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Evaluation of Forage Legumes for Low-Input Farming Systems

G. W. Evers and J. L. Gabrysch

Summary

Of the forage legumes tested, 'Overton R18' rose clover produced the greatest dry matter yield. 'Tibbee' crimson clover, 'Kondinin' rose clover, and 'Hairy' vetch were also productive. Sampled monthly, dry matter per acre increased from February through May and then decreased sharply in June because the plants had matured and were beginning to deteriorate. Protein percentage was inversely related to plant maturity. Legumes contained from 24 to 33% protein in February, and then protein dropped to 8 to 16% by June. Nitrogen (N) content of the top growth usually peaked in May and ranged from 85 to 158 lb N/A for the best entries. These forage legumes could be used on set-aside acreage in farming systems to reduce nitrogen fertilizer needs, control weeds, and protect the soil, which would normally be fallowed.

Introduction

Low-input sustainable agriculture is being promoted by people who think that high rates of commercial N fertilizer and pesticides used in farming systems are contaminating our soil and water. Past government farm programs have encouraged maximum production per acre, which requires high inputs of fertilizer and farm chemicals. Recent public pressure has caused changes in the 1990 farm bill toward farming systems that promote crop rotations and management practices to reduce levels of off-farm inputs. Nitrogen fertilizer is a major input cost for all grain crops. Because large amounts of energy are required in producing N fertilizer, its cost to producers is vulnerable to the price of oil and other forms of energy.

Legumes will be important in new farming systems that emphasize lower N fertilizer and pesticide inputs. When infected by the proper rhizobial strain, legumes can use N from the atmosphere, which can be transferred to the soil if the legume crop remains on the land. Legumes also act as cover crops, which protect the soil from erosion, provide weed control through plant competition, and improve soil structure and fertility. Alternating a forage legume with row crops also breaks up disease and insect cycles.

The objective of this study was to evaluate cultivars of five forage legume species for dry matter production, protein percentage, and N production in southeast Texas to assess these legumes potential for row crop rotations.

Keywords: clover / nitrogen / cover crop.

Procedure

Experiment I

The test site was on the George Ranch on an Edna fine sandy loam in Ft. Bend County. The study was planted November 9, 1988, on a prepared seedbed. Entries and their respective seeding rates (lb/A) were Kondinin and Overton R18 rose clover (10 lb), 'Koala' and 'Nungarin' subterranean clover (14 lb), Tibbee crimson (12 lb), 'Jemalong' and 'Serena' medics (10 lb), and Hairy vetch (30 lb). At planting, 60 lb of phosphorus (P)/A were applied. Experimental design was a complete randomized block, replicated four times with a plot size of 13.3 x 25 ft. Two 1.8-ft^2 samples were taken at random from each plot on May 17, 1989. All plots were allowed to mature and produce seed.

Plots were mowed off in September 1989 to promote reseeding and were fertilized with 60 lb P/A. A 12- x 16-in. (1.3-ft^2) sample was taken at random from each plot the first week of each month from February through June 1990. Forage samples were dried and weighed to estimate yield and then analyzed for N by the Kjeldahl procedure to determine protein percentage. Pounds of N per acre in the plant top growth were calculated from the yield and protein percentage.

Experiment II

A second test was planted on November 10, 1989, next to the reseeding study previously described. Only 'Gulf' ryegrass and the four best entries from the 1988 test were planted. The entries and their respective seeding rates (lb/A) were Koala subterranean clover (16 lb), Overton R18 rose clover (12 lb), Tibbee crimson clover (14 lb), Hairy vetch (30 lb), and Gulf ryegrass (25 lb). At planting, 60 lb P/A were applied. Experimental design, plot sampling, and yield and N determinations were identical to those described for the reseeding year in Experiment I.

Results

Experiment I

Overton R18 rose clover was the highest yielding entry at the only sampling date on May 17, 1989 (Table 1). Koala subclover, Tibbee crimson, and Hairy vetch had similar yields but about 1,500 lb less than Overton R18 rose clover. Serena medic winter-killed. Protein percentage of Hairy vetch was twice as high as those of the other entries. Protein percentage was directly related to maturity. The earliest maturing entries, Kondinin rose and Tibbee crimson, had the lowest protein percentages because they had matured and turned brown by May.

