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Tree Survival and Growth on Graded and Ungraded Minesoil

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Compaction of soil by routine trafficking of earthmoving equipment during reclamation of surface-mined land can reduce tree survival and growth. Several species of trees-white pine (Pinus strobus L.), Virginia pine (P. virginiana Mill.), sugar maple (Acer saccharinum L.), sycamore (Platanus occidentalis L.), red oak (Quercus rubra L.), and black walnut (Juglans nigra L.) were planted on adjacent sites that were alike in all respects except that one was graded by standard reclamation procedures and the other had been abandoned in a semirough and uncompacted state. After 2 years, 42% of seedlings planted on the compacted site had survived, whereas 70% of those planted or, the uncompacted site survived. Trees grew taller on the uncompacted site. Thus, efforts to produce an aesthetically pleasing, smooth surface on reclaimed mined land may be counterproductive, adversely affecting tree survival and early growth. Tree Planters' Notes 41(2): 3-5 ; 1990.

Since passage of the Surface Mining Control and Reclamation Act of 1977, reclamation of mined land in the Appalachian coal region involves replacing the overburden to return the land to approximately the original contour and to restore the land to its original productivity. Slopes are reconstructed and graded smooth with heavy equipment. The final surface is usually "tracked-in" with bulldozers to create depressions (from the bulldozer treads) that can trap seed and water and promote germination of a uniform ground cover.

Unfortunately, traffic associated with grading the final surface and tracking-in a seedbed compacts the surface soil and makes it difficult to plant trees properly. Consequently, trees do not survive well, and when they do, their growth is retarded. Overall, the long-term productivity of sites with heavily trafficked mine soils is greatly diminished.

The effect of compaction on tree performance is not readily recognized by most reclamationists, partially because most species of herbaceous ground cover are not as seriously affected as trees, and because most miners are not familiar with the relationships between soil properties and tree establishment.

About 90% of the surface-mined land in Virginia is planted to trees, and much of the remaining land will return to trees via secondary succession. Given the importance of reforestation on surface mines in this region, this study was established to document the effect that compaction from grading and tracking-in has on tree survival and growth.

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Description of Study

The study was established on a partially reclaimed surface mine in Wise County, VA, in the central Appalachian coal fields. The test site was characterized by uniform overburden material of 2:1 sandstone/siltstone on a 30% slope that was 120 feet long and had a north aspect. Half of the site was graded, tracked-in, and hydroseeded, and the other was left rough-graded. The graded slope had already been operationally seeded with a hydroseed mix containing Kentucky-31 tall fescue and several clover species.

The ungraded slope had approximately 20% cover from volunteer forbs and grasses and was further hand seeded with a mixture of birdsfoot trefoil (10 pounds per acre), Appalow lespedeza (15 pounds per acre), and perennial ryegrass (10 pounds per acre). Fertilizer was applied to provide nitrogen (40 pounds per acre), phosphorus (100 pounds per acre), and potassium (50 pounds per acre). This "reforestation" mixture of legumes, grasses, and fertilizer has been demonstrated to produce a ground cover that is compatible with trees (2). The ground cover was established during June 1986, and trees were planted during April 1987.

Six species of trees were planted on each site: white pine, Virginia pine, black walnut, red oak, sugar maple, and sycamore. Each species was planted in rows from the bottom to the top of the slope. The number of trees per row varied from 10 to 15, depending on the length of the slope. Four rows of white pine *(Pinus strobus* L.) and Virginia pine (*P. virginiana* Mill.) were planted and two rows of black walnut *(Juglans nigra* L.), red oak *(Quercus rubra* L.), sycamore *(Platanus occidentalis* L.), and sugar maple (*Acer saccharinum* L.) were planted. All of the hardwood species were top-pruned to 1 foot before planting.

