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Forage Research in Texas 1985

THE TEXAS AGRICULTURAL EXPERIMENT STATION/Neville P. Clarke, Director/The Texas A&M University System/College Station, Texas

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Contents

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Foreword

Forage research in Texas is conducted throughout the state ranging from the Lower Rio Grande Valley, with essentially a frost-free growing season, to the northern part of the state which may enjoy only about 185 days frost-free. Active programs span the state from deep East Texas with ample rainfall to those areas of the state where rainfall limits the extent and productivity of plant growth. Forage production research problems are also addressed from sea level to approximately a mile high.

Crop and animal scientists throughout the state meet annually to discuss and plan research. The results and progress from those investigations are summarized in this document. No attempt was made to include summaries of the total program but, rather, to concentrate on emerging results of primary interest to producers and other scientists as well. The reader will note that the contents address nearly all aspects of forage—including animal utilization, growth and productivity of warm- and cool-season grasses, breeding and adaptation of grasses and legumes, soil fertility, and establishment and management.

The information presented is intended for the specific purpose of keeping producers, extension personnel (many of whom cooperated in these investigations) and other researchers informed as to the direction and extent of forage research in Texas. As additional data are obtained, studies finalized, and conclusive results developed, journal articles will be published.

On behalf of the Texas Agricultural Experiment Station, let me express appreciation to the many research leaders and contributors for their cooperative effort in summarizing these results. This publication represents a continued effort to serve the public, particularly livestock producers in Texas.

Neville P. Clarke, Director
Texas Agricultural Experiment Station

TEXAS A&M UNIVERSITY
RESEARCH AND EXTENSION CENTERS

Forage Research In Texas, 1985

Diet Selection and Nutritive Value of Coastal Bermudagrass as Influenced by Grazing Pressure

L. D. ROTH, F. M. ROUQUETTE, JR., AND W. C. ELLIS

Summary

Coastal Bermudagrass *(Cynodon dactylon)* was continuously grazed by cattle at one of four grazing pressure levels. Forage and esophageal samples were collected in early-, mid- and late-summer. Average daily gain (ADG [pound/day]) of stocker calves was measured over a 114-day period. The forage availability (lb dry matter/A) varied inversely with grazing pressure. Differences existed among grazing pressure levels in leaf proportion in the available forage (P=0.02), but there were no differences in leaf proportion of the diet (P=0.53). The neutral detergent fiber (NDF) content of leaf in the available forage decreased (P=0.01) as grazing pressure was increased, as did NDF content of the leaf in the diet (P=0.0001). No significant differences existed among grazing pressure levels for NDF content of stem in the available forage (P=0.23) or in the diet (P=0.33).

Introduction

The performance of individual grazing animals generally decreases as grazing pressure increases. This depressed performance may be due to effects of grazing pressure on the morphology, physiology, and growth of the forage plant. These interactions at the plant-animal interface remain largely conceptual and unquantified. This study was conducted to examine the influence of grazing pressure on these plant-animal interactions. Leaf and stem proportions and fiber content of the available forage and the diet were used as indicators of selectively grazed components of the forage, its nutritive potential, and responses by the plant to grazing pressure.

Procedure

A 4-month study was conducted during the summer months at the Texas A&M University Agricultural Research and Extension Center at Overton. Four pastures of Coastal bermudagrass *(Cynodon dactylon)* were continuously grazed, with a put-and-take variable stocking rate to maintain four levels of grazing pressure (pound of forage per dry matter/100 lb animal liveweight). The pasture sizes were 5.3 A (low, L), 5.3 A (medium low, ML), 3.2 A (medium high, MH), 2.3 A (high, H) with corresponding grazing pressure levels listed in Table 1. Each pasture was stocked with two yearling Brahman steers that were esophageally and ruminally fistulated, four F-1 Brahman x Hereford cows and their calves, five stocker calves, and a variable number of put-and-take animals as required to regulate grazing pressure to

KEYWORDS: Neutral detergent fiber/Coastal Bermudagrass/leaf/stem.

TABLE 1. PASTURE SIZE, STOCKING RATE, AND GRAZING PRESSURE OF COASTAL BERMUDAGRASS

	Grazing pressure level			
	High (H)	Medium high (MH)	Medium low (ML)	Low (L)
Pasture size, A	2.3	3.2	5.3	5.3
Stocking weight, 100 lb animal wt/A	82.5	49.0	33.8	26.2
Actual grazing pressure lb forage DM/100 lb animal wt	7.4	27.5	75.5	155.6

maintain targeted levels of forage availability. All animals were weighed at 28-day intervals, with gains of the stocker calves reported over a 114-day period.

Samples of available forage and esophageal extrusa were collected in early- (June 28, date 1) mid- (August 20, date 2), and late-summer (September 17, date 3). Forage availability was measured by clipping four areas of 1 ft^2 each to ground level. The clipped forage was hand-separated into leaf and stem portions. Neutral detergent fiber content was determined on the leaf and stem components after grinding to pass a 2 mm screen.

Esophageal extrusa (diet) samples were collected daily from the two esophageal fistulated steers at each grazing pressure level during three 3 consecutive days for date 1, and 2 days for dates 2 and 3. The extrusa samples were freeze-dried and separated into leaf and stem components by a vertical-draft air column. The separated components were used to determine proportions of leaf, stem, and fiber content of the diet.

Results and Discussion

The mean forage availability and average daily gain (ADG) of stocker calves is displayed in Figure 1. Forage availability ranged from 4,497 lb/A from L grazing pressure to 721 lb/A from a high (H) grazing pressure. The ADG of the stocker calves differed (P=0.0001) due to grazing pressure levels and ranged from 1.39 lb/day for L to 0.29 lb/day for H.

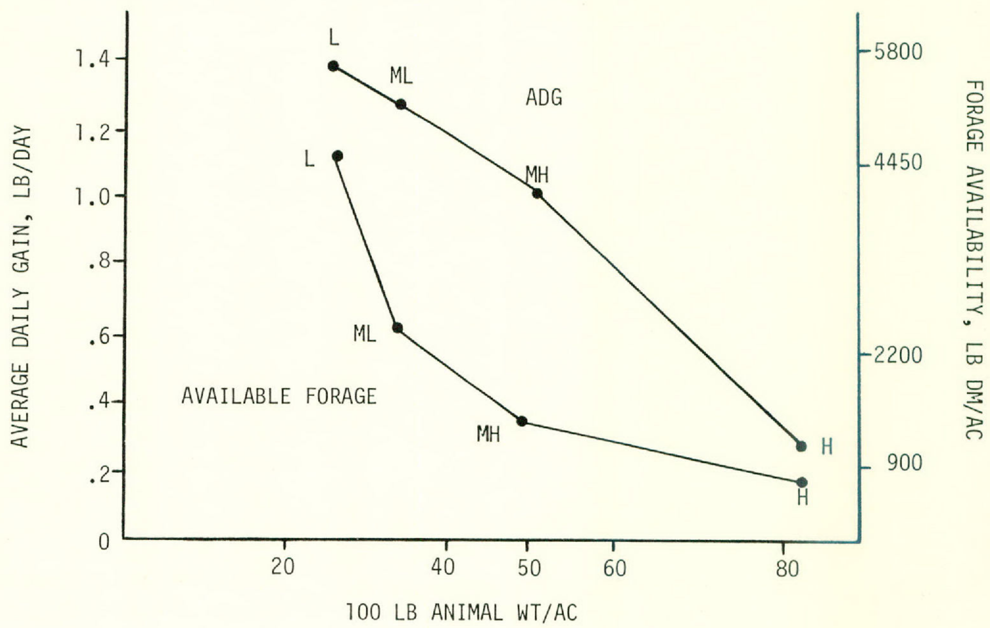
The mean leaf proportions of available forage and diet are shown in Figure 2. The mean leaf proportion of available forage differed (P=0.02) due to grazing pressure levels and ranged from 39.7 percent for L to 51.6 percent for H. A numerical trend was present for the leaf proportion of available forage to increase with increasing grazing pressure. No differences (P=0.53) existed among grazing pressure levels for mean leaf proportion in the diet which ranged from 82.7 percent for L to 78.5 percent for H. The differences in leaf proportions of available forage and the diet within grazing pressure levels indicated an apparent selectivity by the grazing animal for the leaf component of the available forage.

The mean NDF content of leaf in the available forage is shown in Figure 3. The NDF content of leaf in the available forage differed (P=0.01) due to grazing pressure levels. Differences (P=0.0001) in NDF content of leaf in the diet existed among grazing pressure levels. Mean leaf NDF content of the diet was highest in L at 72.1 percent and decreased to 59.6 percent for H. The fiber content of the selectively grazed leaf tended to be lower than the fiber content of the leaf present in the available forage at the same grazing pressure level. This suggests the ability to selectively graze the less mature leaves present in the available leaf population.

No differences in NDF content of stem existed in the available forage (P=0.23) or in the diet (P=0.33) (Fig. 4). The NDF content of stem from the diet was generally less than the NDF content of stem in the available forage at the same grazing pressure level. The lack of a difference among grazing pressure levels in fiber content of stem in the diet suggested that animals on different grazing pressure levels were consuming stem of similar maturity.

In the study, as grazing pressure increased, the leaf proportion in the diet did not change but fiber content of

Fig. 1. Average daily gain of stockers at four levels of forage availability.



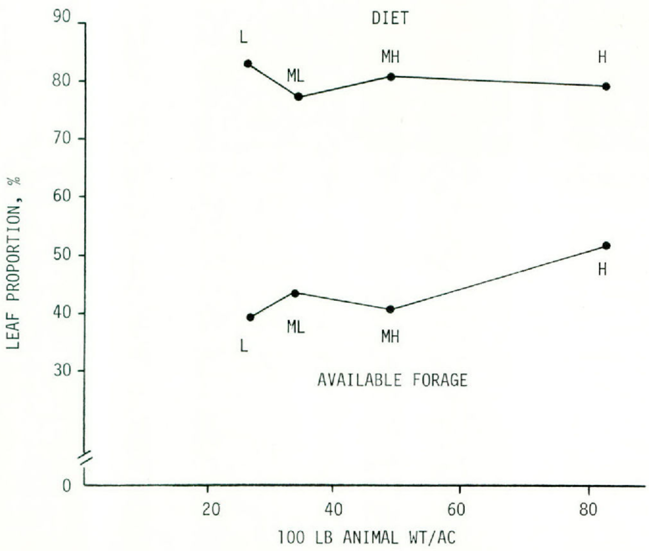


Fig. 2. Percent leaf in diet of stockers and available forage of Coastal bermudagrass at four grazing pressures.

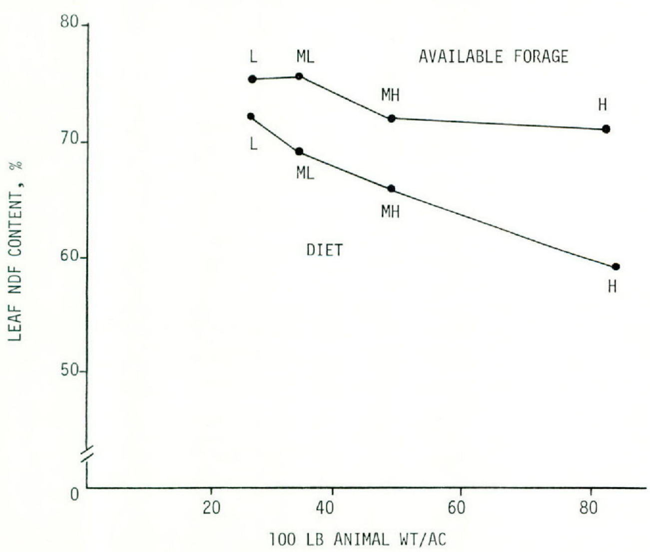


Fig. 3. Neutral detergent fiber (NDF) content of diet and available forage of Coastal bermudagrass at four grazing pressures.

