4-1988

Forage Production on Reclaimed Surface Mined Land in Eastern Kentucky

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COOPERATIVE EXTENSION SERVICE

AGRONOMY NOTES

Volume 21, No. 2 April 1988

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Introduction

Forage crop production for hay or pasture can be important for the utilization of the many acres of reclaimed surface mined land in eastern Kentucky. Even though grasses and legumes are seeded during reclamation to provide ground cover and reduce soil loss, these areas are not usually managed for forage crop production. On the other hand, these vast land areas have the capability to provide significant amounts of desirable grasses or grass-legume mixtures for cattle when well-managed.

Several studies have been conducted on surface-mined land in eastern Kentucky to assess the level of production using grasses or grass-legume mixtures, determine needed amounts of fertilizers, and to study the introduction of legumes into established grass stands. Several grasses have been used in reclamation but tall fescue tends to dominate after 4-5 years. Legumes are seeded during reclamation because they support nitrogen fixation, some of which is used by the grasses, but only a few legumes persist because of high soil acidity, low soil phosphorous or a short life cycle.

Soil Conditions

Most of the "mine soils" available for growing vegetative cover are high in coarse fragments and are of predominately sandstone, siltstone and shale materials in various phases of weathering to smaller fragments. These "mine soils" have lower organic matter and moisture holding capacity, and are usually more compacted.

Studies Conducted

Martin County-Kenhy Fescue

The purpose of this study was to (1) determine N and P_2O_5 rates needed for optimum production on "mine soil," and (2) determine how long optimum yields can be maintained without added potash for tall fescue. Soil test results from the area before seeding were as follows: pH-5.5, P-11 lbs/acre, and K-307 lbs/acre. Kenhy tall fescue was seeded on freshly prepared "mine soil" on September 7, 1982 following the application of 36 lbs N/acre and 92 lbs P_2O_5/acre for establishment. Annual treatments of N and P_2O_5 were applied March 2, 1983, March 26, 1984, March 19, 1985 and March 17, 1986. In 1984 and 1985, an additional 80 lbs N/acre was applied on September 4 of both years to stimulate additional fall growth (stockpiling).

Table 1 lists the dry matter yields from harvesting the Kenhy tall fescue during early and mid-season, and from the early fall N application that was used to increase fall growth for potential stockpiling. Most of the yield increase can be attributed to the N application. The yield response to P_2O_5 rate was somewhat variable. Yield difference between years was also variable due to the influence of rainfall on these areas of low moisture holding capacity. The annual application of 120 lbs K_2O/acre did not consistently increase yields above the N + P_2O_5 rates, indicating that the soil was capable of providing adequate K.

Table 1. Dry matter yield from Kenhy tall fescue following spring fertilizer treatments, Martin Co., 1983-1986.

	Early and mid-season			Stockpiled[1]	
N + P_2O_5 + K_2O	1983	1985	1986[2]	1984	1985
lbs/acre					
0 + 0 + 0	1240	910	235	75	165
40 + 0 + 0	2540	3420	745	1020	730
40 + 40 + 0	2800	3925	1705	1435	1020
40 + 80 + 0	2805	4355	1465	1940	1335
40 + 120 + 0	2500	3465	1580	1285	1100
80 + 0 + 0	3370	4530	965	870	1435
80 + 40 + 0	3790	5920	1350	1590	1635
80 + 80 + 0	2380	4060	2000	1300	895
80 + 120 + 0	2410	4620	1275	1785	1125
120 + 0 + 0	2290	3135	825	495	480
120 + 40 + 0	2710	4015	1845	930	810
120 + 80 + 0	3360	6415	2505	1575	1420
120 + 120 + 0	4130	4910	1630	1785	965
120 + 120 + 120	3680	6095	2425	1950	1660
LSD (.05)	363	882		156	207

[1] An additional 80 lbs N/acre applied on September 4 each year before harvest on November 16 and 12, respectively, for the two years except to the check plots.

[2] Only one early season harvest.

When the total dry matter yields (excluding stockpile data) for 1983, 1985 and 1986 were combined and placed on a relative basis (Figure 1) it was apparent that yields were highest with the annual application of 80 lbs P_2O_5/acre, and 80 or 120 lbs N/acre. This data further confirms that the greatest yield increases were obtained from annual N applications, and that some P_2O_5 was needed to produce optimum yields at this location.

The plant analysis results in Table 2 indicate that N and P percentages were increased with increasing rates of applied N and P_2O_5, respectively. K percentage did not appear to increase with the annual application of 120 lbs K_2O/acre.

Several of the nutrient concentrations for N, P, and K were below levels considered adequate for good plant growth (N-2.2; P-.25; and K-2.0).

Figure 1. Relative dry matter yields of Kenhy fescue as affected by either (a) P_2O_5 rate or (b) N rate from total forage produced in 1983, 1985 and 1986, Martin Co.

