DIRECT SEEDING FOR FORESTATION[1]

Walter H. Davidson[2]

Abstract.--Direct seeding, an attractive alternative to planting, is not a simple method of forestation. Past experiences show far more failures than successes. Well documented procedures must be followed to insure any degree of success. In general, conifers have given the best results. Black walnut and black locust are notable exceptions. Current research suggests that other hardwoods may be successfully direct-seeded.

INTRODUCTION

Direct seeding is an attractive alternative to planting seedlings. Large acreages can be seeded in a relatively short time, less manpower is needed, and seedings can be made at times when planting is not feasible. Direct seeding, however, is not a simple method of forestation and its successful application requires technical knowledge and skills. Regardless of the potentials of direct seeding, if seeding techniques are faulty or miscalculations are made, only failure will result. It is the intent of this paper to present the state of the art of direct seeding as a reclamation tool, to present guidelines for reclamation seeding, and suggest research needs to more efficiently develop seeding techniques.

PAST EXPERIENCE

Early reports of reclamation for forestation indicate that direct seeding was attempted in many regions as an alternative to tree planting. Among the earliest attempts was direct seeding of black walnut made in 1939 in Illinois (Schavilje 1941). He reported good first year germination and survival with average seedling height of 12 inches. Limstrom (1960), however, discourages the use of direct seeding due to inconsistent results and failures of earlier trials. A seeding of black walnut, black cherry, and bur oak on 13 sites in Missouri, Kansas, and Oklahoma, resulted in complete failure of the black cherry. After 6 years black walnut survival was 15 percent and bur oak was 24 percent. Other seedings of black walnut resulted in survivals ranging from 6 to 82 percent. Additional testing included more species, both conifers and hardwoods, but again the results can only be classed as fair to poor. He attributed the failures to, "(1) drying out of germinating seedlings, (2) mice and other rodents pilfering the seed, and (3) erosion and siltation".

Rodents were cited as the major limiting factor to early direct seeding trials in central Pennsylvania (Bramble and Sharp 1949). However, trials in the anthracite region of Pennsylvania showed spring seeding of red oak, Virginia pine, pitch pine, and red pine gave satisfactory germination. White oak, Norway spruce, white pine, and Japanese larch either failed completely or gave very poor germination.[3]

Loblolly pine was successfully seeded on steep spoil banks in a 1961 experiment in Tennessee (Thor and Kring 1964). This study of seeding versus planting showed that planted seedlings produced higher survival rates, but cost of planting exceeded that of seeding. The major disadvantage of direct seeding was poor distribution of stocked seed spots.

Between 1930 and 1940, black walnut seed was available for reclamation seeding in Indiana (Medvick 1973). Apparently the results were unsatisfactory and seedlings were planted

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[2]Research Forester, USDA-Forest Service. Northeastern Forest Experiment Station, Forestry Sciences Laboratory, P. O. Box 152, Princeton, West Virginia 24740.

[3]Unpublished report on forest planting and seeding experiments on lands stripped for coal in the anthracite region. 1951. Pennsylvania Bureau of Forests and Waters.

in the period 1941 to 1950. Direct seeding was tried again in 1950. About 1960, acceptable walnut planting stock was developed and there is no record of further direct seeding trials.

Thirty-year evaluations of plantations in Illinois indicate that the performance of seeded black walnut is comparable to planted seedlings (Ashby et al. 1978). In addition, seeding of black walnut is recommended on sandy, unvegetated areas.

Direct seeding of black locust was a common reclamation practice in West Virginia during the 1940s and 1950s. An evaluation of about 20,000 acres of these seedings showed only about 20 percent had successful establishment of trees (Brown and Tryon 1960). About 50 percent of the stands were rated as complete failures. In an attempt to determine the causes of failure, a series of experiments were established in 1958 to 1960. The effects of site factors and seeding methods on germination and survival of black locust, Virginia pine, pitch pine, and white pine were investigated (Brown 1973). Black locust and pitch pine gave the best results. Spoil moisture, seed bed condition, seed treatment, seed coverage, and competition from herbaceous plants, were listed as factors affecting germination and initial survival.

Other recent experimentation includes tests with loblolly, shortleaf, Virginia, and white pine by the Tennessee Valley Authority (Zarger et al. 1973). In these 1966 trials, stratified seed treated with bird and rodent repellants was used. Seed was broadcast by hand or cyclone seeder and also by helicopter. First year results showed Virginia pine gave the best and most consistent results; white pine was the poorest.

