FORAGE PRODUCTION ON A MINESOIL IN SOUTHERN WEST VIRGINIA[1]

B. L. Wolf, L. D. Emerson and J. C. Sencindiver[2]

Abstract. Forage production and legume persistence were evaluated on a Kaymine minesoil (loamy-skeletal, mixed, nonacid, mesic Typic Udorthents) in Boone County, West Virginia for the 1987 through 1989 growing seasons. The area was hydroseeded in the spring of 1985 with a mixture of grasses and legumes. Starting in 1987, three harvests per year were taken at three areas with four subplots per area. The 1987 yields averaged 2.48 ton/acre for area 1, 2.83 ton/acre for area 2, 1.94 ton/acre for area 3. The 1988 yields averaged 1.16 ton/acre for area 1, 1.28 ton/acre for area 2, and 1.15 ton/acre for area 3. The 1989 yields averaged 1.44 ton/acre for area 1, 1.78 ton/acre for area 2, and 1.81 ton/acre for area 3. The total production for each year varied greatly from plot to plot due to a number of environmental factors that included a severe drought in August 1987 and all of 1988. However, reasonable forage production was obtained over the three-year period. These results demonstrated the potential for high quality forage production on a nonacid minesoil in West Virginia.

Additional key words: Land use, minesoil classification, minesoil mapping, crop yields.

Introduction

Studies on classification and characterization of minesoils in West Virginia began approximately 20 years ago. These studies generated data on minesoil properties and variability which resulted in the development of minesoil series. Through cooperative efforts of the USDA Soil Conservation Service and the West Virginia Agricultural and Forestry Experiment Station seven minesoil series have been identified and established in West Virginia. Five of these series were originally classified, mapped and correlated in southern West Virginia (Wolf, 1988).

Although minesoil series have been identified, land-use data for reclaimed mined lands are scarce. These data are needed to develop interpretations for land-use management decisions. Therefore, the purpose of this study was to evaluate forage production on the Kaymine series, a southern West Virginia minesoil with high potential for growing quality grasses and legumes.

Study Area

The study area is located in Boone County, where approximately 10 percent of the county's 322,000 acres had been disturbed by surface mining by 1987 (Wolf, B. L., Soil Survey of Boone County, West Virginia. Unpublished manuscript). Boone County is in the southern coal fields of West Virginia, which have been identified as Surface Mining Province 1 (West Virginia University, 1971). This area is within the deeply dissected unglaciated Appalachian plateau. Steep and very

[1]Paper presented at the 1990 Mining and Reclamation Conference and Exibition, Charleston, West Virginia, April 23-26, 1990.

[2]B. L. Wolf is Soil Scientist, SCS, Beckley, WV; L. D. Emerson is Agronomist, Hobet Mining, Inc., Madison, WV; J. C. Sencindiver is Professor of Soil Science, West Virginia University, Morgantown, WV.

Proceedings America Society of Mining and Reclamation, 1990 pp 121-125
DOI: 10.21000/JASMR90010121

steep slopes range in relief from 600 feet to as much as 1400 feet. The coal beds represent the earlier of two basins of coal deposition during Pennsylvanian time. In general the sulfur content of coal and overburden is low and neutralization potential ranges from low to high.

The humid, continental type climate of the area is characterized by sharp seasonal temperature changes. Average daily temperatures are approximately 73°F in summer and 34°F in winter. Average annual precipitation is 40 to 45 inches. Native vegetation of the area is mixed hardwood forest (Core, 1966).

The study site is located at the Hobet Mining, Inc. surface mine near Madison in the northwestern part of Boone county. Fiveblock and Stockton-Lewiston coal seams (Allegheny and Pottsville formations) are mined by mountaintop removal methods. Fiveblock overburden is drilled, blasted, and moved with a large electric shovel and large trucks. Stockton-Lewiston is 80 to 100 feet beneath the Fiveblock seam. The overburden is removed by blasting, and it is relocated by an electric dragline with a 72-cu yd bucket. A mixture of acid and neutral to alkaline mudstone, shale and sandstone occurs between the coal seams. Hobet Mining, Inc. uses the neutral to alkaline mudstone, shale and sandstone as a topsoil substitute (Emerson, 1988).