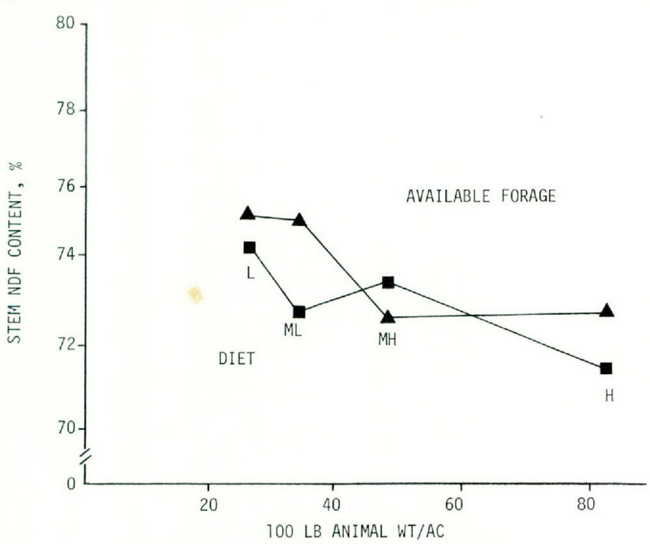


Fig. 4. Neutral detergent fiber (NDF) of diet and available forage of Coastal bermudagrass at four grazing pressures.

the leaf declined which could result in a higher quality diet. However, as grazing pressure was increased, animal performance declined as a result of restricted DM intake. These results demonstrate the complexity and interactive nature of factors at the plant-animal interface. Further research is needed to understand the preferences the animal has in selecting its diet, and how these preferences and forage growth interact with grazing pressure. Knowledge of these variables at the plant-animal interface is necessary to project the most economical systems of animal production from forages.

Influence of Grazing on Morphology and Nutritive Value of Coastal Bermudagrass

L. D. ROTH, F. M. ROUQUETTE, JR., AND W. C. ELLIS

Summary

A study was conducted to measure the effects of graded levels of grazing pressure upon the growth, morphological, and nutritive value responses of Coastal bermudagrass. Four pastures of varying size were stocked with a similar number of cattle to obtain the desired levels of available forage. Beginning in June, forage measurements were made at approximately 2-week intervals through September. The forage growth rate did not differ ($P>0.05$) among grazing pressure levels, although specific forage growth rate increased ($P<0.01$) with increased grazing pressure level. As grazing pressure increased, the proportion of green stem in the available forage decreased ($P<0.01$), and the proportions of green leaf and dead forage in the sward increased ($P<0.01$). The neutral detergent fiber content of the green leaf, green stem, and dead forage components of the sward decreased ($P<0.01$) with increasing grazing pressure level.

Introduction

A major objective of grazing management is to optimize the relationships between the production and utilization of forage and animal performance for a given set of inputs and resources. In order to achieve that optimization, knowledge of the quantitative relations between grazing pressure and the sward and animal responses at the plant-animal interface is necessary. Defoliation by the grazing animal is a major determinant of the growth and morphological structure of the

KEYWORDS: Grazing pressure/bermudagrass/forage growth/forage morphology/nutritive value.

forage plant (Harris, 1978). Altering the morphological structure of the plant can affect the degree of selectivity the animal may exert for the preferred forage components (Stobbs, 1973). Additionally, grazing pressure can alter the composition of the available forage, and thereby affect the nutritive value of the diet selected by the grazing animal.

The primary objective of the research reported in this manuscript was to quantitatively measure the growth, morphological, and nutritive value responses of Coastal bermudagrass to different levels of available forage established by graded levels of grazing pressure.

Procedure

Four contiguous pastures of various sizes and graded levels of grazing pressure were used to obtain the desired levels of available forage. The pasture sizes and mean grazing pressures (pound of forage per dry matter/100 lb animal body weight) achieved are listed in Table 1. All pastures were fertilized at the total rate of 250-100-100 of N-P_2O_5-K_2O. Phosphorus and potassium were applied in October and nitrogen applied in five equal applications from February to September.

Each pasture was stocked with a grazing herd consisting of two yearling bi-fistulated (rumen and esophageal) yearling Brahman steers, four F-1 Brahman x Hereford cows and their suckling Simmental-sired calves, and five Brahman crossbred stocker calves. The study utilized cows with fall-born calves (October and November) until the calves were weaned on July 12. On July 15, cows with spring-born calves (February and March) of identical breeding were added to the grazing herd in each pasture, and remained until the conclusion of the study on September 25. The grazing was continuous, using a put-and-take, variable stocking rate to maintain the desired levels of available forage. The targeted levels of available forage (lb forage dry matter/A) are listed in Table 1.

The quantity of available forage and additional measurements of forage growth rate, morphology, and nutritive value of the available forage were made at approximately 14-day intervals. The amount of available forage was determined by clipping to ground level. The forage growth rate (lb forage dry matter/A/day) was determined by differences in the amount of forage dry matter present in two protected, enclosed areas per pasture (F_O) and in unprotected areas available for grazing at the start of the growth period (F_N) when the growth period was N days.

$$\text{Forage Growth Rate} = \frac{F_N - F_O}{N}$$

The specific forage growth rate was calculated by dividing the forage growth rate by the amount of available forage present at the start of the growth period.

$$\text{Specific Forage Growth Rate} = \frac{\text{Forage Growth Rate}}{F_O}$$

TABLE 1. PASTURE SIZE, TARGETED AND ACHIEVED AVAILABLE FORAGE, AND RESULTANT MEAN GRAZING PRESSURES FOR COASTAL BERMUDAGRASS

	Grazing pressure level			
Item	High (H)	Medium high (MH)	Medium low (ML)	Low (L)
Pasture size, A	2.3	3.2	5.3	5.3
Available forage, lb dry matter/A				
Targeted	900	1,800	2,700	4,500
Achieved[1]	980	1,729	2,480	3,971
Grazing Pressure[1] lb forage dry matter/ 100 lb animal wt	12.0	38.9	70.5	156.4

[1]Mean values for study period.

The clipped forage samples used to measure the amount of available forage were hand-separated into green leaf, green stem, and a category classified as "dead." The dead category contained inflorescences, plant parts which appeared to have senesced, and stolons or rhizomes which were pulled to the surface through grazing. All components were dried in a forced draft oven at 55°C for 48 hours, and then weighed to determine component proportions of the sward. The components were then ground through a Wiley mill fitted with a 2 mm screen and subsequently analyzed for NDF content (Georing and Van Soest, 1970).

Results and Discussion

The quantity of available forage was reduced by increasing the grazing pressure level (Table 2). While the grazing pressure levels of medium low (ML) and low (L) did not hold their targeted rank for quantity of available forage on June 1, distinct differences were maintained among the grazing pressure levels after that date. The forage growth rate did not differ ($P>0.05$) among grazing pressure levels (Table 3). However, a difference was evident ($P<0.01$) across measurement dates with forage growth tending to decline as the season progressed. The forage growth rates measured in

TABLE 2. THE AMOUNT OF AVAILABLE FORAGE ACHIEVED BY FOUR GRAZING PRESSURE LEVELS

	Grazing pressure level			
Date	High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	Pounds of Dry Matter/Acre[1]			
Feb. 24	2,860	2,762	3,338	3,213
Mar. 14	1,039	1,983	1,607	2,387
Apr. 13	782	1,629	1,188	2,124
June 1	318	548	1,270	1,048
June 28	968	1,454	1,640	2,884
July 13	1,044	1,667	2,310	4,411
Aug. 2	1,139	2,703	3,607	6,999
Aug. 20	524	1,540	3,046	6,396
Sept. 4	565	1,999	3,601	5,222
Sept. 17	548	1,011	3,199	5,018
Mean	980	1,729	2,480	3,971

[1]N = Four areas/grazing pressure level/date.

TABLE 3. THE FORAGE GROWTH RATE OF COASTAL BERMUDAGRASS GRAZED AT FOUR GRAZING PRESSURE LEVELS

Date	Grazing pressure level			
	High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	Pounds of Dry Matter/Acre Day[1]			
June 28	126.3 ± 24.6[2]	115.5 ± 2.1	142.6 ± 31.5	149.4 ± 0.12
July 13	[3]	92.4 ± 38.2	124.3 ± 6.8	243.7 ± 3.0
Aug. 2	67.8 ± 7.1	156.3 ± 7.4	73.7 ± 13.0	116.6 ± 11.6
Aug.	40.1 ± 4.9	16.7 ± 26.1	47.7 ± 2.7	-116.2 ± 7.1
Sept. 4	64.9 ± 16.6	50.0 ± 46.0	76.8 ± 38.7	-6.5 ± 61.3
Sept. 17	44.7 ± 12.6	33.7 ± 41.3	23.6 ± 70.7	35.1 ± 65.1
Mean	68.8	77.4	81.4	70.4

[1]N = Two exclosures/GPL/date.
[2]Values are mean ± Standard deviation.
[3]No observation for H on July 13 due to animals disturbing exclosures.

TABLE 4. MEAN RAINFALL AND RAINFALL MEASURED AT TEXAS AGRICULTURAL EXPERIMENT STATION, OVERTON FROM MAY THROUGH SEPTEMBER

Month	Rainfall measured during trial	16-year mean rainfall
	Inches	
May	7.20	4.49
June	8.43	4.45
July	1.57	2.95
August	2.17	1.81
September	1.18	4.37
Total	20.55	18.07

TABLE 5. THE SPECIFIC FORAGE GROWTH RATE OF COASTAL BERMUDAGRASS GRAZED AT FOUR GRAZING PRESSURE LEVELS

Date	Grazing pressure level			
	High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	Specific Forage Growth Rate[1]			
June 28	0.396 ± 0.035[2]	0.241 ± 0.119	0.113 ± 0.018	0.144 ± 0.021
July 13	[3]	0.064 ± 0.025	0.076 ± 0.004	0.085 ± 0.002
Aug. 2	0.066 ± 0.005	0.098 ± 0.029	0.032 ± 0.003	0.027 ± 0.007
Aug. 20	0.036 ± 0.010	0.005 ± 0.008	0.013 ± 0.001	-.017 ± 0.001
Sept. 4	0.124 ± 0.032	0.031 ± 0.027	0.025 ± 0.013	-.001 ± 0.010
Sept. 17	0.083 ± 0.029	0.033 ± 0.041	0.006 ± 0.021	0.007 ± 0.013
Mean	0.141	0.079	0.044	0.041

[1]N = Two exclosures/GPL/date.
[2]Values are mean ± Standard deviation.
[3]No observation for H on July 13 due to animals disturbing exclosures.

this study corresponded to the time and amount of moisture received. The greatest amount of precipitation, 8.43 inches, was received during the growth period which ended on June 28 (Table 4). This also coincided with the highest forage growth rates determined for all grazing pressure levels (Table 3). Additionally, the moisture for August was received at a time to account for the small increase noted in forage growth rates for the period ending September 4.

The specific forage growth rate (SFGR) increased ($P<0.01$) with increased grazing pressure level (Table 5) and decreased with advancing date in the season. The SFGR was an indicator of the growth produced by each unit of available forage. The trend for greater SFGR with increased grazing pressure level indicated that each unit of available forage was becoming more productive as grazing pressure was increased.

A significant difference ($P<0.01$) existed among grazing pressure levels as the proportion of the green leaf component present in the available forage (Table 6) increased with increased grazing pressure level. In addition, the proportion of green leaf component differed ($P<0.01$) among measurement dates. The proportion of green leaf component in the available forage of this study followed a pattern suggested by the SFGR. All grazing pressure levels achieved their maximum SFGR during the growth period ending June 28, which coincided with the highest leaf proportions for all grazing pressure levels, except the high (H) grazing pressure level. After June 28, the decline in proportion of green leaf in the sward coincided with a time of moisture shortage and decreased SFGR, although the amount of available forage continued to increase.

Increasing the grazing pressure level tended to decrease ($P>0.01$) the stem proportion of the sward (Table 7). The changes in morphological composition of the sward due to grazing pressure were exemplified by the divergent trends and growth habits on the L and H pastures, respectively (Table 8). Coastal bermudagrass grown at L had an erect form and a high tiller density. Visual observations suggested that new growth was expressed as fine, long leaves extending beyond the terminal growing point of the stem. This structure of the plant and high tiller density enabled the animal to easily select the new growth of leaves in the upper horizon of the forage canopy, and to discriminate against stem material with little restriction on bite size. In contrast, observations of the sward growing at the H indicated an altered growth structure resulting from this level of defoliation. Tiller density on the H pastures was reduced as compared to the other grazing pressure levels, with the growth being characterized by short, thick rhizomes growing horizontal to the ground and producing short leaves which remained close to the stem. The very low growth structure makes accessibility by the animal difficult. And, coupled with only slight extension of the leaf from the stem, the ability of the animal to select against stem material may be restricted.

