The Influence of Seed Scarification and Site Preparation on Establishment of Black Locust on Surface-Mined Sites[1]

D. R. Roberts and S. B. Carpenter
Graduate Assistant, Department of Forestry, University of Kentucky, Lexington, and Head, Department of Forestry, Oklahoma State University, Stillwater

Controlled environment and field studies were conducted to determine the best scarification procedures for black locust seed. Results showed site preparation method must be matched to seed preparation method to obtain optimum results.

The establishment of black locust (*Robinia pseudoacacia* L.) on surface mine spoil for erosion control and soil development is a common practice in the Appalachians (*2*). Rapid germination is especially important when direct-seeding tree species to minimize competition from grass.

Prompt germination of black locust is hindered by the thick, impermeable seedcoat. The seedcoat weathers slowly so only a few seeds germinate at a time (*5*). Scarification of the seedcoat with sulfuric acid increases the percentage and rate of germination (*4*). However, while the scarification procedure increases germination, it also decreases the ability of seeds to survive unfavorable microclimatic conditions. Site preparation can decrease the severity of the environment and therefore allows a more intensive scarification.

In this study, the effects of scarification on black locust seeds were investigated, and treatments were designed to analyze the effects of field procedures on the germination potential. Controlled environment scarification tests were used to determine the best scarification procedure for seeds to be sown on mine spoils.

Methods

Controlled environment. Black locust seeds were placed in concentrated sulfuric acid (two parts acid to one part seed). Subsamples were removed after 10, 30, 60, and 90 minutes. A control lot received no acid treatment. The seeds were rinsed thoroughly with tapwater upon removal from the acid. Four treatments were imposed on the seeds from each scarification period (fig. 1). Forty seeds from each treatment were placed in a convection oven at 34° C for 24 hours. Half these seeds (20) were watered immediately after planting. The remaining seeds were watered 72 hours after planting. Each treatment received 250 milliliters of distilled water daily, once watering commenced.

Spoil material in which to plant the seeds was collected from the same site that was to be used for field studies. A 4-centimeter-deep layer of subsurface spoil was placed in three seed flats, with another 1-centimeter-deep layer of surface spoil on top. The dark shale surface was covered with 2.5 centimeters of bark mulch similar to that described for the field test. Seeds were applied to the surface of the mulch and worked into it slightly to simulate raking as was done in field plots. Seeded flats were placed 0.3 meter below a light source providing 350 μ einsteins/m^2/sec incident light at the

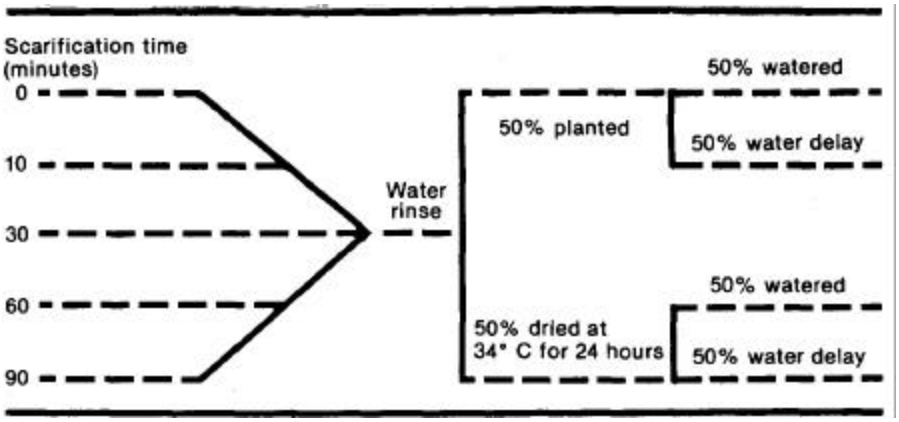

Figure 1.—*Scarification and preconditioning treatments performed on black locust seedlings for the controlled environment germination tests.*

[1] The investigation reported in this paper is in connection with a project of the Kentucky Agricultural Experiment Station. The research was supported in part by the Mt. Drive Coal Co., the Institute for Mining and Minerals Research, and the McIntire-Stennis Cooperative Forestry Research Program.

spoil surface. A 12-hour photoperiod was used during the 1-month germination trial.

Field. Black locust seeds were scarified for 60 minutes, rinsed, dried in a convection oven at 34° C overnight, and then transported to the field. The seeds were sown in 14 plots 15 square meters in size at rates of 6 or 12 kilograms per hectare (5 and 10 lb/acre). Seeds were applied, at each rate, to seven plots mulched with 2.4 centimeters of bark and to seven similar plots of bare mine spoil. The seeds were applied with a Panama seeder and then raked into the surface.

Table 1.—*Effect of scarification period (length of time in concentrated sulfuric acid) on germination of black locust seed after 1 month under controlled environmental conditions*

Scarification time	Mean final germination[1]	Mean final germination percentage
Min		
0	3.3a[2]	16.3
10	5.0a	25.0
30	5.3a	26.3
60	11.3b	56.3
90	9.3b	46.3

[1]Four replicates of each experiment with 20 seeds.