Materials and Methods

Three representative areas of the surface mine were subdivided into four plots, each 34 inches x 12 feet, for a total of 12 plots. In 1985 the plot areas were fertilized with 800 lb/acre of 15-30-15. Wood cellulose mulch was applied at 900 lb/acre. No lime was applied. Prior to seeding, the seedbed was prepared by a Rome disk-harrow with 32-inch disk blades pulled by a bulldozer. The areas were hydroseeded in the spring of 1985 with 27 lb/acre of mammoth red clover (Trifolium pratense L.), 27 lb/acre of birdsfoot trefoil (Lotus corniculatus L.), 27 lb/acre of vernal and buffalo alfalfa (Medicago sativa L.), 54 lb/acre of orchardgrass (Dactylis glomerata L.), and 18 lb/acre of timothy (Phleum pratense L.).

At the time of the first harvest the species composition on area 1 was birdsfoot trefoil, red clover, alfalfa, orchardgrass and KY-31 tall fescue (Festuca arundinacea Schreb.). Very little timothy was present. Area 2 consisted primarily of alfalfa, orchardgrass and KY-31 tall fescue. Vegetation on area 3 was similar to area 1. Although KY-31 tall fescue was not seeded on the plots, it was seeded on adjacent steeper areas of the minesoil and had spread to the research plots.

All plots were undisturbed until the first harvest. In 1987, 1988, and 1989 three cuttings per year were taken: late May or early June, mid to late July, and early to mid September. All plots were harvested with a 34-inch wide sickle bar mower. Oven-dried weights of all vegetation were recorded.

Maintenance fertilizer was applied to all plots at the rate of 280 lb/acre of 0-46-60 in September 1987 and 1988, and 500 lb/acre of 10-20-20 in August 1989.

The minesoils on the study site were mapped according to National Cooperative Soil Survey standards. One soil pit was dug, and the minesoil was described and classified (Soil Survey Staff, 1975). This pit represented the minesoils at all three plot areas. Each horizon was sampled and analyzed for standard physical and chemical properties. Total sulfur was determined by an automated sulfur analyzer for samples crushed to pass a 60-mesh screen. All other properties were determined by methods outlined by the Soil Survey Staff (1984).

Results and Discussion

Minesoil Properties

The minesoil on the study site was mapped as Kaymine very channery loam, 3 to 8 percent slopes, stony. The soil surface was covered with 0.01 to 1.0 percent stones 3 to 24 inches in diameter and a few boulders larger than 24 inches. The Kaymine series is classified as loamy-skeletal, mixed, nonacid, mesic Typic Udorthents. The minesoil profile described on the site (Table 1) is representative of the series. This profile was described on an area contiguous to the plot areas, but on a steeper slope. The major difference between this profile description and the official series description (OSD) is the presence of an AC horizon which was not described in the OSD. Although there may be minor differences between the minesoil profile description and the minesoils on the plots, both fit within the range of characteristics of the Kaymine OSD.

The parent material of the official Kaymine series consists of a mixture of mudstone, shale, sandstone, and frequently small amounts of coal wasted during the mining process. Rock fragments for the particle-size control section (depth of 10 to 40 inches) for the series range from 35 to 80 percent by volume. In the control section of the profile at the study site the rock fragments ranged from 60 to 75 percent by volume (Table 1). The surface horizon had 60 percent rock fragments. Dominant textures of the official Kaymine series are loam and silt loam,

Table 1. Kaymine soil profile description.

Classification: loamy-skeletal, mixed, nonacid, mesic Typic Udorthents
Pedon No.: S-86-WV-005-12-(1-4)
Location: Boone County, Hobet Mining surface mine 1.7 miles west of main office complex in Pit #4.
Vegetation: Birdsfoot trefoil, orchard grass, KY-31 tall fescue.
Parent Material: Surface mine spoil of mudstone, sandstone and coal from mining between No. 5 Block and Upper Stockton coal seams.
Physiography: Side slope of ridgetop removal.
Slope: 52 percent
Drainage: Well Drained
Elevation: Approximately 1240 feet.
Geology: Upper Kanawha formation and lower Allegheny formation
Aspect: Northwest
Described by: Wolf, Sencindiver, Kingsbury
Sampled by: Wolf, Sencindiver, Kingsbury
Date sampled: 8-6-86
USGS Quad Coord.: 81° 52' 55'' W; 38° 06' 30'' N. Mud Quad

