ESTABLISHMENT OF NATIVE HARDWOODS ON MINED LANDS REVEGETATED UNDER CURRENT REGULATIONS[1]

by

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Abstract. This project is evaluating the survival of 5 native hardwood tree species under different levels of seeded herbaceous cover in northwestern Pennsylvania. Three sites were reclaimed in 1991 and planted with 1-0 seedlings immediately after seeding. Tree species included red oak, red maple, black birch, quaking aspen, and black locust. Measurements were taken of herbaceous cover and tree survival in fall, 1991. The Kylertown site had the lowest overall survival (52%) among the 3 sites, probably due to more severe climatic and edaphic conditions. The Brandy Camp and Harmony sites both had overall survival rates of 72%. Red oak, red maple, and black locust had better survival rates than aspen and black birch. Perennial herbaceous vegetation was late in developing due to drought conditions. Comparisons of "high" vs "low" herbaceous cover revealed that tree survival was higher with "low" levels of cover in 14 of 15 comparisons (5 species x 3 sites). Anticipated growth of herbaceous species in 1992 will likely magnify differences in survival between low and high cover treatments.

Introduction

A significant amount of research has been reported during the past 40 years on revegetation of Eastern lands mined for coal (Limstrom 1960, Czapowskj 1970, Davis et al. 1971, Ashby et al. 1978, Ruffner 1978, Vogel 1981, Ashby et al. 1988). Many of these studies involved abandoned sites characterized by a high percentage of coarse fragments, low fertility, and high acidity (Armiger et al. 1976). Abiotic factors, particularly spoil physical and chemical properties, in large part limited the establishment of plant species and controlled successional pathways. Soil pH was the major limitation to plant growth in many cases.

Recent reclamation legislation, particularly Public Law 95-87, "The Surface Mining Control and Reclamation Act of 1977", emphasizes returning lands to approximate original contours, saving and replacing topsoil, and establishing dense herbaceous cover (Leedy 1981). The current reclamation practices created sites with improved abiotic conditions compared to prior reclamation sites, but led to a reduction in the use of trees in the reclamation process (Vogel 1979). Mined lands are graded, topsoiled, limed, fertilized, seeded, and mulched; the end result being an aggressive grass/legume pasture.

With current methods of saving and replacing topsoil, handling "hot" spoils, and lime application, pH is

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not the limiting factor it once was. Herbaceous competition, soil compaction, and animal damage have been identified as significant influences on tree survival and growth on newly-reclaimed sites. Trees are not used as extensively, and the species of trees used are generally not typical of adjacent unmined areas.

In northwestern Pennsylvania, trees which survive best on current reclamation sites are black locust (Robinia pseudoacacia), red pine (Pinus resinosa), and Japanese larch (Larix japonica). Japanese larch is not native to the area, and central Pennsylvania is on the edge of the range for both red pine and black locust. Coal companies, in response to regulatory pressures, have taken the path of least resistance to recover bond monies by establishing dense grass/legume fields which meet the 70% cover requirement. In many cases the land use has changed from a forest to a grassland, although few pastures are utilized by livestock.

With the advent of P.L. 95-87, site physical and chemical limitations were reduced (Hughes 1990). As a result, biotic factors not operative on older sites can now limit the use of trees in reclamation (Vogel 1979). Results from past research on orphaned or abandoned sites may not be reproducible on current mine sites. Wade et al. (1985) examined tree and shrub survival on an 18-year-old acidic site in Kentucky. They cautioned that the lack of regrading, amendments, and herbaceous cover-cropping in their study site may well produce results different than those achieved under current reclamation regulations.

Considerable evidence indicates that competition from seeded herbaceous species is a serious factor for the establishment of hardwoods (Bey et al. 1976, Erdmann 1967, von Althea 1971, Vogel 1980, Hutnik 1983, Ashby et al. 1988, Hughes and Garthe 1989). Soil compaction is also a concern (Torbert and Burger 1990), and animal damage to tree seedlings is prevalent in many parts of Pennsylvania (Marquis 1981).

Conifers or hardwoods such as black locust reportedly survive best on sites under current regulations. Few studies, however, have examined native hardwoods and methods of enhancing their growth and survival under current reclamation conditions. The proposed research seeks to evaluate methods for establishing native hardwood tree species on newly-reclaimed areas, primarily through reducing herbaceous competition and animal browsing. Specific objectives are:
1. to determine the growth and survival of five species of early successional native hardwoods under two rates of herbaceous competition and presence/absence of deer; and
2. to determine if native tree species survival can be enhanced by modifying current herbaceous seed planting techniques.

Methods

Three research sites (Kylertown, Brandy Camp, and Harmony) in western Pennsylvania were established on areas reclaimed in 1991 . At each site, 2 levels of herbaceous competition and 2 levels of deer browsing were evaluated for their impact on the growth and survival of 5 native hardwoods. Levels of competition are "high" (tree seedlings are planted into drilled herbaceous rows), and "low" (seedlings planted into unseeded strips appx. 36" wide). The unseeded strips were created by plugging 4 seeding ports on a 10-port drill, or by skipping the appropriate distance between adjacent passes of the drill.