[2]Means followed by the same letter did not differ significantly at $P < 0.05$.

Table 2.—*Effects of postscarification treatments on germination of black locust seed after 1 month under controlled environmental conditions*

Treatments	Mean final germination percentage[1]
Planted immediately, irrigated immediately	36a[2]
Planted immediately, irrigated 3 days later	42a
Dried at 34° C, irrigated immediately	26a
Dried at 34° C, irrigated 3 days later	32a

[1]Mean germination of four scarification treatments.

[2]Means followed by the same letter did not differ significantly at $P < 0.05$.

Table 3.—*Survival of direct-seeded black locust seedlings on bare mine spoil and bark mulch plots after one growing season*

	Number of seedlings per hectare given seeding rates of:	
Treatment	6 kg/ha	12 kg/ha
2.4-cm bark mulch	8,8751	23,750
Control (bare mine spoil)	0	0

[1]Average calculated from means of all treatments employing bark mulch.

Results

Controlled environment tests. Sulfuric acid scarification for 60 and 90 minutes was effective, increasing seed germination from 16 percent for nonscarified seed to 56 and 46 percent for the 60 and 90 minute treatments, respectively (table 1). Slight, but nonsignificant, increases in germination were observed after 10- and 30-minute scarifications. A 3-day irrigation delay did not significantly affect the total germination of black locust seeds (table 2). Drying the seeds at 34° C for 24 hours had no effect on total germination (table 2).

Field Plots. None of the scarified seeds applied to the bare mine spoil plots survived the first growing season (table 3). Germination had occurred (radicles had penetrated the seedcoat), but the seeds had dried out before the radicles could penetrate the soil.

Seedling survival was greatly increased by site preparation with bark mulch (table 3). Survival was sparse in areas where soil was compacted or where the bark mulch had been washed away during the winter.

Discussion

Scarification in sulfuric acid for 60 and 90 minutes increased the germination of black locust seeds in the controlled environment study. Black locust ground cover may be increased by as much as 100 to 200 percent through the use of seed scarification. The uniformity and rate of seedling establishment can also be increased by the scarification treatment (*6*). The percentage of germination of black locust seeds that is inhibited by the seedcoat can vary considerably between seedlots (*4*). It is of considerable importance for each seedlot to be tested for the optimum scarification time.

Rinsing the residual sulfuric acid from the seeds is a very important aspect of the scarification procedure. Drying the seeds at 34° C after rinsing removes excess moisture without decreasing germination (table 2). If the seeds are allowed to remain moist after rinsing, fungal growth and premature germination may occur before sowing.

Delaying irrigation for 72 hours after sowing did not result in decreased germination (table 2). This implies that, if improper germinating conditions exist at sowing time, the seeds will continue to survive for at least 72 hours.

The primary reasons for the poor seed survival on bare mine spoil were unfavorable moisture and temperature conditions when the seed began to germinate.

The 2.4-centimeter bark mulch treatment significantly increased seed survival on the field plots (table 3). Mulching with bark and straw increased soil moisture retention and decreased extremes of soil temperature (*1*). Areas washed free of bark mulch during the winter had sparse seedling survival.

Another strategy that can be used to increase black locust seedling establishment in unfavorable environments is decreased seed scarification. Less scarification results in a greater innate protection of the seed by the seedcoat.

Soil compaction is noticeably detrimental to seedling establishment and growth. Drastic effects of soil compaction on germination rate and survival in direct-seeded black locust were shown by Brown (*3*). Soil compaction from heavy vehicle use should be avoided on sites where black locust establishment is planned.

Literature Cited

1. Albers, D. J.; Carpenter, S.B. Influence of site, environmental conditions, mulching, and herbaceous ground cover on survival, growth, and water relations of European alder seedlings planted on surface mine spoil. Proceedings symposium on surface mining hydrology, sedimentology and reclamation: Lexington, KY: University of Kentucky; 1979: 23-32.
2. Boyce, S. G.; Merz, R. W. Tree species recommended for strip mine plantings in western Kentucky. Tech. Pap. 160. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1979. 12 p.
3. Broqn, J. H. Site factors and seeding methods affecting germination and survival of tree species direct seeded on surface-mined sites. Bull. 620. Morgantown, WV: West Virginia University, Agricultural Experiment Station; 1973.
4. Chapman, A. G. Scarification of black locust seed to increase and hasten germination. J. For. 34: 66-74; 1936.
5. Heit, C. E. Propagation from seed. Part 6 Hardseededness-a critical fac tor. Am. Nurseryman. 125(10): 10-12, 38-96; 1967.
6. Meginnis, H. G. Sulphuric acid treatment to increase germination of black locust seed. Circ. 453. Washington, DC: U.S. Department of Agriculture; 1937. 34 p.