A trend was present at increased grazing pressure levels for a decrease in ($P<0.01$) the NDF content of the green leaf (Table 9), green stem (Table 10), and the dead (Table 11) forage components. Further, all forage components increased ($P<0.01$) in NDF content with advancing date in the season. The NDF content of forages is an indication of the amount of cell wall constituents present (Goering and Van Soest, 1970). Young, growing plant tissue has a lower cell wall content than mature or senescent material of the same species (Mowat et al., 1969). The trend for an increase in the NDF content of the green leaf at the ML and L and the green stem

TABLE 6. THE PROPORTION OF GREEN LEAF IN COASTAL BERMUDAGRASS SWARDS GRAZED AT FOUR GRAZING PRESSURE LEVELS

	Grazing pressure level			
Date	High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	Leaf percent[1]			
June 28	52.1 ± 7.1[2]	49.7 ± 5.0	46.7 ± 3.9	43.2 ± 1.8
July 13	47.9 ± 8.9	49.6 ± 1.1	43.3 ± 2.0	40.0 ± 4.5
Aug. 2	25.7 ± 2.2	21.9 ± 2.0	38.5 ± 8.9	30.7 ± 2.9
Aug. 20	33.2 ± 2.1	20.4 ± 0.32	34.5 ± 1.2	42.5 ± 6.7
Sept. 4	62.0 ± 1.9	32.0 ± 1.5	44.6 ± 5.3	31.4 ± 0.67
Sept. 17	68.2 ± 3.1	31.2 ± 6.1	42.5 ± 1.8	26.6 ± 0.28
Mean	48.2	34.1	41.7	35.8

[1]N = Four samples/GPL/date.
[2]Values are mean ± Standard deviation.

TABLE 7. THE PROPORTION OF GREEN STEM IN COASTAL BERMUDAGRASS SWARDS GRAZED AT FOUR GRAZING PRESSURE LEVELS

	Grazing pressure level			
Date	High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	Stem percent[1]			
June 28	42.0 ± 7.6[2]	46.1 ± 4.8	49.7 ± 2.5	51.2 ± 3.2
July 13	38.9 ± 6.2	45.1 ± 3.7	52.4 ± 3.3	55.7 ± 5.2
Aug. 2	47.6 ± 4.3	59.9 ± 4.2	57.7 ± 9.9	66.8 ± 1.4
Aug. 20	43.6 ± 12.4	64.5 ± 0.32	58.3 ± 12.3	56.8 ± 5.8
Sept. 4	34.8 ± 0.34	64.5 ± 0.49	58.6 ± 5.0	62.5 ± 0.62
Sept. 17	29.9 ± 5.7	61.2 ± 3.2	50.4 ± 1.0	71.8 ± 0.01
Mean	39.5	56.9	54.5	60.6

[1]N = Four samples/GPL/date.
[2]Values are mean ± Standard deviation.

TABLE 8. THE PROPORTION OF DEAD FORAGE IN COASTAL BERMUDAGRASS SWARDS GRAZED AT FOUR GRAZING PRESSURE LEVELS

	Grazing pressure level			
Date	High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	Dead Forage percent[1]			
June 28	5.8 ± 5.0[2]	4.1 ± 3.1	4.0 ± 2.9	5.6 ± 3.1
July 13	13.0 ± 7.3	5.0 ± 2.6	4.3 ± 2.3	4.2 ± 1.5
Aug. 2	26.7 ± 3.8	18.2 ± 5.1	3.8 ± 1.9	2.6 ± 1.8
Aug. 20	23.2 ± 10.3	15.2 ± 0.59	7.2 ± 8.8	0.7 ± 0.82
Sept. 4	3.2 ± 2.2	3.5 ± 1.1	4.3 ± 0.26	6.1 ± 0.06
Sept. 17	4.5 ± 1.1	7.6 ± 2.8	7.1 ± 2.8	1.6 ± 0.28
Mean	12.2	9.0	5.1	3.8

[1]N = Four samples/GPL/date.
[2]Values are mean ± Standard deviation.

TABLE 9. THE NEUTRAL DETERGENT FIBER (NDF) CONTENT OF GREEN LEAF IN COASTAL BERMUDAGRASS SWARDS GRAZED AT FOUR GRAZING PRESSURE LEVELS

	Grazing pressure level			
Date	High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	NDF percent[1]			
June 28	68.7 ± 3.2[2]	69.4 ± 2.3	74.3 ± 3.0	74.3 ± 1.9
July 13	68.3 ± 1.6	72.2 ± 2.2	76.2 ± 2.5	75.4 ± 1.8
Aug. 2	77.4 ± 1.6	76.5 ± 1.5	76.4 ± 1.5	74.5 ± 0.58
Aug. 20	74.7 ± 3.4	74.8 ± 2.5	77.4 ± 2.3	76.0 ± 1.7
Sept. 4	74.8 ± 0.42	76.6 ± 0.18	77.9 ± 0.07	76.8 ± 0.42
Sept. 17	75.9 ± 3.3	76.6 ± 0.47	77.9 ± 0.01	76.9 ± 0.23
Mean	73.3	74.4	76.7	75.7

[1]N = Four samples/GPL/date.
[2]Values are mean ± Standard deviation.

TABLE 10. THE NEUTRAL DETERGENT FIBER (NDF) CONTENT OF GREEN STEM IN COASTAL BERMUDAGRASS SWARDS GRAZED AT FOUR GRAZING PRESSURE LEVELS

	Grazing pressure level			
Date	High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	NDF percent[1]			
June 28	70.3 ± 2.7[2]	69.5 ± 2.0	72.7 ± 2.8	73.3 ± 2.9
July 13	71.9 ± 0.84	71.9 ± 1.6	74.2 ± 0.77	76.2 ± 1.1
Aug. 2	71.3 ± 6.9	77.6 ± 0.82	78.0 ± 0.94	76.8 ± 2.7
Aug. 20	74.6 ± 0.62	76.1 ± 0.86	77.5 ± 4.4	76.5 ± 1.3
Sept. 4	75.2 ± 0.14	77.0 ± 0.14	80.0 ± 0.21	80.0 ± 0.78
Sept. 17	78.1 ± 0.33	78.8 ± 1.2	79.5 ± 0.98	80.0 ± 0.75
Mean	73.6	75.2	77.0	77.1

[1]N = Four samples/GPL/date.
[2]Values are mean ± Standard deviation.

TABLE 11. THE NEUTRAL DETERGENT FIBER (NDF) CONTENT OF DEAD FORAGE IN COASTAL BERMUDAGRASS SWARDS GRAZED AT FOUR GRAZING PRESSURE LEVELS

	Grazing pressure level			
Date	High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	NDF percent[1]			
June 28	74.2 ± 0.53[2]	67.8 ± 0.48	70.9 ± 0.40	69.9 ± 0.46
July 13	59.5 ± 0.97	69.1 ± 0.49	69.7 ± 0.25	74.2 ± 0.17
Aug. 2	63.0 ± 0.15	71.3 ± 0.18	73.1 ± 0.38	72.3 ± 0.59
Aug. 20	69.3 ± 1.4	79.8 ± 1.4	77.9 ± 0.64	78.8 ± 1.4
Sept. 4	80.1 ± 0.13	79.1 ± 0.57	78.6 ± 0.14	81.9 ± 0.64
Sept. 17	80.1 ± 1.1	80.1 ± 0.64	78.6 ± 0.41	78.6 ± 0.18
Mean	71.0	74.5	74.8	76.0

[1]N = Two samples/GPL/date.
[2]Values are mean ± Standard deviation.

material of the bermudagrass at the four grazing pressure levels may be due to the accumulation and consequent aging of this forage (Burton et al., 1967). A higher defoliation rate associated with an increased grazing pressure level would theoretically result in a younger mean age of leaf material in the sward and a subsequent lower NDF content. Although the NDF content of green leaf declined with increased grazing pressure level, the small difference in NDF content of green leaf between the high and low grazing pressure levels did not infer a great difference in age. The similarity among grazing pressure levels to increase in NDF content of forage material with advancing date may have been the result of the increased environmental temperatures (Deinum, 1966). The trend of declining NDF content of forage components with increased grazing pressure level indicated a sward of greater nutritive value at the H grazing pressure level.

In conclusion, the level of grazing pressure did not alter the forage growth rate of the sward. However, increasing the grazing pressure level resulted in an increase in the growth rate per unit of available forage, which was attributed to the greater proportions of the green leaf component present in the sward. The higher rates of defoliation associated with increased levels of grazing pressure were deemed casual of the increase in proportion of the green leaf component in the sward and the decrease in NDF content of forage components.

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Development of Yearling Horses on Pasture and Supplemental Feed

F. M. ROUQUETTE, JR., G. W. WEBB, AND G. D. POTTER

Summary

Six Quarter horse yearlings, three colts, and three fillies, which averaged about 650 lb and 53 inches in height at the shoulder, were assigned to each of two pasture treatments: (1) pasture (PO), and (2) pasture + 8.3 lb supplemental feed/head/day (PF). Bermudagrass pastures were sod-seeded with Elbon rye, Gulf ryegrass, and Yuchi arrowleaf clover in mid-October and grazing was initiated in mid-March on the winter annual forages. From late May to October 2, all horses grazed bermudagrass exclusively. During the winter pasture phase (March 15 to May 29), horses on PF had average daily gains (ADG) twice that of horses on PO (1.87 lb versus 0.97 lb). The ADG for the 201-day trial was 1.46 for PF and 1.12 for PO. Stocking rates of slightly more than three horses per acre resulted in seasonal gains of 706 lb/A for PO and 937 lb/A for the PF treatment. The horses grew less than 2 inches in height during the treatment period. Horses on the PF treatment had higher condition scores and more rib fat at termination of the trial. Rump fat thickness, however, was the same for horses on both treatments.

Introduction

The development of yearling horses is often costly as well as time consuming. Ration selection becomes critically important in meeting the nutritional requirements for growth and gain. Forages such as alfalfa and other temperate forages have long held traditional roles in supplying a portion of the daily nutritional needs of the horse. With the combination of winter and summer pastures in the southeastern United States, high quality forages are available and may be suitable for the development of certain kinds of yearling horses. The primary objective of this trial was to determine the biological feasibility of developing yearling Quarter horses on an exclusive forage diet.

Procedure

The six Quarter horse yearlings were allotted to each of two pasture treatment groups based on sex, weight, height, and body condition. The two pasture treatments were as follows: (1) (Pasture Feed, PF) pasture plus 8.3 lb/head/day of a 14 percent protein supplemental feed; and (2) Pasture Only (PO) until August 28, and 8.3 lb/head/day of 14 percent supplement from August 28 to October 2. Horses were group-fed (50 lb/group) once a day during the trial. Bermudagrass [*Cynodon dactylon* (L.) Pers.] was sod seeded with 'Elbon' rye (*Secale cereale* L.), 'Gulf' ryegrass (*Lolium multiflorum* Lam.), and 'Yuchi'

KEYWORDS: Coastal Bermudagrass/horse/pasture/supplemental feed.

arrowleaf clover (*Trifolium vesiculosum* Savi.) in mid-October. Full-time, continuous grazing of the cool-season annual forages was initiated on March 15. By mid- to late May, the cool-season forages constituted less than 25 percent of the diet, and from June to October, all horses grazed bermudagrass exclusively. Although the stocking rates were held relatively uniform among pastures at approximately 3.0 horse-equivalents/A (700 lb = 1 horse equivalent), forage available to ground level was measured at monthly intervals. Liveweight and height at withers measurements were taken approximately 30-day intervals throughout the 201-day trial. At termination of the trial, all horses were conditioned scored and fat thickness estimates made over the rump and rib by an electronic scanner.

Results and Discussion

Pastures used in this trial were stocked at 3.0 horse-equivalents/A for the PO treatment and 3.2 horse-equivalents/A for the PF treatment with each horse unit being equivalent to 700 lb. As evidenced by the forage data, forage availability was in adequate supply at all times, with the exception of July, so as not to restrict *ad libitum* intake (Table 1). Nutritive value of forage samples as estimates of diet selection was similar between groups (Table 2). Relative to stocking rate trials with beef cattle on adjacent pastures, grazing pressures which allowed for more than 100 lb dry matter forage per 100 lb body weight were designated as light stocking rates and resulted in maximum individual animal performance (Rouquette et al., 1984). The magnitude of the grazing pressures expressed as pounds of dry matter forage per 100 lb body weight, along with visual observations, suggested that sufficient forage was available to allow for selective grazing within each pasture. However, with the advance in chronological and physiological maturity of the bermudagrass, there was an increased incidence of selective or spot-grazing behavior in both the PO and PF pastures. Although not quantitatively measured in this trial, horses in the PO pastures grazed for longer periods of time than did horses in the PF pastures because the PF group tended to anticipate feeding.