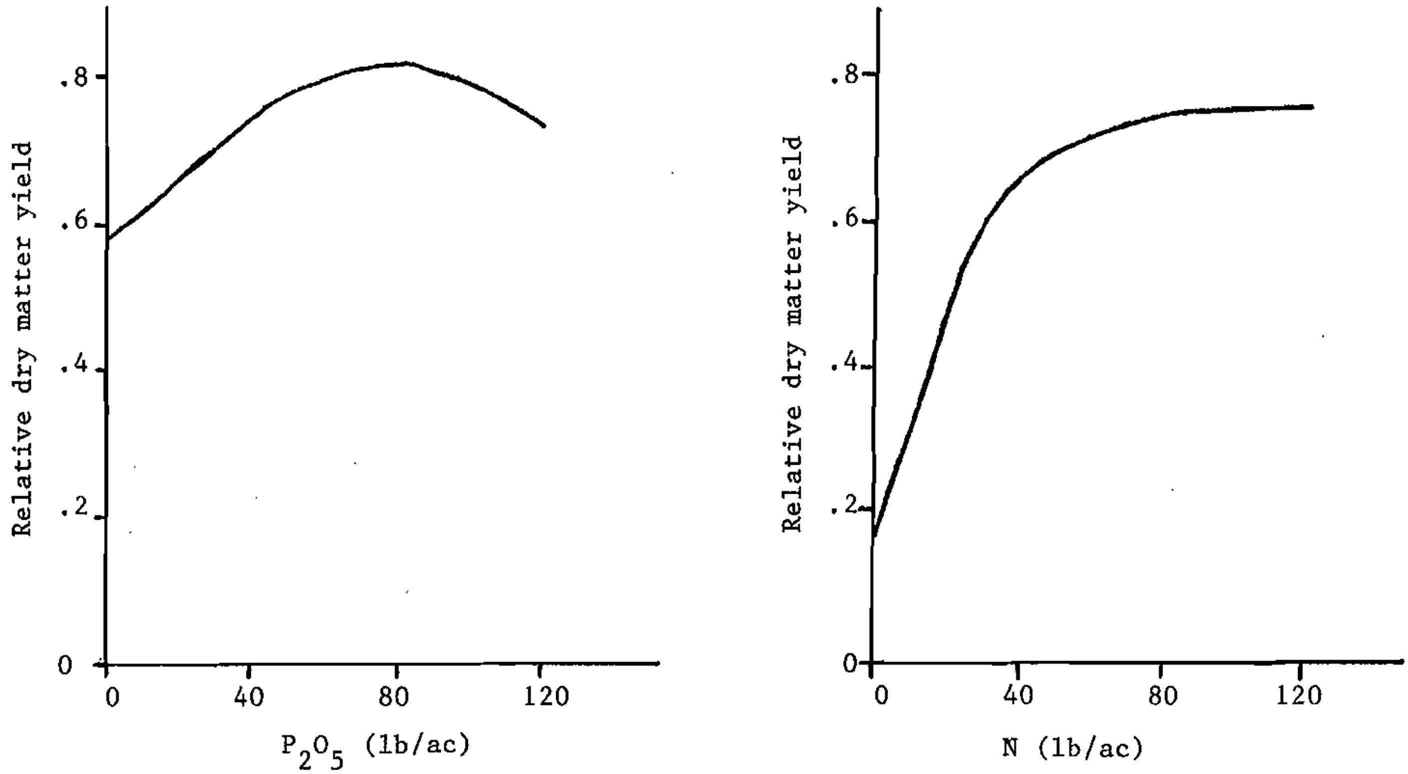

Table 2. Plant nutrient concentration and soil test values following annual fertilizer application to Kenhy tall fescue, Martin Co.

	Plant Nutrient Concentration										Soil Test			
	1983					1985					1985		1986	
$N+P_2O_5+K_2O$	N	P	K	Ca	Mg	N	P	K	Ca	Mg	P	K	P	K
lbs/acre	%										lbs/acre			
0+ 0+ 0	1.3	.15	2.1	.2	.18	1.4	.12	2.3	.3	.22	25	282	38	298
40+ 0+ 0	1.4	.20	2.3	.2	.19	1.4	.11	2.0	.3	.21	16	196	26	254
40+ 40+ 0	1.6	.18	2.4	.2	.20	1.5	.16	2.5	.3	.24	22	180	44	299
40+ 80+ 0	1.8	.24	2.3	.3	.24	1.5	.18	2.3	.3	.23	54	208	88	244
40+120+ 0	1.8	.22	2.4	.2	.24	1.6	.21	2.4	.3	.24	74	178	125	284
80+ 0+ 0	1.6	.17	2.1	.2	.21	1.4	.11	2.2	.3	.20	14	198	18	312
80+ 40+ 0	2.1	.22	2.5	.3	.26	1.5	.15	2.3	.3	.23	18	186	48	240
80+ 80+ 0	2.4	.22	2.4	.3	.28	1.6	.20	2.3	.3	.24	41	186	82	187
80+120+ 0	1.9	.20	2.3	.2	.24	1.7	.22	2.5	.3	.25	77	163	166	228
120+ 0+ 0	2.1	.17	2.4	.2	.24	1.9	.11	2.7	.3	.24	16	230	19	248
120+ 40+ 0	2.2	.24	2.4	.2	.26	1.8	.17	2.6	.3	.25	23	191	44	209
120+ 80+ 0	2.2	.23	2.7	.2	.25	1.8	.20	2.7	.3	.24	44	194	97	313
120+120+ 0	1.5	.20	2.0	.2	.19	1.7	.20	2.4	.3	.23	68	186	113	212
120+120+120	2.2	.26	2.8	.3	.26	1.5	.21	2.6	.3	.21	53	190	134	313

Soil test P values increased with increasing P_2O_5 rates and soil test K values were not consistently decreased by removal nor increased by the K application. After four years of removing forage, the soil test K on many plots remained within a normal variation of the initial soil test K. This indicates that K release from the "mine soil" was adequate for maintaining soil test K while optimum K percentage was present in the growing forage.

