SUCCESSFUL OAK ESTABLISHMENT ON A RECLAIMED SURFACE MINE[1]

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Abstract. We evaluated an 8-year-old northern red oak (Quercus rubra L.) plantation on a reclaimed anthracite surface mine in Pennsylvania. Survival exceeded 70 percent and some of the saplings were growing 2 feet or more each year. The tallest trees were 14 feet and the plantation averaged 8 feet. Absence of a heavy herbaceous cover, little or no soil compaction, good planting technique, and sufficient moisture all contributed to getting the seedlings off to a good start. The success of this plantation shows that red oak can survive and grow well on reclaimed minesoils.

Additional Key Words: Northern red oak, Quercus rubra L., Pennsylvania, anthracite, reforestation.

Introduction

Establishing hardwood trees on reclaimed surface mines is a revegetation technique that coal producing states of the Eastern United States would like to practice. However, the combination of competition from herbaceous species and soil compaction makes successful establishment of oaks (and other woody species) on reclaimed minesoils more of a rarity than a commonplace occurrence. Vogel and Gray (1987) reported that compacted minesoils prevented root penetration of tree seedlings, retarded infiltration of precipitation, and increased the potential for rapid runoff and erosion.

For successful tree establishment on reclaimed surface mines, competing vegetation must be controlled to allow seedlings sufficient time to become established (Byrnes et al. 1984; Frame and Hicks 1984). Ashby et al. (1982) and Davidson et al. (1984) also concluded that soil compaction and competition from herbaceous vegetation are deterrents to tree survival on reclaimed surface mines.

Several hardwood species will grow at a satisfactory rate after they become established, but successfully planted oak often have slow early growth (Kolar et al. 1981). These factors have discouraged planting hardwoods, especially the oaks, on reclaimed mine sites.

The Plantation

We recently found an exception to both of these "truisms" concerning compaction and competition. A surface-mined area in the Southern Anthracite Coal Field of Pennsylvania was successfully planted to northern red oak and some saplings are growing at a rate in excess of 2 feet a year. The overall results are better than one would expect in a forest planting (personal correspondence, H.C. Smith, USDA Forest Service, Parsons, WV, 1989).

The planting report describes the area as having 3 acres affected with 60 feet of shale overburden removed to recover the coal. No top soil was reserved. The initial herbaceous seeding in May 1980 consisted of birdsfoot trefoil (Lotus corniculatus) at 8 pounds/acre, tall fescue (Festuca arundinacea) at 30 pounds/acre, and winter rye (Lolium multiflorum) at 56 pounds/acre.

Amendments included 500 pounds/acre of 10-20-20 fertilizer and 2 tons of agricultural lime/acre. The seeding failed due to droughty conditions during the growing season. Seeding and amendments were repeated in the fall of 1980. Therefore, amendments total 1,000 pounds of fertilizer and 4 tons of lime/acre. In April 1981, 500 red oak (Quercus rubra), 500 white pine (Pinus strobus), and 500 autumn olive (Elaeagnus umbellate) were hand-planted on the site.

By the end of the 1981 growing season, ground cover was estimated at 80 percent and tree and shrub survival estimated at nearly 100 percent. Ground

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cover diminished somewhat over the next 3 years and composition changed with the invasion of pioneer species such as dewberry (Rubus sp.), blackberry (Rubus sp.), quaking aspen (Populus tremuloides), and fire cherry (Prunus pensylvanica). During this time, white pine survival declined to about 80 percent. Red oak and autumn olive had virtually no natural mortality. However, all species suffered some mortality from damage by off-road recreational vehicles.

Evaluation

An evaluation of the oak portion of the planting during the winter of 1988-89 showed good survival with several individuals exhibiting excellent growth. Ground cover was not estimated because evaluations were made during the dormant season.

Four randomly spaced soil samples were taken, two on the bench and two on the slope. They showed a range of physical characteristics from sandy loam to sandy clay loam. Chemical analysis showed an average pH of 5.05 (Table 1). Exchangeable and extractable minerals are shown in Table 2. The average cation exchange capacity was calculated to be 3.82 meq/100 g.

We attempted to measure compaction with a probe type compaction tester, but the soil was too stony to obtain accurate measurements. However, we concluded that the site was not extremely compacted since this was a small operation and heavy vehicle traffic would have been minimal. In addition, the stoniness and sandy clay loam texture of the soil are not conducive to extreme compaction (Table 3).

