surface-mined areas began in the late 1960's. Many small test plantings were established in Pennsylvania, Ohio, Kentucky, West Virginia, and Alabama. Survival and growth were fair to good on some sites. On others, the tests were complete failures. A planting in Pennsylvania was not winter hardy. The trees sprouted each spring only to be frozen back each winter. Scarcity of seed and planting stock in the 1970's precluded additional testing on mined areas. Research with the hybrids on forest lands continued and new crosses were found that were more winter hardy and adapted to a wider range of site conditions. Little and Trew (1979) reported growth rates in excess of 2 feet per year, and survival rates of 100 percent after several years were common in test plantings on forest sites.

In the spring of 1981, I established a test planting of pitch x loblolly hybrids in West Virginia. The planting site was a reclaimed surface mine in Boone County at an elevation of about 1,600 feet. Open-pollinated seedlings from 19 mother trees were provided by the genetics project of the USDA Forest Service, Northeastern Forest Experiment Station, Durham, New Hampshire. Included in the test were 216 hybrid seedlings, 216 pitch pine, and 24 loblolly pine. Initial survival was excellent--nearly 100 percent. After 5 years, survival was 88 percent. Most of the mortality can be attributed to excess moisture in one portion of the planting site (Davidson 1984). The tallest individual tree in the plantation is a hybrid that is 9.0 feet tall. However, on the average, the loblolly pines are 2.2 feet taller than the hybrids and the hybrids 0.4 foot taller than the pitch pines. On the basis of height alone, loblolly is better than the hybrid on this site. However, the major attribute of the hybrid, winter hardiness, has not been strongly tested at this location.

The high survivability and relatively fast growth of the hybrid make it an excellent candidate for reclamation plantings north of the natural range of pure loblolly pine.

Austrian pine. Twelve sources of Austrian pine were tested in a cooperative study conducted by West Virginia University and the Forest Service. Five mine sites in Pennsylvania and West Virginia were included in the test. The results of the tests (Keys et al. 1980) showed survival of Austrian pine in West Virginia was best at an elevation of about 2,500 feet. Two seed sources were identified as having the best potential for planting in the region encompassed by the study. These are a Yugoslavian source, 66-105, and an Austrian source, 66-87. A French source, 66-86, and a Cyprus source, 66-94, did poorly at elevations greater than 3,000 feet.

Austrian pine is a recommended reclamation species in the northeastern coal states. Use of superior seed sources would enhance revegetation efforts.

Sweetgum. Sweetgum is a favored reclamation species in the South-Central Region. However, plantings in northern Illinois, West Virginia, and some sites in Kentucky and Alabama have had poor survival (Vogel 1981). Seed source variation may account for the erratic results of these plantings.

In 1981, I participated in a regional seed source study in cooperation with West Virginia University. In this study we planted seedlings from 33 sources on a reclaimed strip mine in Maryland. Two-year results were reported by Cech and others (1983). Differences among the seed sources were highly significant. Survival of the different sources ranged from 2 to 100 percent. At this time, however, none of the sources tested can be recommended in our region. In general, sources with poor survival had better height growth and, conversely, those with good survival grew poorly.

Ponderosa pine. In 1969, a seed source study of ponderosa pine was established on a very acid (pH 3.4) site in central Pennsylvania. Seedlings from 49 sources were included in the study. An evaluation of the plantation at age 6 showed that 11 sources were superior in both survival and height growth. Overall plantation averages for survival and height were 60 percent and 91 cm, respectively. Averages for the superior sources were 75 percent and 108 cm (Davidson 1977). These values show gains of 20 percent in survival and 16 percent in growth. The best source was from South Dakota on the eastern edge of the natural range of ponderosa pine. This study provides an excellent example of variation within a species due to seed source.

Other species. Several other species have been tested on minesoils. Reports by Thor and others (1974) and Plass (1973) indicated that the sources of Virginia pine could be selected for survival or growth on acid minesoils. However, their research showed that sources with good survival had slow growth and, conversely, that fast-growing sources had poor survival.

USDA Soil Conservation Service tests of black locust identified a superior dominant stem, fast growing clone. Unfortunately, resistance to the locust borer is low (Soil Conservation Service 1978). Early results of selection for borer resistance, using other black locust clones, are encouraging. Results have not been published, but data indicate resistance in some of the clones being tested.[3]

European black alder seed sources also have been tested for surface mine planting. Funk (1979) reported that a Bavarian seed source produced the tallest and largest diameter trees in a test of 15 seed sources. Survival was better than the average of all sources tested but lower than three other seed sources. Another study that included three black alder sources showed some differences among sources. The plantings were on very acid minesoils (pH 3.1 to 3.6) and alder survival was poor. Thus, seed source differences were overshadowed by the harsh planting sites (Davidson 1979).