The impact of deer browsing in fenced and unfenced areas will be evaluated in the future. Fencing was not completed until after survival measurements were taken, thus is excluded from the discussion.

The herbaceous mixture used consisted of that normally used to reclaim such areas, the primary components being birdsfoot trefoil (Lotus corniculatus) and either K-31 tall fescue (Festuca arundinacea) or orchardgrass (Dactylis glomerata). The native hardwoods selected were red oak (Quercus rubra, red maple (Acer rubrum), black birch (Betula lenta), aspen (Populus tremuloides), and black locust. These species were selected because of their natural occurrence in western PA, intolerance to shade, and wildlife or economic value. Black locust was selected because it survives well on mined sites. Tree seedlings (1-0) were hand-planted immediately after sites were seeded in spring, 1991. Each treatment was replicated twice.

Tree survival and height growth were monitored in August, 1991. Herbaceous cover for each treatment was ocularly estimated in August and September, 1991. Percentage of ground cover, by species, was determined on 1 m^2 plots. On the High Competition treatments, 4 plots were randomly located and recorded. On the Low Competition treatments, 4 plots were established on areas seeded to herbaceous species, and 4 plots were established in the bare strips where tree seedlings were planted. This enabled us to quanitfy herbaceous cover, and differences in cover that exist under the High vs Low Competition treatments.

Results and Discussion

Modifying the herbaceous seeding procedure to reduce the herbaceous cover on the small unseeded strips had the desired effect (Table 1). Herbaceous cover in the bare strips under Low Competition was considerably less than herbaceous cover on seeded strips.

Growing conditions in 1991 were very poor due to low soil moisture during a protracted summer drought. Seeded annuals were less dense than in years of average rainfall, and herbaceous perennial cover (trefoil and grasses) did not develop appreciably until the fall, when precipitation improved soil moisture conditions. There was concern at the Kylertown site that the lack of perennial herbaceous vegetation might require replanting the following spring.

Weather and soil conditions varied by site. Brandy Camp and Harmony received more summer rainfall through local thunderstorms than did Kylertown, and this influenced plant development and survival. Kylertown also had shallower topsoil than the other sites. As a result, Kylertown had an overall survival rate of 52%,

Table 1. Total percentage cover (%) on plots reclaimed under High and Low levels of herbaceous competition. Trees in the Low competition level were planted into bare (unseeded) areas.

	Herbaceous Competition		
	High	Low	
Site	All	Seeded	Bare
Brandy Camp	32	44	13
Harmony	24	45	24
Kylertown	20	28	7

while both Brandy Camp and Harmony had overall survival rates of 72%.

There were considerable differences in survival rates among species. Red oak, red maple, and black locust survived better than black birch and aspen (Table 2). Except for red maple, 4 of the 5 species had lowest survival rates at Kylertown. Edaphic and climatic conditions at Kylertown were least suitable to plant survival and growth. Although height data are not included in this report, visual observation indicated that red maple and black locust exhibited the best height growth. Many red oak seedlings, while surviving, exhibited little height growth since planting. This is not unusual for red oak.

Because the herbaceous species began growing so late in the year, the effects of competition were initially thought to be overshadowed by the impact of the drought. Preliminary data on plant survival suggest otherwise. In 14 of 15 comparisons of High vs Low Competition, trees planted under the Low Competition treatments had higher survival rates than those planted under High Competition treatments

Table 2. Percentage survival of 5 hardwood species planted on 3 surface mined areas in western Pennsylvania.

Species (n)[1]	COMPETITION Low	COMPETITION High	Site Average
		Kylertown	
Red oak (48)	72.4	58.3	65.4
Red maple (48)	76.6	67.7	72.2
Black birch (48)	24.5	20.3	22.4
Aspen (36)	41.7	24.8	33.2
Black locust (48)	65.1	59.4	62.2
		Brandy Camp	
Red oak (32)	82.8	80.4	81.6
Red maple (32)	92.9	86.6	89.9
Black birch (32)	61.0	53.1	57.0
Aspen (32)	56.2	41.4	48.4
Black locust (32)	85.2	71.1	78.1
		Harmony	
Red oak (20 & 25)	92.0	60.0	76.0
Red maple (20 & 25)	72.0	60.0	66.0
Black birch (20 & 25)	72.0	36.2	54.1
Aspen (20 & 25)	82.2	70.0	76.1
Black locust (20 & 25)	84.0	92.5	88.2

[1]Number of seedlings planted per treatment. For the Harmony site, 20 seedlings were planted on High Competition treatments, and 25 on Low Competition.

(Table 2). Each individual comparison differs only in the level of seeded herbaceous cover. It therefore seems possible that, even with the drought, herbaceous cover decreased tree survival. Rapid development of perennial herbaceous cover in the fall and the possible impact of herbaceous cover after 1 growing season suggests that interspecific competition will be more severe in 1992.

Conclusions

Seeding techniques to reduce plant cover by creating bare strips were relatively simple and did not appear to affect the overall performance of the reclamation project. Weather, site location, and species influenced tree survival rates, but even after 1 growing season it seems possible that reduced herbaceous cover enhanced tree survival. In addition to the traditional black locust, red oak and red maple show promise as trees for reclamation provided herbaceous cover is controlled.

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