EFFECT OF CLIPPING ON DRY MATTER ACCUMULATION, FORAGE QUALITY AND LEGUME PERSISTENCE ON RECLAIMED SURFACE MINED LANDS[1]

by

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Abstract. Material used as plant growth media during surface mine reclamation are frequently low in available N, P, and K and are drought-prone. Legumes are included in reclamation seeding mixtures because of their symbiotic N_2-fixation ability, however, competition may prevent legume establishment or reduce persistence. A field study was conducted from 1990 through 1992 to test the hypothesis that intermittent clipping of these sites would reduce grass competition and thereby maintain legume stands. Four clipping treatments were imposed providing intervals of 2, 4, and 6 weeks between harvests and a control (no clipping). In 1990 and 1991, clipping at the 2 or 4 wk intervals gave equal yields that were nearly 1 t ha^{-1} lower than those from the 6 wk clipping interval. Crude protein yields did not differ for the different harvest regimes and averaged 0.7 t ha^{-1}. Legume ground cover averaged 3.5, 34.4, 43.2, and 30.0% for the uncut, 2 wk, 4 wk, and 6 wk treatments, respectively. Results of this field study indicate that intermittent clipping is a beneficial management practice for maintaining legumes on reclaimed mine soils.

Additional Key Words: mine reclamation, clipping management, persistence, forage quality, nitrogen content.

Introduction

Surface mining is an efficient means of extracting minerals such as coal when overburden is not excessive. This mining method requires the reclamation of large areas of mine spoil that frequently have serious limitations to plant establishment and growth. Currently, state regulations require that vegetative cover by seeded grasses and legumes be maintained for a period of five years after mining.

Surface mine reclamation is frequently accomplished by the addition of a topsoil substitute because topsoil supplies are insufficient. These materials are almost always very low in organic matter and thus low in available nitrogen (N) and are frequently droughty, low in phosphorus (P) and potassium (K) (Daniels and Burger 1990). Leguminous species are important components of recamation seeding mixtures because of their N contribution to the system because no fertilizer is typically

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applied after seeding. Reclaimed sites are often left unmanaged between seeding and final evaluation of the botanical composition of the vegetation five years later. Legumes suffer sever competition under these conditions and may disappear from the stand before the bond period expires. Reduced grass competition resulting from grazing, clipping or hay harvest during the reclamation period might be beneficial to legume biomass production, persistence, and thus to their N contribution. Earlier harvesting would allow landowners to derive economic returns during the reclamation period.

A field study was conducted to test the hypothesis that intermittent clipping and removal from these sites would reduce grass competition, thereby improving legume stands and their symbiotically fixed N contribution to the sward.

Materials and Methods

A mixture of species commonly utilized in surface mine reclamation in the Appalachian coal fields was seeded in September of 1989. A mixture including tall fescue (Festuca arundinacea Schreb.), orchardgrass (Dactylis glomerata L.), annual ryegrass (Lolium multiflorum Lam.), perennial ryegrass (Lolium perenne L.), annual lespedeza [Lespedeza striata (Thunb.) H. & A.], red clover (Trifolium pratense L.), alsike clover (Trifolium hybridum L.), birdsfoot trefoil (Lotus corniculatus L.), yellow sweetclover (Melilotus officinalis Lam.) and white clover (Trifolium repens L.) was hydroseeded at the rate of 143 kg ha^{-1} along with 840 kg ha^{-1} of fertilizer containing 150 kg ha^{-1} of N and 303 kg ha^{-1} of P_2O_5.

Soil samples were collected at the end of the 1990 growing season to a depth of 8 cm. The soil had a water pH of 5.3, an available P level of 39 kg ha^{-1} and K level of 274 kg ha^{-1} by Mehlich III extraction.