A --0 to 7 inches. Dark gray (10YR 4/2) very channery silt loam; weak fine granular structure; very friable; many very fine and fine roots; many fine vesicular pores; 60 percent stones, channers and boulders (50 percent sandstone, 40 percent mudstone and 10 percent coal); neutral; clear smooth boundary.

AC--7 to 14 inches. Dark gray (10YR 4/1) extremely channery loam; weak fine subangular blocky structure; friable; common very fine and fine roots; many fine vesicular pores; 65 percent stones, channers and boulders (45 percent sandstone, 45 percent mudstone and 10 percent coal); mildly alkaline; clear wavy boundary.

C1--14 to 23 inches. Dark gray (10YR 4/1) very channery loam; massive; firm; few very fine and fine roots; common fine vesicular pores; 60 percent stones, channers and boulders (45 percent sandstone, 40 percent mudstone and 10 percent coal); neutral; gradual wavy boundary.

C2--23 to 65 inches. Dark gray (10YR 4/1) extremely channery loam; massive; firm; 75 percent stones, channers and boulders (50 percent sandstone, 40 percent mudstone and 10 percent coal); neutral.

which were the textures of the minesoil at the study site.

Clay percentages of minesoil horizons on the study site ranged from approximately 22 percent to 24 percent (Table 2). For the official Kaymine series, clay ranges from 18 to 27 percent. Rock fragment (> 2 mm) percentages by weight ranged from 72 to 85 in all minesoil horizons at the study site (Table 2).

Organic carbon values for all horizons at the study site were low (Table 3). Electrical conductivity and total sulfur values were relatively low. Salt levels in the minesoil were not high enough to adversely affect plant growth. All pH values were above 6.5, which is about the middle of the range of 5.6 to 7.8 for the official Kaymine series. In some horizons, base saturation is greater than 100 percent indicating some free Ca from calcium carbonates in the minesoil.

Forage Yields

Forage yields varied over the three years with maximum yields occuring in 1987 (Figure 1). Yields were reduced in 1988 by an extreme drought, and the weakened plant condition probably contributed to lower than expected yields in 1989. Yields for the first cutting were consistently higher than yields of the other two cuttings, which is common for cool-season species. Several factors may have affected the yields. First, fertilization near the end of each growing season may have boosted spring growth. Second, more precipitation may have fallen in the spring than in the summer. This hypothesis was probably true in 1988, the very dry year, but in most years the average monthly precipitation in the summer is similar to the average monthly precipitation in the spring (Wolf, 1988). However, summer rains often come as thunderstorms, and much of the water runs off the soil surface. Fourth, deer and insect damage was noted on some plots, and this damage seemed to be worse at the second and third cuttings.

Species composition changed over

Table 2. Physical properties of Kaymine minesoil.

Horizon	Particle Size (mm) >20	6-20	2-6	<2	Texture (<2mm) clay	silt	sand	Moisture Retention (15 Bars)
	% by weight							
A	35.5	21.6	15.0	27.9	22.8	51.1	26.1	6.4
AC	38.3	23.0	14.0	24.7	24.4	48.7	26.9	6.0
C1	29.0	26.7	16.2	28.1	21.9	45.6	32.5	5.7
C2	53.6	16.2	15.3	14.9	23.1	45.6	31.3	5.8

the period of the study in areas 1 and 3 primarily because of a loss of red clover. Alfalfa, orchardgrass, and tall fescue persisted in all of the plots.

Conclusions

Kaymine minesoil can sustain a mixed grass-legume crop under low levels of management. In this study, yields were reduced by drought, extreme heat, insects and deer, but the high pH values and potential rooting depths of greater than 60 inches in the Kaymine series are conducive to sustaining a deep-rooted legume such as alfalfa. Better production could result by soil testing for possible macro- and micro-nutrient deficiencies and by implementing a better fertility program. The major obstacle to large scale harvesting would be the surface stones which could cause equipment breakage during the first couple of cuttings until they were found and removed. During future reclamation of similar sites, mine operators should make an effort to place non-stony materials or materials with small stones at the minesoil surface.