Table 1. Chemical analysis

Sample No.	pH	CON M.Mho	Total acid meq/100 g	EXCH ALUM --- ppm ---	Total PO_4-BR
5207	4.9	.05	3.92	3.20	2.38
5208	4.9	.03	3.28	2.71	2.52
5209	5.2	.05	2.16	1.64	5.15
5210	5.2	.05	2.44	1.84	7.02
Mean	5.05	.045	2.95	2.34	4.27

We made a 100-percent tally of the oaks, measuring diameter at breast height (DBH) on all trees 4.5 feet and taller. Heights were estimated on several trees to obtain maximum heights of the tallest trees and a stand average. To determine any differences between trees planted on the bench to those planted on the outslope, we made a separate tally for each area.

Results

There were 140 trees on the bench and 216 on the slope, or 71 percent of the trees planted. We were not able to determine percent survival on outslope vs bench, but it appeared to be about equal. Results of the tally showed that 8 years after planting the tallest trees were 14 feet (4.27 m), with many trees having annual height increments of 2 to 3 feet (60 to 90 cm). Figure 1 shows one of the taller trees. Our estimated average height of the entire planting was 8 feet (2.44 m). The diameter measurements showed that 29 percent (41 trees) on the bench had no diameter; i.e., less than 4.5 feet tall vs 19 percent (40 trees) on the outslope with no diameter. Diameters of the bench trees taller than 4.5 feet averaged 0.7 inch (1.8 cm) while outslope trees averaged 0.6 inch (1.6 cm). Since a greater percentage (81 vs 71) of the trees on the outslope had reached 4.5 feet or taller, it appears they are growing slightly faster than the trees on the bench.

Conclusion

Our evaluation shows that red oak can be established successfully on reclaimed surface mines if they are planted properly and if compaction and competition are not severe. The oaks in this planting have survived well and are growing at a rate equal to or better than plantations on undisturbed sites.

Table 2. Exchangeable and extractable metals

Exchangeable metals (ammonium chloride extract)

Sample	meq/100 g				ppm												
No.	Ca	Mg	K	Na	B	Si	Zn	P	Fe	Cu	Mn	Co	Al	Ni	Ti	Cr	Pb
5207	1.68	.82	.20	.12	.35	2.60	1.80	1.62	1.62	.65	18.14	1.54	226.00	1.66	.17	.39	4.22
5208	1.02	.54	.15	.13	.30	3.70	.87	1.48	2.83	.59	1.82	.87	203.15	.71	.20	.39	3.67
5209	2.73	1.44	.15	.13	.25	3.31	.79	2.14	2.10	1.16	8.76	1.32	125.44	1.12	.21	.38	3.45
5210	2.16	1.13	.29	.13	.28	3.78	.49	2.79	1.98	.54	8.30	.92	130.01	.87	.21	.35	3.26
Mean	1.90	.98	.20	.127	.30	3.35	.99	2.06	2.13	.76	9.26	1.16	171.15	1.09	.20	.38	3.65

Extractable metals (weak acid extract)

Sample	meq/100 g				ppm												
No.	Ca	Mg	K	Na	B	Si	Zn	P	Fe	Cu	Mn	Co	Al	Ni	Ti	Cr	Pb
5207	1.54	.77	.16	.02	.58	4.58	2.92	3.46	51.48	5.67	38.94	3.02	802.59	2.64	.31	.30	8.71
5208	.97	.51	.12	.02	.36	9.09	.89	1.91	24.29	1.79	4.50	.70	440.78	.49	.18	.15	5.28
5209	2.99	1.59	.12	.02	.49	6.62	1.59	4.77	51.06	6.54	25.95	2.60	616.79	1.56	.22	.31	8.53
5210	1.95	1.01	.24	.02	.41	9.44	.72	3.64	23.16	1.68	32.29	1.99	421.44	.75	.23	.22	6.77
Mean	1.86	.97	.16	.02	.46	7.43	1.53	3.45	37.49	3.92	25.42	2.08	570.40	1.21	.235	.245	7.32

Table 3. Soil texture

Sample No.	% Sand	% Silt	% Clay	Texture
5207	63.9	20.0	16.1	Sandy loam
5208	49.9	28.0	22.1	Sandy clay loam
5209	63.9	18.0	18.1	Sandy loam
5210	53.9	24.0	22.1	Sandy clay loam
Mean	57.9	22.5	19.6	Sandy clay loam

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Figure 1. An 8-year-old northern red oak, 14 feet tall.

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