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Performance of Subterranean Clover and Coastal Bermudagrass on Lignite Mine Spoil

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Summary

A 2-year field study was initiated in 1986 to evaluate the effects of fertilization and inoculation with *Rhizobium* on production of subterranean clover and to assess the effect of this clover on the performance of coastal bermudagrass. In 1987, inoculated subclover fertilized with phosphorus (22 lbs/A) and potassium (42 lbs/A) produced the greatest dry matter yields, and added nitrogen did not significantly increase yield. Inoculated clover plots with no added N yielded approximately 800 lbs/A of additional dry matter as compared to uninoculated plots receiving fertilizer nitrogen (51 lbs/A). In 1988, subclover production was more influenced by fertilization than inoculation, with total yields tending to be greater on all plots receiving at least P and K. Yield of coastal bermudagrass was not significantly different among treatments in 1987, but fertilized plots showed a trend toward greater yields regardless of whether subclover had previously been present. In 1988, total bermudagrass yields tended to be greatest on plots fertilized with N, P, and K where clover had been grown previously, and lowest in the control plots (grass only) with no added N. The incorporation of subterranean clover into a surface mine revegetation scheme emphasizing coastal bermudagrass could result in a more effective reclamation program by increasing high-quality forage production and lengthening the grazing season, while also enhancing yield of coastal bermudagrass grown after established subclover.

Introduction

Subterranean clover (*Trifolium subterraneum* L.; subclover) has not been widely used in mine reclamation programs in Texas. The ability of this legume to meet its own nitrogen demand through the fixation of atmospheric nitrogen when in association with *Rhizobium*, combined with the possibility of supplying nitrogen to subsequent crops, demonstrates the potential benefit of subclover to a mine reclamation program. Coastal bermudagrass (*Cynodon dactylon* L.) monocultures are commonly used in revegetating mine spoil, but this species requires large inputs of nitrogen fertilizer. Subclover can be seeded into existing coastal bermudagrass sods, possibly reducing the need for nitrogen fertilization of the grass and extending the grazing season. The objectives in this study were to determine the effects of inoculation with *Rhizobium leguminosarum* biovar *trifolii* and fertilization on production of subterranean clover and to assess the effect of subclover on the performance of coastal bermudagrass.

Procedure

A 2-year field study was established in October 1986 at the Big Brown Mine near Fairfield, Texas. Field plots of subterranean clover were established in a 6-month-old coastal bermudagrass sod. 'Mt. Barker' subclover was sown by hand broadcasting seed at a rate of 30 lbs/A, then raking the seed into the spoil. The seeds were inoculated with a commercial, mixed-strain inoculant (WR Inoculant; Nitragin Co.) prior to planting. Uninoculated clover plots and control plots containing only coastal bermudagrass were also established. Low numbers (0 to 10^2 rhizobia/g soil) of native rhizobia were present in the mine spoil prior to plot establishment. Three fertilization treatments were utilized in the study. Plots were fertilized with 300 lbs/A of 17-17-17 (N,P_2O_5, K_2O) or 0-17-17, corresponding to application rates of 51, 22, and 42 lbs/A of nitrogen, phosphorus, and potassium, respectively. Nonfertilized plots were also maintained. Individual plots were 6.6 ft by 6.6 ft and four replications of each treatment were included. Subclover and coastal bermudagrass were cut twice in both 1987 and 1988 to a 3-inch height with a rear-bagging Snapper Hi-Vac mower to determine forage yields. All plant materials were oven dried at 70°C for 4 to 5 days, and yields were determined on a dry-weight basis.

Results and Discussion

Dry matter production of subterranean clover in 1987 and 1988 is summarized in Table 1. Yields were greatest in the inoculated, fertilized plots at the first harvest in 1987. Addition of N did not significantly increase yields. Lowest yields were found in the inoculated and uninoculated plots where no fertilizer was applied. At the second clipping, yields were not significantly different between any treatment but tended to be greater in all plots with added P and K. Total yields in 1987 tended to be greater in the inoculated plots across all fertilizer treatments. Inoculated plots fertilized with P and K produced the highest yields, and addition of N did not significantly increase production. In 1988, the response to inoculation was no longer apparent and yields were more influenced by fertilizers. At the first harvest, yields tended to be greater in the plots where N, P, and K were added. Yields were not significantly different between any treatment at the second clipping. Total yields in 1988 tended to be greater in all plots receiving P and K.