Table 3 shows a summary of the growth data taken during the grazing period. There were no differences in height growth between the two treatments as both sets of horses gained nearly 2 inches during the 201-day trial. Respective height gains for colts and fillies were 2.0 and 1.8 inches for PO and 2.2 and 1.2 inches for PF. The relatively small average daily change in height at the withers may be due to the age of the horses when the trial was initiated. Certainly the most rapid stages of skeletal growth occurred prior to the yearling stage.

Horses assigned to the PF treatment gained more weight than did horses on the PO treatment ($P<0.01$)

TABLE 1. PERIODIC FORAGE AVAILABILITIES AND GRAZING PRESSURES

	Treatments			
	Pasture Only		Pasture + Feed	
Date	lb DM/A[1]	lb DM/100 lb BW[2]	lb DM/A	lb DM/100 lb BW
Mar. 15	2,550	192	2,300	181
Apr. 27	3,996	275	5,854	396
May 29	2,719	184	2,868	185
July 3	1,142	58	742	40
Aug. 28	5,227	270	6,224	309
Oct. 2	3,110	154	4,675	222

[1]Pound of dry matter forage/A.
[2]Pound of dry matter forage/100 lb body weight.

TABLE 2. PERCENT PROTEIN AND IN VITRO DRY MATTER DIGESTIBILITY (IVDMD) OF FORAGE IN PASTURE TREATMENTS

	Treatments			
	Pasture Only		Pasture + Feed	
Date	Protein	IVDMD	Protein	IVDMD
	Percent		Percent	
April 4	19.0	76.2	18.8	75.2
May 10	17.5	73.0	20.0	76.7
May 24	9.9	61.7	11.7	65.8
June 11	10.6	55.7	10.9	53.0
June 29	10.2	49.5	11.4	55.0
July 18	16.4	61.3	16.7	59.0
Aug. 1	16.3	58.6	15.1	60.0
Aug. 15	13.8	58.4	14.2	58.4
Sept. 6	11.1	48.0	11.3	50.4
Oct. 2	10.8	49.5	11.0	50.2

TABLE 3. SUMMARY OF GROWTH DATA DURING GRAZING PERIOD

	Treatments	
Item	Pasture Only	Pasture + Feed
Number of animals	6	6
Height at withers, inches		
Initial	54.1	52.8
Gain	1.9	1.7[3]
Avg. Daily	0.0095[3]	0.0085[3]
Weight, lb		
Initial	665	637
Gain[1]		
Period 1	72.5[3]	140.5[4]
Period 2	118[3]	112[3]
Period 3	35.5[3]	40.5[3]
Total	226	293[4]
Avg. Daily		
Period 1	0.97[3]	1.87[4]
Period 2	1.30[3]	1.23[3]
Period 3	1.01[3]	1.16[3]
Total	1.12[3]	1.46[4]
Stocking rate[2], Avg. horse-equiv./A	3.1	3.2
Gain/A[2], Total	706[3]	937[4]
Condition Score, Final	4.2[3]	5.9[4]
Rump Fat, Final	0.76[3]	0.90[3]
Rib Fat, Final	0.89[3]	1.30[4]

[1]Period 1, Mar. 15 to May 29 (75-days); Period 2, May 29 to Aug. 28 (91-days); Period 3, Aug. 28 to Oct. 2 (35-days); Total, Mar. 15 to Oct. 2 (201-days).
[2]Gain per animal x stocking rate = gain/A (1 horse equivalent = 700 lb).
[3,4]Means within rows with different superscripts differ ($P < 0.01$).

(Table 3). However, a closer examination of the weight gain data showed that the weight gain advantage of horses on PF over horses on PO occurred during the winter pasture period. During the winter pasture period (period 1) the average daily gain (ADG) of horses on PF was 1.87 lb; whereas, the ADG of horses on PO was 0.97 lb. Thus, the ADG from PF horses was twice that from PO horses ($P<0.01$). Similar trends between fed and non-fed animals grazing winter pasture have been observed with cattle during the first 60 to 75 days of the grazing period (Rouquette et al., 1982). However, it is not clear as to whether the gain advantage of PF over PO horses was a result of supplemental energy, dry matter, or a combination of both these and other digestive factors.

There were no differences in ADG of horses on either PF or PO during the exclusive bermudagrass grazing period (June to October). The horse ADG from May 29 to August 28 was slightly less than 1.3 lb; whereas, the ADG of horses from August 28 to October 2 when both groups of horses were receiving supplemental feed was approximately 1.0 lb/head/day. Although there were no differences in ADG between the two groups of horses, those horses on PF gained 1.16 lb/day; whereas, those on PO gained 1.01 lb/day. It was anticipated that the PO horses would make some compensatory gains durng this 35-day period. However, the feed did not have an additive nor a compensating effect which may have been due partially to a change in grazing behavior. The horses on the PO treatment tended to behave more like the horses on the PF treatment in that they anticipated a feeding period rather than conducting their previous foraging habits. The overall ADG during the trial was different among treatments, 1.12 for PO and 1.46 for PF, ($P<0.01$) and were similar in magnitude to gains of thoroughbred horses which received similar levels of supplemental feed during the growing phase (Wooden et al., 1984.)

Estimates of body condition were made by condition scoring and electronic scanning of subcutaneous rib and rump fat (Table 3). At the end of the trial, horses on the PF treatment had higher ($P<0.01$) body condition scores, 5.9, than horses on the PO treatment 4.2. There were no differences in rump fat of horses between treatments as the rump fat thickness was estimated at approximately 0.8 inches. Differences in rib fat ($P<0.01$) of horses did occur between treatment with those on PO with 0.89 inches and those on PF with 1.30 inches fat thickness.

In summary, yearling horses which started the 201-day trial receiving 8.3 lb/head/day of a 14 percent protein supplement gained more and were fatter than horses which received pasture only. However, the weight gain advantage was attributable to the winter pasture period and not the bermudagrass period. Additionally, these kinds of improved pastures in the southeastern United States are capable of stocking rates in excess of 3.0 horses/A (700-lb equivalent) and can produce more than 900 lb/A gain during the development period. The use of exclusive forage rations for yearling horses was determined to be a biologically feasible method of development, however, the activity and training schedules of the yearlings should be considered.

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Influence of Grazing Frequency and Time of Grazing on Bite Rate

G. KANYAMA-PHIRI AND B. E. CONRAD

Summary

Bite rate of cows and yearling heifers grazing wheat pastures 2 hours every day, 2 hours every other day, or 2 hours every third day were monitored throughout the winter grazing season. Cows maintained a higher bite rate than heifers throughout the season. The bite rate of both cows and heifers decreased with time. There was also a linear decrease in bite rate with plant height. The bite rate of cows decreased 1.9 bites per minute with each one-inch increase in plant height.

Introduction

The use of winter temporary pastures for commercial cow/calf operations are normally not a profitable endeavor because of the expense involved in the establishment and growing of these pastures, the low carrying capacity compared to warm-season perennial pastures, and the net returns to investment in the form of saleable liveweight grains. Under continuous grazing, dry matter losses due to trampling, defecation, and urine spotting can be quite significant and will vary greatly depending on the soil type and winter moisture conditions. But, because of the high quality characteristics of the cool-season annuals and their ready acceptance by livestock, alternate methods to continuous grazing may be feasible.

The study was designed to evaluate limited grazing as a possible alternative for meeting the nutritive require-

KEYWORDS: Bite rate/grazing/cows/heifers.

ments of cows and yearling heifers during the winter. Frequency of grazing and bite rate on temporary cool-season pastures were monitored throughout the winter.

Procedure

Fifteen first calf heifers and 15 short yearling heifers in each of three treatment groups were wintered on a sorghum - sudan hay (round bales) and allowed to graze wheat pastures either 2 hours everyday, 2 hours every other day, or 2 hours every third day. Hay was rationed one roll at a time. Only after it was all eaten was another one made available.

Three cows and three heifers were selected from each treatment group as tester animals. Bite rates were determined after 30 minutes of grazing and again after 90 minutes of grazing by visually counting number of bites per unit of time. Time was recorded to the nearest 0.1 second using a standard stop watch. Five observations were made on each animal at each time period over three growth periods (December 22 - January 11, January 14 - February 6, March 1 - April 15).

The pastures were monitored during each grazing period for dry matter yield and plant height. Average plant height was determined by taking 25 measurements in each pasture. Yield was determined by hand harvesting three 3-foot strips.

Results

Table 1 shows the bite rate for each period for the cows and heifers after 30 and 90 minutes of grazing. The bite rates for both cows and heifers in each treatment decreased with time.

In general there was a negative linear relationship between bite rate and pasture height. In heifers on treatment A this relationship accounted for 62 and 67 percent of the variation in bite rates after 30 and 90 minutes of grazing, respectively. On the other hand, only 9.6 and 24 percent of the variation in the bite rate of the cows could be accounted for by plant height. A similar relation was observed in treatment B when the animals were grazed for 2 hours every other day. The regression equation for cows and heifers following 30 minutes of grazing reflects that for every inch increase in the height of the standing forage the rate of biting for cows and heifers will decrease by 1.9 and 3.1 bites per minute. However, after 90 minutes of grazing the bite rates of cows and heifers decreased by 5.6 and 4.6 bites per minute, respectively. Those animals allowed to graze 2 hours every third day also showed similar decreases with time. The decrease in bite rate after the 90 minutes compared to the rate after the first 30 minutes is probably related more to rumen fill. Bite size apparently had a significant influence on bite rate. As the forage became taller, the bites became larger and the amounts required for a bolus were reduced. Bite size as measured only on the last period.

TABLE 1. EFFECTS OF GRAZING TREATMENTS ON BITE RATE OF COWS AND HEIFERS ON WHEAT PASTURE

Period[1]	Treatment[2]	Bite Rates After 30 min. Grazing		Bites/minute After 90 min. Grazing	
		Cows	Heifers	Cows	Heifers
	A	49	36	41	28
1	B	55	52	43	43
	C	47	41	44	34
	A	59	53	49	44
2	B	57	59	51	51
	C	60	54	50	48
	A	65	63	57	54
3	B	66	67	53	49
	C	66	66	55	59

[1] 1 = December 19, 1984 to January 19, 1985
2 = January to February 1985
3 = March to April 1985

[2] A = Graze every day
B = Graze every other day
C = Graze every third day

Influence of Grazing Pressure on Forage Digestibility, Intake, and Liveweight Gain

L. D. ROTH, F. M. ROUQUETTE, JR., AND W. C. ELLIS

Summary

The effects of grazing pressure on organic matter intake (OMI), organic matter digestibility (OMD) of the diet, and average daily gain (ADG) by cattle were evaluated with 'Marshall' ryegrass-'Mt. Barker' subterranean clover-Coastal bermudagrass pastures. A put-and-take, variable stocking rate technique was used to establish four grazing pressure levels (high, H; medium high, MH; medium low, ML; and low, L). Each grazing pressure level was stocked with two esophageal fistulated yearling steers, four lactating cows and their suckling calves, and five stocker calves. The neutral detergent fiber (NDF) content of the diet of the esophageal fistulated steers decreased ($P<0.01$) as grazing pressure level increased. The OMD of the diet was highest ($P<0.01$) at the MH and L grazing pressures. The OMI of fistulated steers and lactating cows was highest ($P<0.01$) on ML, and lowest on H pastures. In contrast, the OMI by the suckling calves declined ($P<0.01$) as the grazing pressure level was reduced. The ADG of stocker calves, suckling calves, and lactating cows declined ($P<0.01$) as grazing pressure level increased. The results of this study indicated that although diet quality was improved as grazing pressure level increased, the greater competition for the available forage restricted the nutrient uptake of cattle on the H grazing pressure and this resulted in a depressed ADG.

KEYWORDS: Coastal bermudagrass/stocking rate/animal performance/intake/digestibility.

