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THE EFFECT OF DAIRY MANURE ON SUMMER ANNUAL BROADLEAVES GROWN AS ALTERNATIVE SILAGES IN THE CROSS TIMBERS

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Summary

Alternative crops, especially silages for the dairy industry, are needed to replace peanut acreage in Central Texas. Kenaf (*Hibiscus cannibinus*) var. India, lablab (*Lablab purpureus*) var. tecomate, combine cowpeas (*Vigna unguiculata*), and sunflowers (*Helianthus annuus*) S682 and S573 were planted at the Stephenville A&M Center in the spring of 1998. Stockpiled dairy manure was applied to half the plots at 5 t dry matter (DM)/acre. Average days to maturity and number of harvests per season varied from 66-82 days and 1-3 harvests, respectively. Yields were highest for the kenaf (14,997 lbs DM/acre) followed by the lablab (8,409 lbs DM/acre). The lowest acid detergent fiber (ADF) and lignin DM concentrations were measured in the kenaf (28.4% and 3.67%, respectively) and the cowpea (28.3% and 4.78%, respectively). The cowpea, lablab and kenaf all had crude protein (CP) concentrations over 16%, DM basis and the kenaf had the highest CP yield (2,465 lbs/acre). The application of manure did not affect DM yields or phosphorus (P) concentration, the latter averaging 0.230%, DM basis.

Introduction

Alternative silage crops with greater yield, better quality parameters and higher soil P extraction capabilities are needed for the dairy industry in Texas. Early spring seeding for corn silages may overlap with winter small grain crops. Sorghum silages may not satisfy the high quality required by dairy cattle. The objective of this trial, undertaken at the Stephenville Agricultural Research and Extension Center, was to investigate summer annual crops other than grasses that might fit into the dairy forage production systems of Central Texas.

Sunflowers have long been utilized as a fast maturing, highly productive silage crop, especially in Eastern Europe and Russia. In contrast, kenaf had traditionally been grown for its fiber until recent selection efforts produced high yielding, digestible varieties. Lablab and combine cowpea, both legumes with known applications to ruminant nutrition, have been utilized

in many production systems as quick developing, high protein annual forages. The first objective of this trial was to measure days to maturity, yields and quality indicators of these annual summer broadleaveas to investigate their potential as silage crops.

With the large amounts of manure produced on dairies and available for application to crop fields, phosphorus build-up in the soil is a concern. By measuring differences in crop P uptake, silage producers can better manage manure field application and P build-up. Dairymen can also decrease P import onto dairies by recycling maure P through forage. The second objective of this trial, therefore, was to monitor P uptake by summer silage crops to obtain a better understanding of P balance within dairy systems.

Procedure

On April 24, 1998, 28' X 12' plots were seeded with 5 commercially available summer, annual broadleaves (see Table 1 for a list). These were replicated 4 times as blocks. These plots were split and dairy manure was applied at 5 tons/acre, DM basis. Manure analysis indicated that average P concentration was 0.58% and average nitrogen (N) concentration was 1.3%, DM basis. Ammonium nitrate was applied only to the kenaf and sunflower at a rate of 160 lbs N/acre to plots without manure and 30 lbs N/acre to all plots with manure, 130 lbs N/acre already having been applied in the manure. Soil tests of the field in which the trial was located indicated 16 ppm soluble P. The manure added 58 lbs P/acre. Irrigation was applied as needed (see Table 2).

Only the inner 6 ft X 6 ft of each plot was harvested. Sunflowers were harvested only once, when they reached 1/3 full seed, while the remaining entries were harvested whenever their canopies closed. Kenaf and lablab were cut 3 times and the other entries once. All entries were harvested at a 5 in stubble height. Dried and ground herbage samples from each harvest of each sub-plot were then batched over the season. This sample was analyzed for neutral detergent fiber (NDF), ADF, cellulose, lignin, P and CP concentrations using traditional wet chemistry techniques.