Table 1—*Tree survival and growth on a mine soil as affected by surface grading compaction*

	Survival (%)		Tree height (in)		
Species	Graded & tracked-in	Rough-graded	Graded & tracked-in	Rough-graded	Height response (%)
Black walnut	55	100	17	22	29
Red oak	40	62	17	17	0
Sugar maple	60	100	23	46	100
Sycamore	0	69	—	51	—
Virginia pine	63	42	18	22	22
White pine	37	43	10	17	70

Results

The greater amount of compaction on the smooth slope was immediately apparent during tree planting. Even during the early spring, when soils were relatively moist, it was very difficult to make a large hole with the dibble bar on the graded slope. On the rough-graded slope, however, planting holes were easy to open with a tree planting bar. After 2 years, more trees survived, and surviving trees were taller, on the rough-graded site than on the conventionally prepared tracked-in site.

Overall, tree survival on the rough-graded slope was nearly 70%, but it was only 42% on the compacted tracked-in slope (table 1). The effects of compaction were most severe on the hardwood species. All black walnut and sugar maple seedlings planted on the rough-graded slope survived, but only 50% and 60% of those planted on the smooth slope survived. On the rough-graded slope, 70% of the sycamores survived, and some grew to more than 4 feet tall in 2 years. On the compacted slope, however, none survived.

Compaction due to final grading reduced the rate at which the surviving trees grew. Most species were taller on the rough-graded slope. The effect was greatest for sugar maples, which grew twice as tall on the uncompacted site. The differences will probably become even more dramatic with time. Although trees have not yet been measured during the third year, it was observed that the oaks have added as much as 2 feet of new growth on the rough-graded slope, but only several inches on the compacted slope.

Tracking-in is usually done to obtain a more uniform ground cover. In this study, however, the best ground cover after 3 years occurred on the site that was not tracked-in. The cover on the graded slope was very lush during the first year, but subsequently has become sparse and appears to be unhealthy. On the other hand, the reforestation ground cover on the rough-graded slope was sparse during the first year (1986) but has subsequently become very dense.

The ability of certain tree species to tolerate adverse conditions was also noted. Virginia pine, a shallow-rooted species, survived much better than white pine on the compacted site. Observations at other sites indicate that Virginia pine is better suited to poor sites. Even at older ages when white pine typically grows much faster, Virginia pine will continue to outperform white pine on compacted soils (1). On the other hand, Virginia pine is very sensitive to shading, which it survived poorly on the rough-graded slope. The reforestation ground cover was designed to be sparse during the first year when trees are being established and then become dense when trees have grown above the cover. Poor survival of Virginia pine would not have occurred if seedlings had been planted during the year that the cover was seeded.

Early results from this comparison of ground cover and tree performance on these two differently prepared sites clearly demonstrate that normal reclamation grading practices to produce a smooth slope and uniform ground cover reduce tree survival and growth. This study also shows that good ground cover can be obtained without grading and tracking-in. The dense leguminous ground cover that resulted on the rough-graded slope is less likely to need follow-up work to meet legal requirements for mine reclamation. Leaving reclaimed sites in an uncompacted, semirough condition is less expensive and results in a more productive forest land use.

Literature Cited

1. Klemp, M.T.; Torbert, J.L.; Burger, J.A.; Schoenholtz, S.H. 1986. The effect of fertilization and chemical weed control on the growth of three pine species on an abandoned bench and return-to-contour site in southwestern Virginia. In: Graves, D.H., ed. Proceedings, 1986 Symposium on Mining, Hydrology, Sedimentology, and Reclamation; 1986 December 8-11; Lexington, KY. UKY BU142. Lexington, KY: University of Kentucky: 77-82.
2. Torbert, J.L.; Burger, J.A.; Preve, R.E. 1986. The effect of ground cover species and nitrogen fertilizer rate on the successful establishment of hydroseeded trees. In: Graves, D.H., ed. Proceedings, 1986 Symposium on Mining, Hydrology, Sedimentology, and Reclamation; 1986 December 8-11. UKY BU142. Lexington, KY: University of Kentucky: 83-87.