Introduction

The performance of the individual grazing animal generally decreases as grazing pressure is increased, while a simultaneous increase in total liveweight gain per unit of land is noted. These responses to grazing pressure appear to be mediated by the interactive factors at the plant-animal interface and their influence on the quantity and quality of forage consumed by the grazing animal. The exact relations at the plant-animal interface remain largely conceptual and qualitative. The objectives of this study were to evaluate the influence of grazing pressure on forage intake and digestibility and liveweight gain of cattle grazing Coastal bermudagrass.

Procedure

Coastal bermudagrass was oversown with 'Mt. Barker' subterranean clover and 'Marshall' ryegrass and grazed from February to September. Four contiguous pastures, situated on a Darco soil and varied in size, were grazed at four levels of grazing pressure to obtain the desired quantities of available forage (Table 1) as well as the mean grazing pressures (lb forage dry matter/100 lb animal liveweight).

Each pasture was continuously grazed with a grazing herd consisting of two yearling esophageal and rumen fistulated Brahman steers, four F-1 Brahman x Hereford cows and their Simmental-sired suckling calves, and five Brahman crossbred stocker calves. Cows with fall-born (October and November) calves were used until July 12 when the calves were weaned, and then replaced by cows with spring-born (February and March) calves. A put-and-take, variable stocking rate, using cow and calf pairs or dry cows as regulators, was employed to maintain the desired levels of available forage.

The diet of cattle at each grazing pressure level was determined by collection of esophageal extrusa samples from the esophageal fistulated steers present in each pasture at approximately 2-week intervals. To avoid altering the grazing behavior due to fasting (Sidahmed et al., 1977) extrusa samples were collected during peak grazing periods without previously restricting the animals from feeding. The extrusa samples were analyzed for proportion of leaf and stem material, was well as neutral detergent fiber content (NDF) of dietary leaf and stem material by a modification of the procedures of Goering and Van Soest (1970). This paper will present the NDF content of the diet as a whole, based on the dietary leaf/stem proportions and their respective NDF contents.

Intake digestibility trials began on June 21 (trial 1), August 15 (trial 2), and September 19 (trial 3). Esophageal extrusa was soaked in a solution of either La or Yb and administered through a gelatin capsule as a pulse dose particulate marker for estimating fecal output (FO). Fecal grab samples were collected serially post-dose for 5 days. The fecal samples were ground to pass a 2 mm screen in a Wiley mill. The esophageal extrusa from the fistulated steers and fecal samples from each animal were analyzed for indigestible NDF (INDF) content. The INDF content was defined as the organic matter insolubles in a neutral detergent solution after a 6-day in vitro fermentation. The INDF concentration was expressed as a fraction of the organic matter content (OM) of the extrusa and fecal samples. The INDF of esophageal extrusa collected from the fistulated steers at each grazing pressure level was used as the extrusa INDF for the cows and calves at that grazing pressure level. Organic matter digestibility (OMD) was calculated as:

$$\text{OMD} = 1 \quad \frac{\text{INDF of estrusa OM}}{\text{INDF of fecal OM}}$$

Samples of the Yb- and La-labelled extrusa administered to each animal and fecal samples were analyzed for market concentration, on an OM Basis, by neutron-activation. Estimates of daily FO were computed by fitting a one-compartment, time-dependent non-linear regression model to the marker concentration of the fecal samples as obtained serially post-dose. Organic matter intake (OMI) was calculated as:

$$\text{OMI} = \frac{\text{FO}}{\text{1-OMD}}$$

The effects and interaction of grazing pressure level, trial, date, and class of cattle were analyzed using the General Linear Model procedure of the Statistical Analysis System (SAS, 1982).

TABLE 1. PASTURE SIZE, TARGETED AND ACHIEVED AVAILABLE FORAGE, AND RESULTANT MEAN GRAZING PRESSURES FOR COASTAL BERMUDAGRASS

	Grazing pressure level			
Item	High (H)	Medium high (MH)	Medium low (ML)	Low (L)
Pasture size, A	2.3	3.2	5.3	5.3
Available forage, lb dry matter/A				
Targeted	900	1,800	2,700	4,500
Achieved[1]	980	1,729	2,480	3,971
Grazing Pressure[1] lb forage dry matter/ 100 lb animal wt	12.0	38.9	70.5	156.4

[1]Mean values for study period.

Results and Discussion

The NDF content of the diet of the fistulated steers differed ($P<0.01$) among the grazing pressure levels as increased grazing pressure level decreased the NDF content (Table 2). In addition, differences ($P<0.01$) existed among the measurement dates. The NDF content of the diet at the H, MH, and ML fluctuated in response to changes in the sward. The decrease in NDF content of the diet noted September 4 for the H, MH, and ML occurred after forage growth was initiated by rainfall. The stability of NDF content of the diet at the L was reflective of the greater amount of forage available per animal; thereby, allowing a similar diet to be selected throughout the study. Further, the absence of a change in NDF content of the diet at the L indicated a

TABLE 2. THE NEUTRAL DETERGENT FIBER (NDF) CONTENT OF THE DIET OF STEERS GRAZING COASTAL BERMUDAGRASS AT FOUR GRAZING PRESSURE LEVELS

Date	Grazing pressure level: High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	NDF percent			
June 24[1]	64.67 ± 3.28[3]	65.94 ± 4.15	69.42 ± 2.01	70.38 ± 3.32
July 15[2]	62.05 ± 0.68	69.23 ± 4.16	70.02 ± 6.48	73.07 ± 1.65
Aug. 2[1]	61.58 ± 3.57	70.44 ± 2.08	72.48 ± 3.78	72.53 ± 1.83
Aug. 20[1]	63.08 ± 4.06	68.72 ± 1.53	69.85 ± 4.08	72.53 ± 3.85
Sept. 4[2]	49.73 ± 1.68	66.23 ± 2.70	66.22 ± 5.46	72.80 ± 1.69
Sept. 19[1]	60.77 ± 3.67	70.94 ± 3.07	71.80 ± 2.40	72.25 ± 3.96
Mean	60.87	68.69	70.20	72.18

[1]N = Six samples/grazing pressure level.
[2]N = Four samples/grazing pressure level.
[3]Values are mean ± Standard deviation.

more mature sward that did not exhibit an increase in forage growth with added rainfall.

Differences (P<0.01) in OMD of the diet existed among grazing pressure levels, trials, and classes of cattle (Table 3). Part of any differences among classes of cattle may be the result of using the INDF content of the diet of the fistulated steers to calculate the OMD of the diet by the lactating cows and suckling calves. Neglecting grazing pressure levels, bermudagrass consumed by the fistulated steers had the highest mean OMD, with the diet selected by the suckling calves having the lowest mean OMD of the diet. The slightly depressed OMD of the diet consumed by the suckling calves may be the result of lactose depressing cellulose digestibility (Bailey and Orskov, 1974). The seasonal decline in OMD of the diet measured at the MH, ML, and L was reflective of the increase in dietary stem material and NDF content.

The OMI differed among grazing pressure levels (P<0.05), trials (P<0.01), and class of livestock (P<0.001) (Table 4). The fistulated steers at the H, MH, and L had a greater OMI at trial 2 than trials 1 and 3. However, the lowest OMI for the fistulated steers at ML occurred at trial 2. The fistulated steers at the ML had the greatest season-mean OMI, while the MH steers had the lowest season-mean OMI. The OMI by the suckling calves declined through the season except for those at the H which had an increase in OMI at trial 2. The lower OMI by the suckling calves during trial 2 and 3, as compared to trial 1, resulted from the calves younger age and probable greater milk consumption due to dams' stage of lactation. The season-mean OMI by suckling calves increased as grazing pressure level increased.

The OMI by lactating cows increased from trial 1 to trial 2, and declined thereafter except for the lactating cows at the H which decreased in OMI throughout the season. The increase in OMI by lactating cows at MH, ML, and L was reflective of the replacement of the fall-calving cows with spring-calving cows which were at an earlier stage of lactation. From trial 2 to trial 3, the decline in OMI by lactating cows at all grazing pressure levels corresponded to a period of declining OMD of the diet. In addition, the continuous decline in OMI by lactating cows at the H resulted from increased competition for forage at this grazing pressure level.

The ADG of cattle in this study differed (P<0.01) among grazing pressure levels, periods and class of livestock (Tables 5, 6, 7). The ADG of stocker calves (Table 5) declined as the season progressed and tended to

TABLE 3. THE ORGANIC MATTER DIGESTIBILITY (OMD) OF THE DIET BY FISTULATED STEERS, SUCKLING CALVES, AND LACTATING COWS GRAZING COASTAL BERMUDAGRASS AT FOUR GRAZING PRESSURE LEVELS

	Grazing pressure level (GPL): High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	OMD percent			
Fistulated Steers				
trial 1	59.0 ± 9.5[1 2]	59.4 ± 3.6	57.3 ± 4.2	57.0 ± 2.3
trial 2	43.2 ± 7.8	59.9 ± 3.7	51.5 ± 1.6	52.2 ± 4.0
trial 3	57.8 ± 7.7	38.7 ± 8.0	45.2 ± 5.0	53.0 ± 5.2
Mean	53.3	52.7	51.3	54.1
Suckling Calves				
trial 1	59.6 ± 3.5[3]	60.9 ± 3.9	60.4 ± 3.9	60.8 ± 2.9
trial 2	42.2 ± 5.6	51.7 ± 5.1	43.6 ± 5.7	48.3 ± 4.8
trial 3	52.1 ± 6.9	43.3 ± 6.1	44.3 ± 3.0	46.3 ± 2.7
Mean	51.3	51.9	49.4	51.8
Lactating Cows				
trial 1	62.7 ± 2.9[4]	62.7 ± 2.5	61.1 ± 3.1	57.9 ± 3.4
trial 2	47.6 ± 7.0	52.8 ± 4.3	46.4 ± 4.5	50.4 ± 5.3
trial 3	44.5 ± 6.3	46.3 ± 6.5	47.5 ± 3.4	48.7 ± 4.4
Mean	51.6	53.9	51.7	52.3

[1]N = Four samples from each of two steers/GPL/date.
[2]Values are mean ± Standard deviation.
[3]N = Four samples from each of four calves/GPL/date.
[4]N = Four samples from each of four cows/GPL/date.

TABLE 4. THE ORGANIC MATTER INTAKE (OMI) BY FISTULATED STEERS, SUCKLING CALVES, AND LACTATING COWS GRAZING COASTAL BERMUDAGRASS AT FOUR GRAZING PRESSURE LEVELS

	Grazing pressure level: High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	OMI (lb OM/100 lb BW)			
Fistulated Steers[1]				
trial 1	0.69 ± 0.39[4]	1.08 ± 0.53	2.96 ± 0.85	1.57 ± 0.19
trial 2	2.24 ± 0.30	2.44 ± 0.85	2.31 ± 0.36	2.63 ± 0.50
trial 3	1.58 ± 0.86	0.95 ± 0.39	2.93 ± 0.45	1.46 ± 0.30
Mean	1.50	1.49	2.73	1.89
Suckling Calves[2]				
trial 1	1.60 ± 0.49	1.56 ± 0.56	1.78 ± 0.63	1.07 ± 0.66
trial 2	1.12 ± 0.38	1.03 ± 0.45	0.98 ± 0.27	0.88 ± 0.32
trial 3	0.62 ± 0.08	0.86 ± 0.26	0.61 ± 0.09	0.83 ± 0.06
Mean	1.11	1.15	1.12	0.93
Lactating Cows[3]				
trial 1	1.77 ± 0.60	1.43 ± 0.44	2.05 ± 0.99	1.34 ± 0.27
trial 2	0.82 ± 0.09	2.59 ± 0.75	2.83 ± 0.61	1.92 ± 0.78
trial 3	0.62 ± 0.17	1.18 ± 0.34	1.51 ± 0.33	1.82 ± 0.18
Mean	1.07	1.73	2.13	1.69

[1]Two steers/grazing pressure level.
[2]Four calves/grazing pressure level.
[3]Four cows/grazing pressure level.
[4]Values are mean ± Standard deviation.