Results & Discussion

Days to first harvest varied from 66 days after planting (DAP) for the kenaf and cowpea to 82 DAP for the lablab (Table 1). The cowpea, in particular, started to flower very early and did not cover the plots adequately. An indeterminate flowering type, such as "Iron-clay" may be more appropriate for multiple harvest cropping. The cowpea and the sunflower were unable to

resprout following the first harvest. The kenaf and lablab, however, were able to resprouted from the 5" bases and were each harvested a total of 3 times before cold temperatures terminated the trial in October. The kenaf increased DM yield during the second harvest while the lablab showed a steady decrease with each harvest (Table 3).

Total DM yield for the season was highest for the kenaf at nearly 7.5 tons/acre (Table 3). This was 78% higher than the next highest producing entry, lablab, which in turn was 74% higher than the average sunflower yield. The combine cowpea had relatively low production at 1.3 tons/acre. If an early, short season crop is desirable within the cropping system, however, results from the first harvest indicate that DM yields were highest from the lablab and two sunflower entries, all of which accumulated over 2 tons/acre in under 12 weeks. The number of harvests over the season (Table 1) will also affect harvest costs and should be a factor in species selection by producers.

The fiber fraction concentrations were lowest in cowpea and kenaf (Table 4). Cowpea and kenaf ADF averaged 28.5% compared to a 32.4% average for the two sunflower entries. Kenaf had the lowest lignin fraction, 3.67%, compared to 4.78% for the cowpea and an average 6.00% for the remaining 3 entries. This difference in lignin is particularly important in ruminant nutrition since this fiber fraction is essentially non-digestible in the rumen.

The cowpea, lablab and kenaf all had CP concentrations over 16.5% (Table 5). Both the sunflower entries were much lower at 10.8%. When yield was factored into the equation, however, the kenaf had the greatest CP yield at 2,465 lbs/acre for the season. Lablab had only 60% of this CP yield but was much more productive than the remaining entries. Lablab, however, had this CP yield without the benefit of N fertilizer application.

Phosphorus concentration was highest in the two legumes: lablab at 0.313 % and cowpea at 0.286 % (Table 5). The non-legumes averaged only 0.185%. However, when yields are factored in, the kenaf and lablab both extracted 26 or more lbs P/acre from the soil. This is only about half the P applied in the manure, which implies a net increase in soil P. The sunflowers and cowpea, by comparison, only extracted 4 ppm P from the soil.

Neither plant P nor CP were affected by manure application in any of the species studied (Table 6).

Conclusions

In the search for a high yielding, high quality silage alternative to corn or sorghum, kenaf was the most promising summer broadleaf. Questions remain, however, as to its palatability to

cattle. Also, the timing of its late season production may interfere with small grain seeding. Additionally, the cost of multiple harvests and N requirements need to be considered.

Because soil analysis indicates only what P will be available to the crop over the season (not total soil P), the removal of 30 lbs P/acre from the soil by kenaf does not necessarily guarantee a 15 ppm P decrease in subsequent soil analysis. Phosphorus that was previously fixed in the soil (and not registered in the first soil analysis) may become available to take the place of the P removed by the plant roots. But there can be no argument that 15 ppm P was removed from the total soil P pool (plant-available as well as soil-fixed) if 30 lbs P/acre was removed by the kenaf.

Lablab also showed some promise in this study. If an earlier crop termination date is required to allow small grain or clover/medic seeding, the loss of a relatively poor third harvest results in a total 140 day production of 7,400 lbs DM/acre. Since no N was applied, costs are low for a good return in quality and yield as well as high soil P extraction from the soil back to the ruminant. Lablab has been shown to be highly palatable and digestible to cattle and goats but the latter, in particular, needs to be confirmed for Tecomate lablab.

Additional research needs to be done. This might include the continued search for other alternative broadleaf silages. The digestibility and palatability of some entries need to be further investigated. The use of viney legumes such as lablab or iron-clay cowpea grown in mixtures with annual grasses may increase both yield and quality of silages but compatibility needs to be examined.

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Table 1. Number of harvests, number of days after planting (DAP) to first harvest, number of DAP to last harvest and average days to maturity for five summer silage broadleaves grown during the 1998 season at the Stephenville Agricultural Research Center.