Field tests in West Virginia have indicated that bicolor lespedeza, false indigo, black locust, green ash, Virginia pine, shortleaf pine, and loblolly pine can be recommended for direct seeding in the southern region of the state (Plass 1976). Shortleaf and loblolly pine have also shown greater tolerance to a range of spoil conditions in a greenhouse test (Plass 1974). Identification of the promising species resulted from a species evaluation trial in which 34 species of trees and shrubs were hydroseeded on five sites. The sites were classified by elevation and species were selected for testing on the basis of planting recommendations for the site class. Results at higher elevations and in the northern region of the state were variable. Some species show promise but none can be recommended except for additional testing.

Direct seeding as a reforestation technique has been extensively practiced in the South. Nevertheless, in a survey of direct seeding in the South (Mann 1968), the only reference to reclamation seeding is for loblolly pine on Alabama spoils.

At a direct seeding symposium in 1973, Abbott reviewed direct seeding programs in the United States. Only West Virginia was mentioned for direct seeding a sizeable acreage of surface mined lands. Reference was made to direct seeding black locust which accounted for 62 percent of the State's acreage reforested in 1972.

In a publication on plant performance on surface mines (Soil Conservation Service 1978), Virginia pine, loblolly pine, and black locust are listed as tree species most likely to produce acceptable stands from direct seeding.

Reviewing the past experiences with direct seeding for reclamation illustrates the need for selecting the right species, preparing a suitable seed bed, providing protection to the seed, and seeding at the proper time.

CURRENT RESEARCH

In spite of the problem associated with direct seeding, many operators are attempting to establish trees from seed and research to find acceptable species and dependable seeding techniques is continuing. I installed a series of study plots in late April and early May using a variety of species. Grass species were seeded at the same time in an attempt to meet reclamation requirements for erosion control and site protection. Because of the late timing of the trials, early results are not promising.

Another current study on direct seeding is being done by Clark Ashby.[4] This work involves studies using the spot seeding technique with a variety of species. Early results are encouraging for black walnut, several oak and hickory species, and silver maple. Black locust is acceptable but is poorer than some of the other species. Black cherry and hackberry have performed poorly.

Undoubtedly more research is being conducted throughout the region. New regulations and standards for reclamation have become more stringent and direct seeding must

[4]Ashby, W. Clark. 1980. Personal communication.

be demonstrated to be a reliable technique for forestation.

GUIDELINES FOR DIRECT SEEDING

Many guides have been published on direct seeding for reforestation. The principles of direct seeding apply both to reforestation and forestation of surface mined lands. However, there are differences that must be recognized when the seeding is for reclamation. A surface mine is not the same as a logged area or old field. Soil conditions may be considerably different. Erosion potential is high and must be considered. In addition, a defined measure of success must be achieved within a set time frame.

The following guidelines are general rules which must be considered to insure the highest chance of success when direct seeding.

Species selection

Native species usually have the highest potential for success. Priority should be given to species that are successfully planted in the region. Some species, such as black cherry, are difficult to seed successfully. Use of such species should be limited to small trials until seeding techniques are perfected.

Seed quality

Only good quality seed should be used. Certified seed is recommended. Geographic source of the seed may also influence its quality (Belcher 1976).

Seed treatment

Seed having internal or seed coat dormancy should be scarified and/or stratified to insure prompt germination. Treatment to protect the seed from birds and mammals should also be applied. There are restrictions on chemicals used for seed protection which require state certification of the user. Many seed companies can provided treated seed.

Seedbed preparation

A freshly prepared seedbed will give the best conditions for germination and establishment.

Time of seeding

Early spring is usually the best time to seed. Fall seeding is acceptable if the soil conditions are such that the seed will not be washed away or covered too deeply by siltation. Fall seeding can provide natural stratification.

Seeding method

Broadcast seeding is the easiest method to use. It can be by hand, cyclone seeder, hydroseeder, helicopter, or fixed-wing aircraft. However, large quantities of seed are required and unless discing or some other treatment is applied, the seed may not be covered properly. Spot seeding or drilling uses less seed and provides better seed coverage ensuring better germination and more uniform spacing. This can be an important factor if seed is scarce or high priced seed is used.

Liming and fertilizing

Liming and fertilizing can improve germination and seedling growth (Vogel and Berg 1973). However, invading herbaceous plants will be encouraged and the competition could be detrimental to the tree seedlings.

Combination seedings

Herbaceous plants are needed for cover and erosion control. However, competition from herbaceous plants will reduce the success of tree seedings. At this time, the options are to seed the herbaceous species one year and spot seed the following year in spots prepared by scalping or using herbicides. Another possibility is to spring seed trees, then over-seed with grasses in the fall. There has been limited success seeding both herbaceous species and trees at the same time. If this technique is used species selection is critical and fertilization should be minimal to inhibit rapid development of the grasses.