TABLE 5. THE AVERAGE DAILY GAIN OF WEANED STOCKER CALVES GRAZING CLOVER-RYEGRASS-BERMUDAGRASS AT FOUR GRAZING PRESSURE LEVELS

Date	Grazing pressure level (GPL)			
	High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	Pound/animal/day[1]			
Feb. 23 to Mar. 29	2.40 ± 0.46[2]	3.00 ± 0.70	2.88 ± 0.37	3.08 ± 0.31
Mar. 20 to May 23	0.24 ± 0.46	1.2 ± 0.48	1.4 ± 0.18	1.7 ± 0.59
May 23 to June 16	1.0 ± 0.18	1.4 ± 0.42	1.8 ± 0.51	2.0 ± 0.77
June 16 to July 12	0.79 ± 0.59	1.7 ± 0.51	1.3 ± 0.46	1.5 ± 0.48
July 12 Aug. 10	-2.4 ± 0.95	0.40 ± 0.44	1.0 ± 0.31	1.0 ± 0.35
Aug. 10 to Sept. 26	-0.02 ± 0.57	0.55 ± 0.68	1.0 ± 0.33	0.90 ± 0.81
Mean Feb. 23 to Sept. 26	0.51	1.2	1.5	1.8

[1]N = Gain of five animals/GPL/date.
[2]Values are mean ± Standard deviation.

TABLE 6. THE AVERAGE DAILY GAIN OF SUCKLING CALVES GRAZING CLOVER-RYEGRASS-BERMUDAGRASS AT FOUR GRAZING PRESSURE LEVELS

Date	Grazing pressure level (GPL)			
	High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	Pound/animal/day[1]			
Feb. 23 to Mar. 29	3.43 ± 0.35[2]	3.34 ± 0.66	3.23 ± 0.46	3.30 ± 0.29
Mar. 29 to May 23	1.7 ± 0.35	2.40 ± 0.35	2.40 ± 0.15	2.79 ± 0.09
May 23 to June 16	1.0 ± 0.51	1.5 ± 0.44	2.42 ± 0.13	2.77 ± 0.46
June 16 to July 12	0.51 ± 0.64	1.2 ± 0.73	1.3 ± 0.22	1.90 ± 0.48
July 12 to Aug. 10	1.1 ± 0.35	2.20 ± 0.18	2.24 ± 0.26	2.93 ± 0.48
Aug. 10 to Sept. 26	0.64 ± 0.40	1.80 ± 0.31	1.9 ± 0.59	2.46 ± 0.18
Mean	1.4	2.1	2.2	2.64

[1]N = Gain of four suckling calves/GPL/date.
[2]Vlaues are mean ± Standard deviation.

increase as grazing pressure was reduced. As displayed in Table 6, the suckling calves on the reduced grazing pressure levels had a greater ADG than those suckling calves on the high grazing pressure levels. The ADG of fall-born suckling calves decreased with advancing date in the study until weaning on July 12. Similarly, the spring-born suckling calves showed a decline in ADG during the study period. The ADG of the lactating cows (Table 7) decreased as grazing pressure was increased. No definite seasonal trend in ADG was evident for the fall-calving cows, while a decline in ADG was noted for the spring-calving cows.

The results of this study indicated that the NDF content of the diet tended to decrease as the grazing pressure level was increased; however, the OMD of the

TABLE 7. THE AVERAGE DAILY GAIN OF LACTATING COWS GRAZING CLOVER-RYEGRASS-BERMUDAGRASS AT FOUR GRAZING PRESSURE LEVELS

Date	Grazing pressure level (GPL)			
	High (H)	Medium high (MH)	Medium low (ML)	Low (L)
	Pound/animal/day[1]			
Feb. 23 to Mar. 29	-0.09 ± 0.51[2]	-0.37 ± 0.57	0.26 ± 0.59	0.86 ± 0.07
Mar. 29 to May 23	-1.3 ± 0.04	0.70 ± 0.57	0.84 ± 0.33	2.1 ± 0.68
May 23 to June 16	0.73 ± 0.90	-0.09 ± 0.88	0.92 ± 1.0	0.95 ± 0.84
June 16 to July 12	-0.62 ± 2.1	-0.15 ± 1.8	-0.09 ± 0.42	-0.33 ± 1.3
July 12 to Aug. 10	-3.59 ± 0.77	-0.02 ± 0.86	0.33 ± 0.62	0.73 ± 0.95
Aug. 10 to Sept. 6	-3.96 ± 1.9	-2.22 ± 1.8	-1.3 ± 0.29	-2.53 ± 0.68
Mean	-1.6	-0.33	0.35	0.59

[1]N = Gain of four lactating cows/GPL/date.
[2]Values are mean ± Standard deviation.

diet was greatest at the MH and L. The OMI measured was greatest at the ML and lowest at the H for the fistulated steers and lactating cows, while a theorized increased milk production with reduced grazing pressure level resulted in a trend of declining OMI by suckling calves as grazing pressure level was lowered. A restriction in nutrient intake from forage or milk reduced the ADG of stocker calves, lactating cows and suckling calves at the high levels of grazing pressure. The reported trends reflect the interactive nature of factors at the plant-animal interface and their consequential effect on animal performance.

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Evaluation of Bermudagrass Selections for South Texas (1983-84)

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Summary

Ten bermudagrass selections *(Cynodon dactylon* and *Cynodon nlemfuensis)* plus a local ecotype of African stargrass *(Cynodon plectostachyus)* were evaluated for forage dry matter production during 1983 and 1984. Plots were harvested at 6-week intervals and annual dry matter yields ranged from 5 tons/A for NK-37 to more than 7.5 tons/A for Tifton 68. Of the released lines evaluated in this study, Tifton 68 and Brazos yielded significantly more than Coastal, Tifton 44, or NK-37.

Introduction

Bermudagrass is considered generally to be the most important pasture species in Texas. During the past 20 years, a considerable effort has been devoted to the evaluation of promising new hybrids for improved tolerance, yield, and forage quality at many locations throughout Texas (Holt 1984; Holt and Conrad, 1981, 1984; Rouquette and Florence, 1984). However, little information is available concerning the performance of these hybrids under irrigated sub-tropical conditions. The objective of this study was to evaluate the production potential, disease tolerance, and insect tolerance of selected bermudagrass hybrids under irrigation at Weslaco.

Procedures

Five experimental bermudagrass selections (B-1, B-2, B-12, B-13, and P-7) a local ecotype of African stargrass, and five commercially available cultivars (Brazos, Coastal, NK-37, Tifton 44, and Tifton 68) were established in 200-square foot plots in April 1983. The plots were arranged in a randomized complete block design with three replications on a Raymondville clay loam soil.

During establishment, the plots were irrigated at 6-week intervals to facilitate establishment. Clipping was initiated in July 1983 when approximately one-half of the plots were completely covered with vegetation.

Fifty pounds per acre of nitrogen (N), phosphorus (P), and potassium (K) were applied to the plots in spring 1983 and 1984. Thereafter, 50 lb/A of N was applied at 6-week intervals. Supplemental irrigation was applied at 6-week intervals regardless of rainfall.

Forage yields were determined by harvesting a 3.3 x 17-foot swath from each plot. Grab samples were taken and dried at 60°C for 48 hours to determine dry matter percentage.

KEYWORDS: Bermudagrass hybrids/forage yield/cultivars.

Results

Cumulative dry matter production for 1983 and 1984 is shown in Table 1. Differences in total dry matter production for 1983 were directly related to rate of establishment with Tifton 68, B-1, B-2, B-12, B-13, and African stargrass being superior to other entries for rate of establishment.

Dry matter yields for 1984 were reduced greatly due to drought. Although plots received irrigation at 6-week intervals, low infiltration rates apparently restricted the recharge of the soil profile.

The cultivars Tifton 68, Brazos, and selections B-12 and B-13 were the highest yielding entries in 1984. Coastal, which has been shown consistently to be one of the highest yielding entries at College Station (Holt, 1984; Holt and Conrad, 1981) and Overton (Rouquette and Florence, 1984) ranked eighth among 11 entries during the first 2 years of evaluation at Weslaco (Table 2).

Most entries showed adequate levels of disease and insect tolerance during 1983 and 1984. African stargrass and line B-2 were both found to be susceptible to leaf rust. The other entries displayed little susceptibility under field conditions.

All entries were affected by leaf feeding beetles of the family Chryromelidae throughout the 1983 and 1984

TABLE 1. BERMUDAGRASS YIELDS AT WESLACO, TEXAS

		Year	
Entry	1983	1984	Total
Tifton-68	14,035	17,413	31,448
B-13	14,219	16,766	30,985
B-12	13,588	17,071	30,659
B-1	12,036	15,882	27,918
Brazos	9,110	17,234	26,344
P-7	11,273	13,904	25,177
B-2	12,232	12,817	25,050
Coastal	10,419	14,117	24,536
Stargrass	10,152	13,756	23,908
Tifton 44	8,120	13,018	21,138
NK-37	8,968	11,490	20,457
Mean	11,287	14,861	25,926
LSD (0.05)	2,688	3,711	4,409

TABLE 2. RELATIVE RANKING OF DRY MATTER YIELDS OF BERMUDAGRASS CULTIVARS[1]

	Location		
Entry	College Station[2]	Weslaco[3]	Overton[3]
B-13	1	2	4
P-7	2	6	-
Coastal	3	8	3
B-12	4	3	5
B-1	5	4	16
Brazos	6	5	-
Tifton 44	7	10	13
B-2	8	7	14

[1]Rankings; 1 = highest yielding cultivar.
[2]3-year average.
[3]2-year average.

summers. However, these insects did little damage to the plants and there were apparently no differences in susceptibility between genotypes.

Likewise, all genotypes were susceptible to rice stem borer *(Eoreuma loftini* Dyar). While all genotypes were susceptible, the number of tillers damaged was generally below 1 percent in small-plot evaluations. However, a large increase block of Tifton 68 was shown to be a desirable host for rice borer and the cultivar should be regarded as very susceptible to damage by this insect.

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Forage Production Potential of Sixteen Bermudagrass Selections

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Summary

Sixteen bermudagrass hybrids were compared for seasonal and total dry matter production during each year of a 3-year period. Yields were hand-clipped from small areas within each plot and complete plot defoliation was achieved using cows and calves. Thus, all hybrids were exposed to the physical effects of grazing and trodding. Because of dry conditions during July through September 1982 and 1984, bermudagrass yields were similar for those 2 years. Slightly higher mid-summer rainfall in 1983 allowed total yields in excess of 12 tons dry matter. The 3-year average yields indicated that Coastal bermudagrass continued to produce as much forage as any of the new plant breeding lines tested. And, because of a mid-summer reduction in dry matter production which was linked directly to a lack of drought resistance, Tifton 44 bermudagrass was one of the lowest forage producing hybrids evaluated.

KEYWORDS: Bermudagrass/dry matter production/ Coastal/Tifton 44.

Introduction

Coastal bermudagrass has been used extensively throughout the South and Southeastern United States for a pasture and hay crop for more than 35 years. Plant breeders have shown that substantial improvements in nutritive value were possible with certain hybrid bermudagrasses. Thus, there are plant breeding materials available which are potential replacements for Coastal bermudagrass. This trial was initiated to evaluate some of the hybrid bermudagrasses for dry matter, stand maintenance and vigor, and to compare these selections with Coastal and Tifton 44 bermudagrass.

Procedure

Fourteen bermudagrass hybrids from Dr. Glenn Burton's breeding program (USDA, Tifton, Georgia), along with Coastal and Tifton 44 bermudagrasses, were planted in 8 x 20 feet plots. An 8-foot fallow border was left between all plots to prevent soil contamination from the vigorous, stoloniferous types. Plots were established in 1981 and were not harvested until the 1982 growing season. Two, 1-square foot, quadrants were hand-clipped from each plot when grass reached approximately 8 to 12 inches in height. During 1982, plots were harvested to a 2-inch stubble height; whereas, in 1983 and 1984, plots were harvested to ground level (0-inch stubble height). After collecting yield data from the plots, cows and calves were allowed to graze the entire area. A large number of animals were used so that the plots were grazed to an approximate 1-inch height as rapidly as possible (2-day period). Animals were removed from the plots and the grass was allowed to grow until the next harvest period. Fertilizer was applied during the growing season for annual rates of 580-100-100, 340-100-100, and 245-100-100 lb/A N-P_2O_5-K_2O,respectively for 1982, 1984, and 1984. A high nitrogen rate was used during 1982 to discourage spot grazing due to defecation areas. During the second year and third years, however, spot grazing was not a problem in the plots.