Beginning in 1990, four clipping treatments were imposed, providing intervals of 2, 4, and 6 wk. The fourth treatment was left unharvested. Treatments were randomly assigned to plots measuring 1.5 x 6.1 m in four randomized complete blocks. Clipping regimes continued during 1990 with 12, 6, and 4 harvests for the 2, 4, and 6 wk interval treatments, respectively, and in 1991 with 7, 5, and 4 harvests for the 2, 4 and 6 wk interval treatments. Drought during 1991 reduced herbage growth and reduced the number of harvests taken. Biomass above 6 cm stubble was harvested and weighed to determine plot fresh weight yields. A subsample of 300 g fresh weight was collected from each plot and dried at 60° C. After drying, each sample was reweighed and ground to pass a 1 mm screen for forage quality analysis.

Each sample was analyzed for total N, neutral detergent fiber (NDF), acid detergent fiber (ADF), cellulose and acid detergent lignin (ADL) using methods modified by Robertson and Van Soest (1980).

In October 1991, four randomly selected quadrant counts were made quantifying legume stands in each plot. Quadrants measuring 10.2 x 50.8 cm, divided into 20 squares (5.08 cm^2 each) were used. Four random counts were made in each plot by tossing the quadrant. For each sample, the number of quadrant cells containing a legume plant were counted.

Results and Discussion

Dry matter yields were reduced in the second year of the experiment by drought (data no shown). Treatment x year interaction effects were insignificant, therefore, the data are presented as means of both seasons.

Although several species were seeded during the reclamation process, tall fescue dominated the mixture by the end of the study. In earlier work with forage production on reclaimed mine soil, tall fescue was the highest yielding of 16 perennial grass cultivars and species (Laue et al. 1982).

Clipping treatment affected dry matter yields and all forage quality constituents (Table 1). Clipping at the 2 or 4 wk intervals gave equal yields that were nearly 1 t ha^{-1} lower than those from the 6 wk clipping interval. Crude protein yields did not differ for the different

harvest regimes and averaged 0.7 t ha^{-1}.

Forage quality was greatest for the 2 wk clipping interval (Table 1). Nitrogen concentrations were similar for forage harvested at 4 wk or 6 wk intervals and higher for forage harvested at 2 wk intervals. Neutral detergent fiber and ADL concentrations were highest in forage from plots clipped at 6 wk intervals and lower for other intervals. Cellulose and ADF concentrations increased with each increment of harvest interval. Samples were collected at the end of the 1991 growing season to determine the quality of forage present on unclipped plots at that time. Nitrogen averaged 11.8 g kg^{-1} over the four replicates and NDF, ADF, cellulose and ADL averaged 657, 390, 292, and 59.0 g kg^{-1}, respectively.

Legume contribution to the stands was greatly affected by clipping. Percent legume ground cover averaged 3.5, 34.4, 43.2, and 30.0% for the uncut, 2 wk, 4 wk, and 6 wk treatments, respectively. The three clipped treatments were equal in legume cover and significantly greater ($P < 0.01$) than that of the unclipped plots. Detailed information on the species composition of the swards was not collected but observations indicated that red clover was absent regardless of clipping treatment. White clover dominated most plots but alsike clover was present in some.

Results of this two-year study indicate that intermittent harvesting of reclamation forage mixtures increased legume persistence and improved the quality of available forage compared to the uncut treatment.

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Table 1. Forage yields and quality of mixed swards grown on reclaimed mine soils and harvested at two, four, or six week intervals.

Harvest Interval	Yield		Nitrogen	NDF	ADF	Cellulose	ADL
	DM	CP					
weeks	.....t ha^{-1}.....		..... %				
Two	3.41 b†	0.71 a	3.36 a	44.1 B	23.3 C	19.7 C	3.15 B
Four	3.42 b	0.59 a	2.69 b	46.7 B	27.0 B	22.6 B	3.67 B
Six	4.33 a	0.70 a	2.52 b	50.2 A	30.9 A	26.2 A	4.29 A

† Means in the same column followed by the same letter are not significantly different at the 0.05 probability level using Tukey's test.