Table 1. Dry matter (DM) production, protein percentage, and nitrogen yield of forage legumes seeded in October 1988 and sampled in May 1989.

Legume	Yield	Protein	Nitrogen
	lb DM/A	%	lb/A
Overton R18 rose	4739 a*	13.2 c	100 b
Koala subclover	3308 b	14.8 b	78 c
Tibbee crimson	3281 b	10.7 d	56 d
Hairy vetch	3227 b	27.9 a	144 a
Kondinin rose	2633 c	10.8 d	46 d
Nungarin subclover	1445 d	13.0 c	30 f
Jemalong medic	1242 d	14.0 bc	28 f
LSD 0.05	514	1.4	17

*Values within a column followed by the same letter are not significantly different at the 0.05 level, Waller-Duncan K-ratio T test.

Hairy vetch produced the most pounds of N per acre because of its substantially higher protein percentage at the May sampling date.

The second-year performance from volunteer stands are reported in Table 2. All plots had some volunteer plants; Kondinin rose, Tibbee crimson, and Jemalong medic had the best stands. An unusually cold period the third week in December reduced stands of Koala subclover and Jemalong medic, which have poor cold tolerance.

Growth of all entries increased with time until June, when they had matured and began to deteriorate. As in the first year, Overton R18 rose produced significantly more dry matter than did the other entries at the May sampling. Kondinin rose and Tibbee crimson were the next highest yielding, followed by Hairy vetch. All entries had at least a 50% loss in weight from May to June except Hairy vetch, which still had some green leaves.

Protein percentage dropped as the legumes matured. Hairy vetch always had significantly higher protein levels than did the others at all sampling dates. Nitrogen yield as reported here is a function of the amount of top growth and its protein percentage, which are inversely related with time. Early maturing Tibbee crimson peaked in April, and Kondinin rose reached a plateau from March to May. All other entries peaked in May. The top four entries for N production in decreasing order were Hairy vetch, Overton R18 rose, Tibbee crimson, and Kondinin rose.

Experiment II

Legume seedlings were only in the first true leaf stage when below-freezing temperatures occurred in December. Koala subclover was completely killed. Ryegrass produced 4 tons, the highest dry matter yield at the May sampling (Table 3). The test site had received high rates of fertilizer in previous years

Table 2. Dry matter (DM) production, protein percentage, and nitrogen yield of volunteer forage legumes from February to June 1990.

Legume	Feb.	Mar.	Apr.	May	June
			Yield (lb DM/A)		
Hairy vetch	496 b*	1345 c	2196 b	3294 c	2286 b
RH-18 rose	729 a	1987 b	3690 a	7954 a	3906 a
Kondinin rose	714 a	2335 a	3384 a	5364 b	1998 b
Tibbee crimson	621 ab	2175 ab	3708 a	5076 b	1404 c
Koala sub	167 cd	580 d	918 c	2772 c	1530 c
Nungarin sub	261 c	511 d	270 d	1230 d	702 d
Jemalong medic	63 d	207 e	234 d	1044 d	432 d
LSD 0.05	144	285	427	658	320
			Protein (%)		
Hairy vetch	33.2 a	32.4 a	30.6 a	25.3 a	16.5 a
RH-18 rose	26.9 c	23.5 e	18.1 de	10.0 d	10.2 cd
Kondinin rose	29.3 b	25.9 cd	17.5 e	10.9 d	11.1 c
Tibbee crimson	26.7 c	24.9 de	19.4 d	10.5 d	9.3 d
Koala sub	24.1 d	26.5 c	26.9 b	17.3 b	13.8 b
Nungarin sub	27.5 c	28.1 b	19.5 d	15.5 c	11.6 c
Jemalong medic	30.0 b	26.7 bc	22.5 c	16.2 bc	11.7 c
LSD 0.05	1.1	1.5	1.8	1.5	1.6
			Nitrogen (lb/A)		
Hairy vetch	26 b	70 c	107 ab	134 a	60 a
RH-18 rose	31 ab	75 bc	108 ab	126 a	63 a
Kondinin rose	33 a	97 a	96 b	94 b	36 b
Tibbee crimson	27 ab	87 ab	116 a	85 b	21 c
Koala sub	6 cd	25 d	39 c	77 b	34 b
Nungarin sub	11 c	23 d	8 d	31 c	13 cd
Jemalong medic	3 d	9 e	8 d	27 c	8 d
LSD 0.05	7	14	17	18	8