Results and Discussion

Monthly rainfall during the bermudagrass growing seasons of 1982-84 and their deviation from a 17-year average are shown in Table 1. Drought-like conditions

TABLE 1. MONTHLY RAINFALL DURING A 3-YEAR EVALUATION OF BERMUDAGRASS SELECTIONS

Month	1982	1983	1984	17-year Average
April	3.87	0.24	1.58	3.87
May	5.48	7.22	2.74	4.40
June	4.89	8.45	1.75	4.27
July	1.40	1.57	1.75	2.89
August	0.43	2.17	0.84	1.74
September	0.74	1.18	1.35	4.02
October	6.58	2.82	9.34	4.16

TABLE 2. DRY MATTER PRODUCTION OF BERMUDAGRASS SELECTIONS DURING 1982[1]

SELECTION	5-5	5-27	6-15	6-30	7-20	8-10	9-7	10-17	TOTAL[2]
					Pounds/Acre				
T-14	2,400	1,034	2,479	1,565	3,645	2,602	1,236	1,841	16,802 A
T-7	3,096	1,078	2,290	1,476	3,183	2,400	1,205	1,985	16,711 A
T-13	3,024	1,139	2,465	1,407	3,358	2,280	1,493	1,445	16,609 A
T-9	2,304	893	2,434	1,462	3,468	2,607	850	2,292	16,308 AB
Coastal	1,872	1,059	2,815	1,383	2,848	2,590	1,277	1,406	15,250 ABC
T-12	2,376	1,193	2,470	1,260	3,144	2,184	895	1,433	14,955 ABC
T-4	2,544	806	2,237	1,178	2,525	2,530	1,013	1,846	14,679 ABC
T-3	2,592	884	1,570	1,301	2,508	1,704	979	1,428	12,965 BCD
T-5	2,232	991	2,026	1,198	2,424	1,860	550	1,538	12,818 CD
T-11	1,296	907	2,309	1,318	2,537	2,105	979	1,262	12,713 CD
T-10	1,968	855	1,728	1,325	2,753	1,399	1,387	1,003	12,417 CD
T-6	2,184	934	2,134	1,030	1,908	1,810	523	1,886	12,408 CD
T-1	1,536	922	1,894	1,128	2,237	1,618	1,092	1,447	11,873 CDE
T-2	2,088	754	1,253	996	1,913	1,493	668	1,270	10,433 DE
Tifton 44	1,752	914	1,279	1,047	2,100	1,467	756	633	9,948 DE
T-8	1,320	780	1,212	1,024	1,862	1,627	744	399	8,967 E

[1]Plots harvested to a 2-inch stubble height and fertilized with 580-100-100 lb/A N-P_2O_5-K_2O.
[2]Means in the same column followed by different letters differ ($P < 0.05$) according to LSD.

existed during the mid-summer periods of 1982 and 1984; whereas, the same 3-month period of 1983 more closely approximated the longer term average. Seasonal as well as total dry matter production from the 16 bermudagrass selections are shown in Tables 2, 3, and 4 for each of the 3-year periods. Table 5 shows the 3-year average dry matter productions and the relative rank of each hybrid. T-14, T-13, Coastal, and T-4 bermudagrasses were the top yielding hybrids; whereas, T-1, T-8, T-2, and Tifton 44 were the least productive bermudagrasses tested over this 3-year period. Tifton 44 has exhibited acceptable forage production in early spring; however, by mid-summer, its lack of drought tolerance has severely restricted forage production. Based on this trial, Tifton 44 would not be an acceptable replacement for Coastal bermudagrass on the upland, sandy, drought-

TABLE 3. DRY MATTER PRODUCTION OF BERMUDAGRASS SELECTIONS DURING 1983[1]

Selection	5-25	6-8	7-5	8-3	9-6	11-8	Total[2]
				Pounds/Acre			
T-14	4,006	2,271	4,510	5,036	5,098	4,433	25,354 A
Coastal	3,670	2,129	5,110	4,858	5,040	3,888	24,695 A
T-13	3,655	2,304	4,164	5,256	5,239	3,855	24,473 A
T-12	3,694	1,932	4,555	5,117	4,630	3,706	23,634 AB
T-7	3,384	2,009	4,431	4,714	4,253	4,297	23,088 ABC
T-11	3,744	1,678	4,670	4,795	4,723	3,358	22,968 ABC
T-9	2,361	1,747	4,507	4,819	4,263	4,750	22,447 A-D
T-6	2,774	1,618	3,929	4,512	4,997	3,703	21,533 A-E
T-10	3,089	1,836	3,941	4,210	3,792	2,789	19,657 B-F
Tifton-44	3,228	1,788	4,078	4,051	3,480	2,537	19,162 C-G
T-4	2,086	1,531	3,696	3,938	4,198	3,084	18,533 D-G
T-5	1,742	1,488	4,032	4,279	3,936	3,043	18,520 D-G
T-3	2,033	1,339	3,271	3,574	4,253	3,562	18,032 EFG
T-2	2,691	1,218	3,763	3,543	3,226	3,168	17,607 EFG
T-8	2,585	1,462	3,883	3,701	3,552	2,242	17,425 FG
T-1	1,078	617	2,911	3,492	3,240	3,771	15,109 G

[1]Plots harvested to ground level (0-inch stubble height) and fertilized with 340-100-100 lb?A N-P_2O_5-K_2O.
[2]Means in the same column followed by different letters differ ($P < 0.05$) according to LSD.

TABLE 4. THIRD-YEAR DRY MATTER PRODUCTION OF BERMUDAGRASS SELECTIONS[1]

Selection	5-23	7-20	8-27	11-12	Total
			Pounds/Acre		
Coastal	4,092	6,205	2,971	3,706	16,974 A
T-11	3,403	6,598	3,257	3,660	16,918 A
T-6	3,473	6,744	2,374	3,485	16,076 AB
T-13	3,302	5,775	3,129	3,783	15,989 AB
T-7	4,217	5,854	2,261	3,300	15,632 ABC
T-5	3,715	4,968	2,467	4,044	15,194 ABC
T-3	2,933	5,918	2,251	3,989	15,091 ABC
T-14	3,103	5,600	2,686	3,538	14,927 ABC
T-4	2,976	5,782	2,424	3,627	14,809 ABC
T-8	3,211	5,019	2,309	3,888	14,427 ABC
T-12	2,683	5,143	2,662	3,468	13,956 ABC
T-2	3,595	4,380	2,223	3,561	13,759 ABC
T-9	1,327	5,117	2,849	3,984	13,277 BC
Tifton-44	3,924	4,798	1,795	2,693	13,210 BC
T-10	3,631	4,517	1,762	2,609	12,519 CD
T-1	1,601	4,167	1,618	2,520	9,906 D

[1]Plots harvested to ground level (0-inch stubble height) and fertilized with 265-100-100 lb/A N-P_2 O_5-K_2O.
[2]Means in the same column followed by different letters differ ($P < 0.05$) according to LSD.

TABLE 5. THREE-YEAR AVERAGE OF BERMUDAGRASS YIELDS

Selection	Year 1	Year 2	Year 3	Average
			Pounds/Acre	
T-14	16,802	25,354	14,927	19,028
T-13	16,609	24,473	15,989	19,024
Coastal	15,250	24,695	16,974	18,973
T-7	16,711	23,088	15,632	18,477
T-11	12,713	22,968	16,918	17,533
T-12	14,955	23,634	13,956	17,515
T-9	16,308	22,447	13,277	17,344
T-6	12,408	21,533	16,076	16,672
T-4	14,679	18,533	14,809	16,007
T-5	12,818	18,520	15,194	15,511
T-3	12,965	18,032	15,091	15,363
T-10	12,417	19,657	12,519	14,864
Tifton-44	9,948	19,162	13,210	14,107
T-2	10,433	17,607	13,759	13,933
T-8	8,967	17,425	14,427	13,606
T-1	11,873	15,109	9,906	12,296

susceptible soils of the lower South. From the selections evaluated in this trial, Coastal remains as one of the most reliable hybrid bermudagrasses available for improved pasture and hay.

The use of cows and calves as "mob grazers" was an effective and efficient method of evaluating new cultivars for resistances to grazing pressures. However, since the defoliation scheme was established to harvest forage after some accumulation time, this technique as employed simulated rotational rather than continuous grazing. A modification of this technique may be necessary to simulate continuous grazing.

Performance of Bermudagrass Cultivars (1982)

E. C. HOLT, B. E. CONRAD, AND S. SIMECEK

Summary

Fifteen bermudagrass hybrids not previously tested at College Station along with nine other previously tested hybrids and cultivars were evaluated for yield and low temperature survival. Yields ranged from 5 tons/A to 10.6 tons/A in 1983 and 5.4 to 12.2 tons/A in 1984. At least three Georgia hybrids and all of the Oklahoma origin hybrids including those with a previous Pybas designation showed excellent field survival at 14° C temperature. Three Oklahoma hybrids and one Georgia hybrid numerically exceeded Coastal in dry matter yield in 1983 while Brazos, two Oklahoma hybrids, one Georgia hybrid, and four Pybas sources numerically exceeded Coastal in 1984. Tifton 78 (tested as Tifton 78-22) produced about 0.6 tons less forage than Coastal in 1983 and was equal to Coastal in low temperature field survival but performed poorly in 1984. Brazos appears to be equal to the best hybrids in this test and superior to most in yields and winter hardiness.

Introduction

Bermudagrass is the most important tame pasture grass in the humid areas of Texas. Numerous hybrids have been developed and some of these are in production. Coastal is by far the most extensively used bermudagrass hybrid. Both research and producer experience have indicated several important problems in bermudagrass production and utilization including forage quality, cold hardiness, stand density, tolerance to grazing, disease resistance, and yield. The order of these problems will depend on the geographic area and specific use and management of the crop. Cold hardiness is more important in North Texas while disease resistance may be more important wherever bermudagrass is grown.

KEYWORDS: Bermudagrass hybrids/forage.

Experimental Procedure

Fifteen bermudagrass hybrids not tested at College Station prior to 1982, six hybrids from previous tests, and three standard cultivars (Coastal, Tifton 44, Brazos) were planted in 1982. Sources with the prefix Tifton (Table 1) were supplied by Dr. G. W. Burton, Tifton, Georgia. Entries 6 and 7 are the same as B-1 and B-2, respectively, in the 1980 test (see report titled "Performance of Bermudagrass Hybrids and Cultivars in the Brazos River Bottom, 1981-83). All sources with the prefix 74 (Table 1, entries 13-19) were supplied by Dr. C. M. Taliaferro, Oklahoma State University. The sources with the prefix Pybas are the same as in the report listed above and came from the J. Pybas Ranch near Gainesville, Texas where they had survived two severe winters. Entry 25 (Summons Deagen) was added in 1984. Plots, 6 x 20 feet with four replications were planted using four rooted sprigs per plot in July 1982. Rate of spread was slow because of intermittent moisture stress, and slow spreading hybrids did not produce a ground cover prior to frost. The test site was fertilized with 100 lb/A nitrogen (N) per acre each on April 29 and June 27, 1983. Harvests were made on May 27, June 23, July 26, August 24, and September 29, 1983.

TABLE 1. PERFORMANCE OF BERMUDAGRASS CULTIVARS AND HYBRIDS, 1984

	Pounds of dry forage per acre					
Cultivar	4-23	5-24	6-25	9-14	11-13	Total
20 Brazos	1,906	2,618	7,724	8,737	3,315	24,300 A[1]
14 74 × 12-12	2,529	2,326	7,095	7,846	3,379	23,175 A
22 Pybas-2	3,606	2,627	6,015	7,047	3,335	22,630 A
21 Pybas-1	3,498	2,831	5,740	6,616	3,694	22,379 A-B
24 Pbyas-5	3,440	2,635	5,634	6,866	3,713	22,288 A-B
19 74 × 11-2	4,365	2,593	6,112	5,707	3,202	21,979 A-B
11 Tifton 80-10	825	1,961	5,319	7,172	4,571	19,848 B-C
23 Bybas-4	2,861	2,272	6,089	6,183	2,282	19,637 B-D
1 Coastal	1,957	2,672	5,919	5,215	3,352	19,115 C-E
17 74 × 9-1	1,056	2,216	5,747	6,612	3,320	18,951 C-E
16 17 × 17-8	1,982	1,326	4,949	6,272	3,988	18,517 C-E
18 74 × 19-1	564	1,722	5,673	7,481	2,850	18,290 C-E
5 Tifton 79-9	434	1,941	5,586	7,158	2,873	17,992 C-E
2 Tifton 44	1,245	1,615	5,447	6,643	2,468	17,418 C-E
7 Tifton 79-16	219	1,017	2,970	8,904	4,269	17,379 C-E
8 Tifton 79-17	855	2,685	3,237	6,931	3,369	17,077 C-E
6 Tifton 79-13	481	1,572	3,198	8,057	3,496	16,804 D-F
15 74 × 8-1	1,245	1,193	5,850	6,355	2,134	16,777 D-F
10 Tifton 80-5	593	1,323	2,566	7,371	4,424	16,277 E-F
12 Tifton 80-12	502	1,085	920	5,483	4,638	12,628 F-G
13 74 × 12-12	350	429	4,511	5,429	884	11,603 G-H
4 Tifton 79-6	471	601	1,483	5,401	3,521	11,477 G-H
3 Tifton 78	1,126	1,128	2,313	3,668	2,555	10,790 H
9 Tifton 80-2	0	-	1,398	4,606	5,150	11,154 H
25 Summons Deagen	0	-	629	5,210	4,865	10,704 H

[1]Total yields followed by a common letter are not significantly different (0.05 level), Duncan's Multiple Range Test.