Summary

Tree improvement research for surface-mine reclamation is providing superior plant materials for revegetation. Improved survival and growth rates, as well as insect and disease resistance, are the benefits derived from using selected seed sources, superior progeny, or hybrids. Gains of 15 to 20 percent are common for survival and growth compared to average performance.

Land managers and reclamation contractors, through the use of improved species, superior sources, or hybrids, can greatly enhance the results of their revegetation efforts. The added costs of the planting stock often can be justified by planting fewer seedlings and reducing the expense of replanting.

Long-range planning and ordering are needed to give nurseries time to produce sufficient quantities of improved planting stock. However, some improved stock may be available from nurseries involved in tree improvement programs.

Finally, if a desirable species has not performed well in the past, it might be the fault of the seed source. Nursery managers, extension foresters, or forest geneticists may be able to prescribe better sources. If not, seed source or provenance testing may be in order.

Literature Cited

Cech, Franklin C., Roy N. Keys, and Walter H. Davidson. 1983. Establishment and early growth of sweetgum planted on disturbed land. p. 217-228. In P.E. Pope (ed.) Proceedings 3rd Annual Better Reclamation with Trees Conference. (Terre Haute, Ind., June 2-3, 1983).

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[3]Personal communication: Dr. Franklin C. Cech, West Virginia University, 1986.

Czapowskyj, Miroslaw M. 1978. Hybrid poplar on two anthracite coal-mine spoils: 10-year results. USDA Forest Service Research Note NE-267, 5 p. Northeastern Forest Experiment Station. Broomall, Pa.

Davidson, Walter H. 1984. Excess moisture decreases survival and retards growth of hybrid pine seedlings. p. 135-139. In P.E. Pope (ed.) Proceedings 4th Annual Better Reclamation with Trees Conference. (Owensboro, Ky., June 7-8, 1984).

Davidson, Walter H. 1979. Hybrid poplar pulpwood and lumber from a reclaimed strip-mine. USDA Forest Service Research Note NE-282, 2 p. Northeastern Forest Experiment Station. Broomall, Pa.

Davidson, Walter H. 1977. Performance of ponderosa pine on bituminous mine spoils in Pennsylvania. USDA Forest Service Research Paper NE-358, 6 p. Northeastern Forest Experiment Station. Broomall, Pa.

Davidson, Walter H. and Willis G. Vogel. 1983. Hybrid poplars for reclamation. p. 99-109. In P.E. Pope (ed.) Proceedings 3rd Annual Better Reclamation with Trees Conference. (Terre Haute, Ind., June 2-3, 1983).

Funk, David T. 1979. *Alnus glutinosa* provenance trials on Ohio strip mines: sixteen-year results. p. 28-32. In Proceedings 1st North Central Tree Improvement Conference. (Madison, Wis., August 21-23, 1979).

Keys, Roy N., Franklin C. Cech, and Walter H. Davidson. 1980. The performance of Austrian pine seed sources on various sites in West Virginia and Pennsylvania. p. 103-114. In Forest genetics: 25 years of progress: 27th Northeastern Forest Tree Improvement Conference. (Burlington, Vt., July 29-31, 1980).

Limstrom, G.A. 1960. Forestation on strip-mined land in the Central States. U.S. Department of Agriculture, Agriculture Handbook No. 166. Washington, D.C.

Little, S. and I.F. Trew. 1979. Pitch x loblolly pine hybrids: loblollies for the North? Journal of Forestry 77 (11): 709-713, 716.

Plass, William T. 1973. Genetic variability in survival and growth of Virginia pine planted on acid surface-mine spoil. p. 493-507. In R.J. Hutnik and Grant Davis (eds.) Ecology and reclamation of devastated land. Vol. 1. New York: Gordon and Breach.

Schneck, Marcus. 1985. Penn nursery: reforesting the state. Pennsylvania Forests 75 (6): 10-11.

Thor, Eyvind, George Rink, and William T. Plass. 1974. Breeding Virginia pine for better growth on acid spoil. p. 168-174. In 2nd Research and Applied Technology Symposium on Mined-Land Reclamation: Coal and the Environment Technical Conference. (Louisville, Ky., October 22-24, 1974).

Vogel, Willis G. 1981. A guide for revegetating coal minesoils in the Eastern United States. USDA Forest Service General Technical Report NE-68, 190 p. Northeastern Forest Experiment Station. Broomall, Pa.

U.S. Department of Agriculture, Soil Conservation Service. 1978. Plant performance on surface coal mine spoil in Eastern United States. USDA Soil Conservation Service SCS-TP-155, 76 p.