Approximately 800 lbs/A of extra dry matter resulted from inoculation with appropriate rhizobia in lieu of applying fertilizer N in 1987. Even though some indigenous rhizobia were present in the spoil area at the time of establishment, forage production in the initial year was enhanced through seed inoculation. Average total yields in 1988 were nearly

TABLE 1. EFFECT OF INOCULATION AND FERTILIZATION ON YIELD OF SUBTERRANEAN CLOVER GROWN IN LIGNITE MINE SPOIL

Treatment	Fertilizer	Harvest Date 3/87	Harvest Date 4/87	Total-87	Harvest Date 3/88	Harvest Date 4/88	Total-88
		Pounds/Acre					
Clover/Inoc	0-0-0	87	309	396	977	1136+	2113
Clover/Uninoc	0-0-0	0	198	198	871	1830	2701
Clover/Inoc	0-17-17	1375+	815	2190	1398	1887	3285
Clover/Uninoc	0-17-17	202	606	808	1420	1824	3244
Clover/Inoc	17-17-17	1554+	945	2499	2204	1881	4085
Clover/Uninoc	17-17-17	366	994	1360	1733	1773	3506
LSD*		271	NS	1081	704	NS	912

*Mean separation in columns at p = 0.05 by Tukey's studentized range test, NS = not significant.
+Significantly different at p = 0.05 by paired comparison of treatments within each fertilizer level.

twice those obtained in 1987, probably due to the denser plant cover obtained with natural reseeding of the subclover.

Table 2 summarizes the dry matter production of coastal bermudagrass in 1987 and 1988. In 1987, no significant differences were found in yields from any treatment at the first clipping. Yields tended to be higher in control plots (grass only; no clover) at all fertilizer levels, possibly due to greater nutrient or moisture availability due to the absence of subclover. At the second harvest, yields tended to be lower in the control plots across all fertilizer treatments, and were approximately 50 percent greater in the grass plus clover plots. Total bermudagrass production in 1987 was not significantly different among treatments. Fertilized plots showed a trend toward greater yields as compared to unfertilized plots, whether or not clover had been present previously. At the first clipping in 1988, bermudagrass yields tended to be greater on plots where clover had previously grown when at least P and K were added, and lower yields were found on the control plots (grass only) with no added N. At the second harvest, yields tended to be greatest on the grass plus clover plots across all fertilizer treatments. Total dry matter production in 1988 tended to be greater on the plots fertilized with N, P, and K where clover had previously grown. Lowest yields were observed on the control plots (grass only) with no added N. In both sampling years, bermudagrass yields from plots where inoculated clover was previously grown were not significantly different from plots where uninoculated clover was grown as determined by orthogonal contrasts (Table 3). At the second harvest in 1987 and both harvests in 1988, control plots (grass only) yielded significantly lower as compared to plots where inoculated clover had previously grown. Thus, yield of coastal ber-

TABLE 2. EFFECT OF PREVIOUS CLOVER CROP AND FERTILIZATION ON YIELD OF COASTAL BERMUDAGRASS GROWN IN LIGNITE MINE SPOIL

Cover Type	Fertilizer	Harvest Date 6/87	Harvest Date 10/87	Total-87	Harvest Date 7/88	Harvest Date 9/88	Total-88
		Pounds/Acre					
Clover/Inoc	0-0-0	1647	1297	2944	2000	1377	3377
Clover/Uninoc	0-0-0	1367	1195	2562	1670	1210	2880
Grass Only	0-0-0	2120	729	2849	1341	879	2220
Clover/Inoc	0-17-17	1916	1448	3364	2677	1431	4108
Clover/Uninoc	0-17-17	1416	1422	2838	2360	1309	3669
Grass Only	0-17-17	2200	972	3172	1124	1062	2186
Clover/Inoc	17-17-17	2216	1651	3867	3093	1558	4651
Clover/Uninoc	17-17-17	2257	1386	3643	3009	1408	4417
Grass Only	17-17-17	2729	1031	3760	2395	1033	3428
LSD*		NS	+	NS	1007	+	1293

*Mean separation in columns at p = 0.05 by Tukey's studentized range test, NS = not significant.
+Cover type main effect significant at p = 0.05 (See Table 3).

TABLE 3. EFFECT OF COVER TYPE ON YIELD OF COASTAL BERMUDAGRASS ACROSS ALL FERTILIZER LEVELS						
	Harvest Date			Harvest Date		
Cover Type	6/87	10/87	Total-87	7/88	9/88	Total-88
	Pounds/Acre					
Clover/Inoc	1927	1466	3392	2589	1455	4045
Clover/Uninoc	1680	1334	3014	2346	1309	3655
Grass Only	2439	910*	3259	1620*	991*	2611*

*Significantly different from Clover/Inoc as determined by orthogonal contrasts.

mudagrass was increased in plots where subclover was grown prior to the coastal bermudagrass growing season. We speculate that this increase was due to the availability of additional N fixed by the clover and then made available through mineralization of roots, etc., during the growth period of the grass. The beneficial effect of the clover on bermudagrass production was probably not seen at the first harvest in 1987 because initial mineralization of the clover was not enough to benefit the grass.

We have demonstrated that incorporation of subterranean clover in the reclamation regimes at the Big Brown Mine can lead to rapid establishment of ground cover (near complete canopy closure in several months) and to early production of high quality forage. Further, the coastal bermudagrass derives benefit from the legume crop, probably through the provision of additional fixed N by the legume. There is a clear role for the use of legumes in reclamation programs designed to restore mined lands to stable, productive lands free from the hazards of accelerated erosion.