Entry	# harvests	DAP first cut	DAP last cut	Ave. days to maturity
India kenaf	3	66	189	63
Lablab	3	82	189	63
S682 sunflower	1	76	---	76
S573 sunflower	1	76	---	76
Combine cowpea	1	66	---	66

Table 2. Rainfall, irrigation, fertilizer application, cultivation and seeding dates for five summer annual broadleaves at Stephenville.

Date	Event	Description
September, 97	Previous crop	Peanuts
March	Rainfall	4.3”
Pre-seed	Cultivation	Mechanical
	Manure incorp.	10,000 t DM
	N incorp.*	160 lbs/acre
April 24	Plant, drill	
April	Rainfall	0.3”
	Pivot	2.0”
May	Weeding	Hoe
	Rainfall	4.6”
	Pivot	3.0”
June	Rainfall	2.3”
	Pivot	1.0”
July	Weeding	Hoe
	N broadcast**	75 lbs/acre
	Rainfall	1.6”
	Pivot	5.0”
August	Rainfall	0.8”
	Pivot	4.5”
September	Rainfall	3.8”
	Pivot	1.5”
October	Rainfall	3.6”

*Applied to all entries except lablab and cowpea

**Applied to kenaf only.

Table 3. Dry matter production of five summer broadleaf silages grown during the 1998 season at the Stephenville Agricultural Experiment Station.

Entry	First cut	Second cut	Third cut	Total DM
	----------lbs DM/acre----------			
India kenaf	3 713	6 559	4 725	14 997 a
Tecomate lablab	4 575	2 826	1 008	8 409 b
S682 sunflower	4 766	---	---	4 766 c
S573 sunflower	4 893	---	---	4 892 c
Combine cowpea	2 641	---	---	2 641 d
P value				0.001
s.d.				513

*Means in the same column followed by different letters differ (P=0.05) according to Duncan's multiple range test.

Table 4. Quality indicators for five summer annual broadleaf silages grown under irrigation during 1998 at the Stephenville Agricultural Experiment Station.

Entry	NDF	ADF	Cellulose	Lignin
	----------% DM----------			
India kenaf	36.7 b	28.4 b	24.7 ab	3.67 c
Tecomate lablab	40.0 a	30.4 ab	24.5 ab	5.88 a
S682 sunflower	37.8 ab	32.8 a	26.7 a	6.14 a
S573 sunflower	36.4 b	32.0 a	26.0 a	6.00 a
Combine cowpea	35.5 b	28.3 b	23.4 b	4.78 b
P value	0.01	0.002	0.05	0.001
s.d.	0.9	0.9	0.8	0.2

*Means in the same column followed by different letters differ (P=0.05) according to Duncan's multiple range test.

Table 5. Estimated crude protein (CP), phosphorus (P) percentage of herbage, P yield and CP in five summer annual silage broadleaves grown under irrigation during 1998 at the Stephenville Agricultural Experiment Station.

Entry	----------CP----------		----------P----------	
	% DM	lbs/acre	% DM	lbs/acre
India kenaf	16.6 a	2 465 a	0.196 b	29.6 a
Tecomate lablab	17.7 a	1 488 b	0.313 a	26.3 a
S682 sunflower	10.7 b	504 c	0.183 b	8.6 b
S573 sunflower	10.8 b	528 c	0.175 b	8.5 b
Combine cowpea	18.4 a	485 c	0.286 a	7.5 b
P value	0.001	0.001	0.001	0.001
s.d.	0.7	102	0.013	1.6

*Means in the same column followed by different letters differ (P=0.05) according to Duncan's multiple range test.

Table 6. Effect of manure application at 5 t/acre DM on P and CP characteristics averaged for 5 summer annual broadleaves at Stephenville.

Manure Application:	10,000 lbs DM/acre	0 lbs DM/acre	P value	s.d.
lbs DM yield/acre	7 462	6 810	0.17	325
% plant P	0.236	0.224	0.31	0.008
lbs P DM yield/acre	19.2	16.9	0.17	1.04
% plant CP	14.9	14.8	----	0.42
lbs CP DM/acre	1 121	1 062	----	72