CURRENT STUDIES OF SEEDLING GROWTH AND SURVIVAL ON STRIP MINE LANDS'

Amy G. Griffith2

Approximately 70 percent of the seedlings grown in the Bureau of Forestry nurseries are now planted on strip-mined land. The survival of trees on these sites has always been extremely variable. This variation is due to several factors, including spoil pH (Bond et al. 1954), toxicity of parent material (Clarkson 1975) (Berg and Vogel 1973) and quality of initial planting efforts. The pH of spoil material can affect the availability of both essential nutrients and toxic elements which can hinder root development. Spoil pH and toxicity vary considerably depending upon the character of the overburden disturbed. Also, initial herbaceous cover may compete with seedlings and result in high mortality. Because of these problems, it is important to know how well the trees that our nurseries are producing will grow under such conditions. Through Project 20, the Bureau of Forestry has conducted vegetation surveys of previously reclaimed lands and has initiated new research projects to examine survival of tree species planted in mine spoil.

Revegetation Surveys

Beginning in 1981, over 800 sites were examined to determine the survival and vigor of tree species used in the original reclamation plantings. All sites were reclaimed between 1970 and 1977, and had been regraded to the approximate original contour, with topsoil returned. The survival and vigor of each tree species was analyzed by soil pH to find pH levels at which growth or survival was affected by acid conditions. After analysis, most species show little significant difference in survival and vigor at different pH levels. The only exception was European black alder, which exhibited survival between pH 5.0 and pH 5.9 that was superior to survival at lower or higher pH ranges. This peak in growth of alder has been confirmed by previous research (Griffiths and McCormick 1984), which showed good survival down to pH 3.5-4.0, with survival increasing up to pH 6.0 and decreasing thereafter.

When other species were examined, there appeared to be too many site factors, other than pH, which affect seedling growth. Differences in soil fertility and presence of toxic elements due to overburden characteristics, along with the quality of the original tree planting, may have had more significant impact. Also, these areas were planted over an eight-year period, and differences in climatic conditions may have affected survival.

In spite of the number of surveys done, some species were not represented on enough sites to make comparison possible. Additional surveys are being done to increase sample size for future analyses.

Current Research

A number of research projects were initiated in 1984. These were planted throughout the state, with most studies duplicated at least one time. First-year survival and height data was collected in 1985 and statistically analyzed using analysis of variance techniques. Second-year data was collected this spring and is currently being analyzed.

Several of these experiments were designed to study the effects of nitrogen fixing trees on natural invasion by native species and on the growth of companion species. These are:

1. A European black alder monoculture to examine the rate of litter accumulation and decomposition, along with the rate, quantities, and variety of native species established.

2. A mixed alder and black locust planting to look at the progression of natural invasion and the development and/or decline of the alder and locust over time.

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[2] A report of research being conducted by the Bureau of Forestry through Project 20.

Forester, Forest Advisory Services, Bureau of Forestry, Harrisburg, Pennsylvania.

3. An interplanting of European black alder and black locust with red pine, Japanese larch, and green ash to determine the benefits of the nitrogen fixers on other species at low soil pHs.
4. A birch and alder interplanting which examines the effects of N-fixing species on natural invasion in birch stands.

Heights and survival data were collected from these experiments in 1985 and 1986. It is estimated that it will take several more years to determine any effects on natural invasion by the nitrogen fixing species. However, some observations can be made from examination of data from the European black alder monoculture. Survival of the alder ranged from 82 percent to 98 percent after two years, and average heights were from 57.5 centimeters to 123.5 centimeters. This study was planted on three different sites, with spoil pHs found from 3.7 to 5.1. Two of the sites suffered severe die-back from damage caused by 17-year locust; however, the one site without die-back had heights up to 295.5 centimeters (9.7 feet). Survival seemed unaffected by the locust damage, and the trees with terminal die-back are recovering with a bushy form.

Other research projects established in 1984 included:

1. A white pine, pH tolerance study.

2. Grass and herbicide trials.

3. A comparison of pitch x loblolly pine hybrid and red pine.

4. An erosion study.

White pine was planted in high pH (5.0 and above) and low pH (below 5.0) spoils to compare growth and survival. Results were extremely variable in initial analyses, and the quality of planting and competition with herbaceous vegetation appear to have had some effect on survival.

In a grass and herbicide trial, seedlings were planted in combination with grass and soil amendments, and with site preparation using herbicide. Each site was divided into six treatment blocks:

Block A—Grass with lime and fertilizer. No trees.

Block B—Grass with lime and fertilizer. Seedlings planted.

Block C— Seedlings only.

Block D— First year, grass with lime and fertilizer.
Second year; seedlings planted.

Block E —First year, grass with lime and fertilizer. Spot spraying with Roundup in fall.

Second year, seedlings planted.

Block F— First year, grass with lime and fertilizer. Strip spraying with Roundup in fall.

Second year, seedlings planted.

Growth of seedlings when planted alone was either the same or significantly better when compared to seedlings planted with grass. Red pine and Japanese larch showed no significant difference in height, while black locust and European black alder had better growth in ungrassed blocks on several sites.

Survival varied when comparing seedlings planted with or without grass cover. Black locust survived better with grass and soil amendments, while red pine and Japanese larch showed better survival without grass. Little difference was seen in the survival of European black alder with either treatment.

Seedlings were planted in Blocks D, E, and F during Spring 1985. Data will be collected in subsequent years and compared to the original portions of this study.

Growth and survival of pitch x loblolly pine hybrid was compared to that of red pine in another study. Growth of pitch x loblolly hybrid was significantly better in all plots. Survival was near the same for both species, averaging 83.5 percent overall for pitch x loblolly and 79 percent for red pine. Severe sawfly damage was noted in the pitch x loblolly hybrid seedlings in western Pennsylvania, while red pine was unaffected. Growth and survival of the hybrid appear to have been severely reduced on one site and susceptibility to sawfly damage may have an impact on plantings of this tree on other strip mine sites. Pitch x loblolly exhibited a sprawling, bushy form after the first growing season; however, many trees seemed to be outgrowing this form and are beginning to have large height gains.

Three sites, previously strip-mined, with successful stands of pine were clearcut to examine the effects of harvesting on soil erosion. Half of each site was then planted with either European black alder, red pine, or Japanese larch, and the other half of each site was not replanted. Although little natural invasion is usually found beneath conifer plantations on strip mined land, all three areas had heavy cover within two years after clearcutting and no erosion was found on any site. Species which took over the site were different in each case. blueberry, sweetfern, and red maple were found on one; aspen and black locust on another; and birch, aspen, white pine, and red maple invaded the third research area.

It is anticipated that it will be several years before any definite conclusions can be made from most of these experiments. More time is needed for the N-fixing species to have any appreciable effect on surrounding species or to benefit the soil enough to encourage encroachment by native vegetation. First-year data may be compounded by the quality of the planting job, which varies greatly. Data will continue to be collected over the next eight years, and later results will give a much better idea of what effects site factors are having on tree seedlings.

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