References

Core, E.L. 1966. Vegetation of West Virginia. McClain Printing Co., Parsons, WV 217p.

Emerson, L.D. 1988. A substitute plan for reclamation of a mountaintop removal mine in southern West Virginia. p. 274-276. In Mine Drainage and Surface Mine Reclamation. Vol. II. U.S. Bureau of Mines Information Circular 9184.

Soil Survey Staff. 1975. Soil Taxonomy: a basic system of soil classification for making and interpreting soil surveys. USDA Soil Conservation Service. Agric. Handbook No. 436.

Soil Survey Staff. 1984. Procedures for collecting soil samples and methods of analysis for soil survey. Soil Survey Investigations Report No. 1. USDA Soil Conservation Service. 5.

Table 3. Chemical properties of Kaymine minesoil.

Horizon	pH	Total S	EC[1/]	OC[2/]	Exch. Bases Ca	Mg	K	CEC[3/]	Base Sat.
	1:1	%	mmho/cm	%	me/100g				%
A	6.6	0.37	2.38	0.97	8.55	3.14	0.61	8.77	140
AC	7.4	0.40	1.75	0.80	8.70	2.84	0.36	15.81	75
C1	7.3	0.40	2.82	0.74	13.20	2.81	0.37	8.16	201
C2	7.2	0.45	3.02	0.80	16.26	3.63	0.40	10.51	193

[1/] EC = Electrical conductivity of saturated extract.

[2/] OC = Organic carbon.

[3/] Cation exchange capacity by ammonium acetate saturation (Soil Survey Staff, 1984).

West Virginia University. 1971. Mine spoil potentials for water quality and controlled erosion. U.S. Environmental Protection Agency. Water Pollution Control Research Series 14010 EJE 12/71.

Wolf, B.L. 1988. Soil Survey of Wyoming County, West Virginia. USDA Soil Conservation Service in cooperation with West Virginia Agricultural and Forestry Experiment Station.

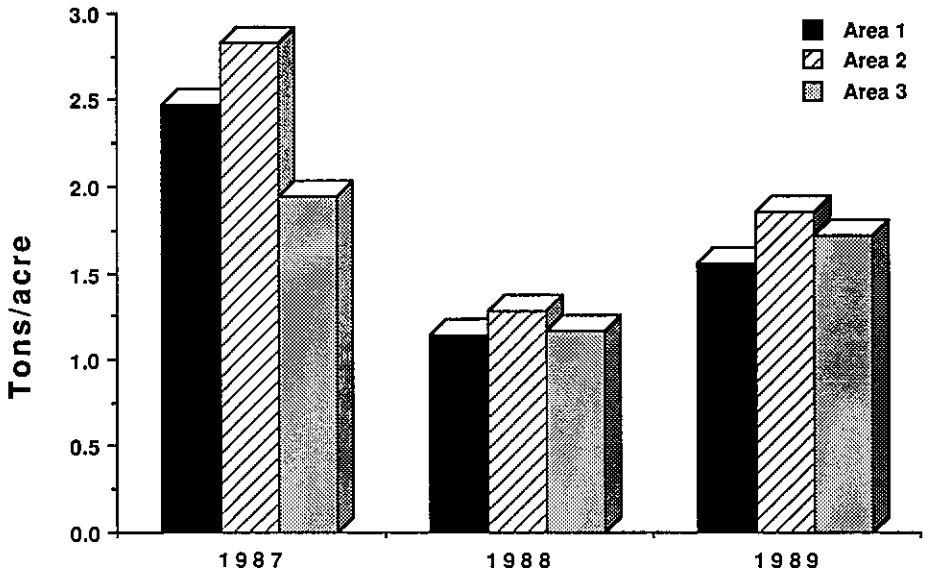

Figure 1. Three-year summary of forage production on the Kaymine minesoil. (Each bar is the sum of 3 cuttings averaged over 4 replications.)