*Values within a column followed by the same letter are not significantly different at the 0.05 level, Waller-Duncan K-ratio T test.

when planted to cotton and grain sorghum. Soil samples taken before this study showed a high rate of 32 ppm of N. Tibbee crimson and Overton R18 rose produced almost twice the dry matter of Hairy vetch at the May sampling, which was similar to that of the reseeding study in Experiment I (Table 2).

As in the reseeding study, protein percentage decreased as plants matured, and Hairy vetch was always significantly higher than the other entries. Tibbee crimson and Overton R18 rose were similar and never more than 3.5 percentage points apart. Protein level of Gulf ryegrass was 27% in February but decreased faster than that of the legumes as the initial soil N was used up and the grass matured.

Nitrogen content of the top growth of the three legume entries peaked in May. Hairy vetch N content was significantly higher than that of Tibbee crimson and Overton R18 rose. Ryegrass top growth had significantly more N than did the legumes in February and March because of the high dry matter yields caused by residual soil N.

Discussion

Hairy vetch, Tibbee crimson, and Overton R18 rose produced the most N per acre. Koala subclover did well the first year but poorly the second year because of the low temperatures in December 1989. A more cold hardy cultivar such as Mt. Barker would probably do as well as Koala did the first year. The medics lacked cold tolerance for the area. Hairy vetch was unique in that its protein percentage was always significantly higher than the other legumes although it was never the highest dry matter producer. If permitted to grow until early May, the most productive legumes would contain from 100 to 150 lb N/A. However, not plowing legume cover crops under until early May prevents the planting of any crop such as cotton, grain sorghum, or corn until the following year.

A possible option for set-aside acreage would be to plant the legume in the fall after the row crop is harvested. The legume would grow through the spring and produce a seed crop. The mature top

Table 3. Dry matter (DM) production, protein percentage, and nitrogen yield of legumes planted November 9, 1989, from February through June 1990.

Legume	Feb.	Mar.	Apr.	May	June
			Yield (lb DM/A)		
Hairy vetch	228 b*	1046 b	2160 c	3672 c	2538 bc
Tibbee crimson	78 c	328 c	2790 b	6300 b	1998 c
RH-18 rose	72 c	303 c	2412 bc	6894 b	4860 a
Ryegrass	608 a	2790 a	4464 a	7938 a	3528 b
LSD 0.05	87	218	434	647	1149
			Protein (%)		
Hairy vetch	31.0 a	30.8 a	30.8 a	26.8 a	20.0 a
Tibbee crimson	27.0 b	27.3 b	20.0 c	11.0 b	8.0 b
RH-18 rose	27.0 c	23.8 c	23.3 b	12.3 b	8.3 b
Ryegrass	27.0 c	20.5 d	8.3 d	5.3 c	5.0 c
LSD 0.05	1.3	1.5	2.1	2.5	1.5
			Nitrogen (lb/A)		
Hairy vetch	11.3 b	51.4 b	106.6 a	157.7 a	81.2 a
Tibbee crimson	3.6 c	14.3 c	89.3 b	110.8 b	25.6 b
RH-18 rose	3.1 c	11.5 c	89.7 b	135.3 ab	63.6 a
Ryegrass	26.3 a	91.1 a	58.7 c	66.5 c	28.5 b
LSD 0.05	3.9	5.4	16.8	27.3	21.8

*Values in a column followed by the same letter are not significantly different at the 0.05 level, Waller-Duncan K-ratio T-test.

growth left on the soil surface would control erosion, conserve soil moisture, provide summer weed control, and allow some of the N to leach into the soil. The following fall, the land could be prepared for crop production. Legumes would volunteer after land preparation and would have to be destroyed at crop-planting time. The volunteer legume stand would provide about 50 lb/A of additional N.

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