These guidelines show that direct seeding is not an easy alternative to planting. Any landowner wishing to obtain trees by direct seeding must be prepared to follow the guides and must be willing to accept failures if weather conditions or other factors occur which cause poor germination, seed losses, or seedling mortality.

RESEARCH NEEDS

Much is known about direct seeding. However, when seeding for reclamation, there are areas which need to be investigated to determine more practical techniques to insure successful seeding.

Among the primary needs are evaluations of various tree and herbaceous combinations to allow for one time seeding operations. Additional testing of hardwood seeding is needed. Timing of lime and fertilizer applications needs to be studied to maintain a herbaceous cover that will not compete too strongly with seedlings.

Continued species evaluations and testing new species is needed to give the landowner a greater selection of species which can be seeded. Seeding rates for hydroseeding need to be evaluated.

Economic studies are also needed to determine if the costs of seeding justify the end result.

SUMMARY

Past experiences have shown that in some instances direct seeding has given satisfactory stands of trees on surface mined lands. In many instances, the results were less than desirable. However, the procedure has appeal for reclamation in that it may be possible to obtain a mixed cover of herbaceous and woody species on a site in a single operation.

Current seeding operations should use species and techniques that have given the best results in the past.

Research is needed to identify species combinations for one step operations and to develop procedures which will give the highest chances for success.

LITERATURE CITED

Abbott, Hershel G. 1973. Direct seeding in the United States. "Direct Seeding Symposium," Dept. of the Envir. Canadian For. Serv. Pub. No. 1339, Ottawa. p. 1-10.

Ashby, W. Clark, Clay Kolar, Mary L. Guerke, and others. 1978. Our reclamation future, the missing bet on trees. IIEQ Doc. No. 78/04, Southern Illinois Univ. Carbondale. 99 p.

Belcher, E. W. 1976. Seed source and vigor. In K. A. Utz (ed.) Proc. of the Conference on Forestation of Disturbed Surface Areas. USDA For. Serv. Atlanta, Ga. p. 20-22.

Bramble, William C. and Ward M. Sharp. 1949. Rodents as a factor in direct seeding on spoil banks in central Pennsylvania. J. For. 47:477-478.

Brown, James H. 1973. Site factors and seeding methods affecting germination and survival of tree species direct seeded on surface-mined areas. West Virginia Univ. Agric. Exp. Stn. Bull. 620. 25 p. Morgantown.

Brown, James H. and E. H. Tryon. 1960. Establishment of seeded black locust on spoil banks in West Virginia. West Virginia Univ. Agric. Exp. Stn. Bull. 440. 33 p. Morgantown.

Limstrom, G. A. 1960. Forestation of strip-mined land in the Central States. USDA Handb. 166. 74 p.

Mann, William F., Jr. 1968. Ten years experience with direct seeding in the South. J. For. 66:828-833.

Medvick, C. 1973. Selecting plant species for revegetating surface coal mined lands in Indiana--a forty-year record. In Russell J. Hutnik and Grant Davis (ed.) Ecology and Reclamation of Devastated Land. Vol. 2, p. 65-80. New York. Gordon and Breach.

Plass, William T. 1974. Factors affecting the establishment of direct-seeded pine on surface-mine spoils. USDA For. Serv. Res. Pap. NE-290. 5 p.

Plass, William T. 1976. Direct seeding of trees and shrubs on surface-mined lands in West Virginia. In K. A. Utz (ed.) Proc. of the Conference on Forestation of Disturbed Surface Areas. USDA For. Serv., Atlanta, Ga. p. 32-42.

Schavilje, Joseph P. 1941. Reclaiming Illinois strip mined coal lands with trees. J. For. 39:714-719.

Thor, Eyvind and James S. Kring. 1964. Planting and seeding of loblolly pine on steep spoil banks. J. For. 62:575-576.

Soil Conservation Service. 1978. Plant performance on surface coal mine spoil in eastern United States. USDA, SCS. TP-155. 76 p.

Vogel, W. G. and W. A. Berg. 1973. Fertilizer and herbaceous cover influence establishment of direct-seeded black locust on coal-mine spoils. In Russel J. Hutnik and Grant Davis (ed.) Ecology and Reclamation of Devastated Land, Vol. 2, p. 189-198. New York. Gordon and Breach.

Zarger, T. G., J. A. Curry, and J. C. Allen. 1973. Seeding of pine on coal spoil banks in the Tennessee Valley. In Russell J. Hutnik and Grant Davis (ed.) Ecology and Reclamation of Devastated Land, Vol. 1. p. 509-523. New York. Gordon and Breach.