Martin County - Renovation with Legumes

Newly prepared "mine soil" with initial soil tests of 8 lbs P/acre and 188 lbs K/acre was seeded to 'Johnstone' tall fescue on September 7, 1982 following the application of 120 lbs P_2O_5/acre. On March 2, 1984 legumes were seeded on the surface into plots of the fescue as outlined in Table 3. The plots were allowed to grow and produce seed in 1983 and 1984 followed by mowing in the late fall of each year. Forage dry matter yields were obtained from a single harvest on June 3 of both 1985 and 1986 (Table 3).

The 1985 yield data suggest that well-established legumes (in their second year) do contribute to additional forage yield either directly from legume growth or by supplying N to the grass or both. Differences between legume treatments in 1985 was more closely related to successful establishment of legumes in the tall fescue. The 1986 yields indicate that birdsfoot trefoil had become well-established and was providing both forage and N to increase the yields. The other legume treatments, except ladino clover, had some legume growth from the seed allowed to develop during the 1984 and 1985 seasons.

Table 3. Legume overseeding treatments, seeding rates and forage yields of legume-tall fescue mixtures on reclaimed mined land, Martin Co.

Legume Treatment	Seeding Rate	Forage Yield 1985	Forage Yield 1986
	lbs/acre	lbs dry matter/acre	
Kenstar Red Clover	12	2610	1026
Redland II Red Clover	12	3395	1247
Birdsfoot Trefoil	12	2720	2512
Ladino Clover	3	2560	965
Kenstar + B. Trefoil	8 + 6	3915	1400
Redland II + B. Trefoil	8 + 6	2140	1199
Ladino + B. Tefoil	1 + 6	1980	1118
No Legume	-	1700	903
LSD (.05)		476	162

Perry County - Annual Ryegrass

An area of existing grass, primarily annual ryegrass, was fertilized on April 17, 1980, with 120 lbs P_2O_5/acre and 80 lbs K_2O/acre according to soil test. N rates of 0, 50, 100, and 150 lbs N/acre were surface broadcast. One area did not have any fertilizer applied prior to seeding and was designated as a no fertilizer check.

Table 4. Dry matter yields of annual ryegrass following fertilizer treatments on reclaimed mine land, Perry Co.

$N+P_2O_5+K_2O$	May 16, 1981 Yield	N	P	DMD[1]	June 11, 1981 Yield	Total Yield
lbs/acre	lbs/acre	--------%--------			--------lbs/acre---------	
0+ 0+ 0	459	1.1	.15	54.0	197	656
0+120+80	751	1.0	.19	54.4	292	1043
50+120+80	1371	1.8	.19	52.8	630	2001
100+120+80	1405	2.6	.24	51.8	960	2365
150+120+80	2195	2.9	.20	53.2	1130	3325

[1]DMD = Dry matter disappearance as determined by acid pepsin digestion.

Yields in Table 4 indicate that most of the yield was obtained in the first harvest and the greatest yield increase was from applied N. There was a yield increase from the P_2O_5 + K_2O alone plus sharp increases with increasing N rates although differences between 50 and 100 lbs of applied N per acre were not very large. Both N and P concentration for the 0 and 50 lbs N/acre rates were low for good plant growth and may be low for adequate animal nutrition. DMD tends to decrease with N rates but was a good level for this method of measurement with ryegrass. These results suggested that N fertilized annual ryegrass can produce significant early season forage for grazing or hay on reclaimed mine land.

Discussion

The results of these three studies indicate that reclaimed mine lands of eastern Kentucky have the potential to produce forage crops for use as grazing or hay in cattle production. These forages can range from all grass, mixtures of grass and short term legumes, and grasses with perennial legumes. Forages grown in these areas will respond to fertilization and other management practices often used in forage production on non-mined land. The largest variables influencing production are moisture supply and fertilizer use. Both grasses and legumes appear to require frequent phosphorus applications and yields of grasses are increased by either N fertilizer or the introduction of legumes as these "mine soils" are low in organic matter which is a significant source of residual N. Regular K_2O applications may not be required on several reclaimed areas as these "mine soils" have the ability to release significant quantities of plant available K.

Similar results could be obtained from other reclaimed areas in eastern Kentucky if grading, seedbed preparation, fertilization and other forage management practices are adequately considered. Some management factors will change with the forage species grown, moisture supply during the growing season and end use of the forage produced.

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