Sprigs were removed from the plots in February 1984 following extended low temperatures in December and January (low temperatures of approximately -14°C and more than 3 days in which temperature was continuously below 0°C, planted in the greenhouse and percentage of live sprigs determined. Also, sprigs were dug, washed, placed in polyethylene bags, and exposed to -4°C temperature in a freezer for 24 hours, then planted in the greenhouse to evaluate survival.

Results and Discussion

Yields of approximately 10 tons or more were produced by light cultivars or hybrids in 1984 (Table 1). Brazos was the highest yielding cultivar followed closely by several hybrids. Spring growth (Table 1) was closely related to winter damage in the 1983-84 winter (Table 2). Total yields in 1984 also were influenced by the degree of winter damage and the rapidity of recovery from the winter damage. Tifton 80-10 showed 50 percent winter kill in the field and only 825 lb of dry matter in April, yet recovered and produced almost 10 tons of forage. Tifton 78 produced only 0.6 tons less forage than Coastal in 1983, showed very little if any stand damage in the winter of 1983-84, yet performed poorly in 1984. We have no explanation for this pattern. Hybrid 74x8-1 followed somewhat the same pattern as Tifton 78 but did not show as drastic a decline in yield as Tifton 78.

While recovery from forage damage may occur in some hybrids with total yield being acceptable, the damage introduces the possibility of weed invasion and invasion of common bermudagrass before a complete ground cover is redeveloped. Thus, winter damage involves more than loss of spring production and is a major consideration in bermudagrass evaluation programs.

Several of the Oklahoma hybrids (entries with a 74 prefix) and the Pybas sources performed satisfactorily in all of the measurements recorded to date. However, none exceeded Brazos in cold tolerance or 1984 yield. Some did become established more rapidly in 1982 and showed better early production than Brazos. Forage quality evaluations, which are not complete, will determine to a large extent whether any of these materials have promise over Brazos.

TABLE 2. SUMMARY OF YIELD AND LOW TEMPERATURE DAMAGE OF BERMUDAGRASS CULTIVARS AND HYBRIDS, 1983-84

Cultivar or hybrid	Pounds of dry forage per acre 1983	1984	Field winter kill 1983-84 (%)	Low temp. freezer damage (%)
20 Brazos	16,007 G-K[1]	24,300 A	0	10
14 74 × 12-12	21,028 A-C	23,175 A	0	10
22 Pybas-2	17,024 F-I	22,630 A	0	3
21 Pybas-1	15,386 I-L	22,379 A-B	0	25
24 Pybas-5	16,735 G-J	22,288 A-B	0	3
19 74 × 11-2	19,114 C-F	21,979 A-B	0	0
11 Tifton 80-10	23,299 A	19,848 B-C	50	60
23 Pybas-4	15,999 G-K	19,637 B-D	3	3
1 Coastal	20,117 B-E	19,115 C-E	3	28
17 74 × 9-1	17,057 F-I	18,951 C-E	0	10
16 74 × 17-8	22,114 A-B	18,517 C-E	0	23
18 74 × 19-1	17,782 E-I	18,290 C-E	0	13
5 Tifton 79-9	18,550 C-H	17,992 C-E	0	47
2 Tifton 44	17,690 E-I	17,418 C-E	3	21
7 Tifton 79-16	18,019 D-H	17,379 C-E	67	30
8 Tifton 79-17	18,770 C-G	17,077 C-E	0	20
6 Tifton 79-13	17,664 E-I	16,804 D-F	63	91
15 74 × 8-1	20,858 A-D	16,777 D-F	0	7
10 Tifton 80-5	15,572 H-K	16,277 E-F	40	56
12 Tifton 80-12	10,137 N	12,628 F-G	53	0
13 74 × 12-12	12,683 M	11,603 G-H	0	13
4 Tifton 79-6	13,020 L-M	11,477 G-H	33	45
9 Tifton 80-2	14,538 J-M	11,154 H	60	42
3 Tifton 78	18,998 C-F	10,790 H	C	47
25 Summons Deagen		10,704 H		

[1]Yields followed by a common letter are not significantly different (0.05 level), Duncan'ss Multiple Range Test.

Dry Matter Yields and Preliminary Evaluation of Forage Quality for Eight Dallisgrass Accessions and Common Dallisgrass

H. LIPPKE, G. W. EVERS AND B. L. BURSON

Summary

Eight dallisgrass accessions were compared to common dallisgrass for yield and forage quality during the 1984 growing season. Plots, arranged in a randomized block with four replications, were sampled or harvested bi-weekly. Because of severe drought from March until mid-July, yields were only half the previous 3-year average. There were no significant differences between dallisgrass entries for neutral detergent fiber or indigestible neutral detergent fiber.

Introduction

Common dallisgrass (*Paspalum dilatatum* Poir.) is well adapted to the soil and climate of southeast Texas as well as much of the Gulf coastal area of the United States. Its prostrate growth under frequent defoliation and its high forage quality relative to competitive warm-season perennial grasses make it an excellent pasture plant for a variety of grazing managements. Dry matter yields from

KEYWORDS: Dallisgrass/yield/forage quality.

common dallisgrass and from eight accessions collected in Uruguay, representing a dallisgrass biotype different from common, have been measured in plots at Angleton for three previous years. Among the accessions, the more erect types yielded more than common when rainfall was adequate, indicating a greater potential for hay production. Drought tended to eliminate differences in yield. No aspect of forage quality has previously been measured, however.

Procedure

Fertilizer application was at the rate of 50 pounds of nitrogen and 60 pounds of P_2O_5 per acre in early June, 1984 and another 50 pounds of nitrogen in early August. The plots, in four replicates, were harvested bi-monthly for yield measurement. At bi-weekly intervals within harvest period, a single plant from each plot was harvested, composited within entry, quickly dried on open pans, and ground for laboratory analyses. Samples were also taken at the bi-monthly total harvests and dried for analyses. Forage quality was characterized by measuring neutral detergent fiber (NDF) and NDF that remained undigested after 6 days of in vitro fermentation (INDF).

Results and Discussion

Very little growth occurred until late spring due to drought. Therefore, no samples were obtained for the April-May period. Samples were taken for NDF and INDF determination beginning June 11 and approximately biweekly thereafter until the end of July, when the entire plots were harvested for yield measurement. Regrowth was again sampled at biweekly intervals, and another total cutting was taken on September 26.

Dry matter yields are shown in Table 1. Although the dallisgrass accessions tended to yield more than common in 1984, none of the differences were statistically significant. The 1981-83 average is shown for comparison.

Table 2 shows the NDF and INDF values by period. Differences among entries within periods were small and statistically not significant. Differences in INDF due to sampling time within the June-July period (not shown) ranged 10 percentage units and were primarily a reflection of rainfall and the resulting new growth just prior to sampling. Overall, the NDF and INDF values indicate that the dallisgrass accessions evaluated here are equal to common dallisgrass in forage quality and may exceed common dallisgrass yields, particularly for hay production.

TABLE 1. FORAGE PRODUCTION OF DALLISGRASS ACCESSIONS AND COMMON DALLISGRASS DURING 1984 AND THE 3-YEAR AVERAGE (1981-83)

Entry	Cutting date: Aug. 1	Cutting date: Sept. 26	Total	1981-83 Average
	Pounds Dry Matter/Acre			
426	3,150	540	3,690	6,810
455	2,960	600	3,550	6,940
458	3,040	660	3,700	7,130
460	3,020	640	3,660	7,240
461	2,900	520	3,420	7,360
544	3,150	600	3,750	6,410
554	2,980	520	3,510	7,180
555	2,750	480	3,220	6,580
Common	2,720	470	3,190	6,190

TABLE 2. NDF AND INDF VALUES FOR DALLISGRASS ACCESSIONS AND COMMON DALLISGRASS FOR TWO GROWTH PERIODS IN 1984

Entry	June-July NDF	June-July INDF	August-September NDF	August-September INDF
	Percent			
426	72.7	22.8	69.8	21.1
455	73.1	22.5	70.2	19.9
458	73.6	23.5	70.4	21.2
460	73.1	23.5	71.4	22.6
461	72.3	22.9	70.8	21.7
544	73.7	23.2	70.3	21.9
554	73.0	22.6	70.3	21.9
555	71.5	21.5	71.3	21.9
Common	73.1	23.6	71.9	23.5

Yield of Spittlebug Tolerant Buffelgrass (1979-81)

M. A. HUSSEY AND W. T. W. WOODWARD

Summary

Five experimental buffelgrass cultivars with differing levels of tolerance to the Mexican spittlebug complex were evaluated for forage dry matter production at Weslaco. Dry matter yields during this study ranged from 10,400 lb/A in the establishment year to 23,000 lb/A in 1980 and 1981. During all 3 years, the forage production of the spittlebug tolerant lines was not significantly different from that of Common buffelgrass.

Introduction

The Mexican spittlebug or "Musca Pinta" is a complex of five species of insects belonging to the genera Aeneolamia and Prosapia (Table 1). Observations from Central America as well as coastal regions of Mexico have indicated that a wide range of warm-season grasses are susceptible to this pest. Buffelgrass appears to be particularly susceptible to "Musca Pinta" (Enkerlin and Morales, 1979).

KEYWORDS: Buffelgrass/Spittlebug/"Musca Pinta"/forage yield.

TABLE 1. SPITTLEBUG "MUSCA PINTA" COMPLEX

Genus	Species
Aeneolamia	postica postica (WLK)
Aeneolamia	postica compechanna (Fennah)
Aeneolamia	postica occidentalis (Fennah)
Prosapia	simulans (Say)
Prosapia	bicincta (Say)

The rapid expansion of spittlebug during the 1960's and early 1970's generated concern that the spittlebug would eventually spread throughout the South Texas Plains. In response to this potential threat, a joint research effort between scientists at Monterrey Technological Institute and The Texas Agricultural Experiment Station was initiated in the mid-1970's. The major thrust of this effort was to develop a screening methodology to facilitate selection for spittlebug-tolerant lines. These evaluations were conducted in an effort to determine the dry matter production potential of spittlebug-tolerant germplasm in South Texas.

Procedures

Selected buffelgrass germplasm, which previously had been evaluated in caged plots and subjected to different intensities of insect pressure at Monterrey, Mexico in 1975, were selected for evaluation at Weslaco (Table 2). Seedlings were started in the greenhouse before being transplanted to the field on July 5, 1979. Each plot consisted of three rows on 40-inch centers, 15 feet long and arranged in a randomized complete block design on a Willacy sandy loam soil.

Nitrogen fertilizer was applied to the plots at a rate of 76 lb/A on March 19, 1980; 93 lb/A on July 25, 1980; and 60 lb/A on August 28, 1981. The center row of each plot was harvested with a flail type small plot harvester to estimate dry matter yield. Supplemental irrigation was applied as shown in Table 3.

Results and Discussion

Dry matter yield of spittlebug-tolerant and susceptible lines of buffelgrass are shown in Table 4. Yields of both susceptible and tolerant lines were similar to that previously reported for Common buffelgrass in South Texas (Wiedenfeld et al., 1980; Woodward, 1980).

Line 35 was the highest yielding genotype in 1980 and 1981 with dry matter yields exceeding 20,000 lb/A. Given that the rankings of buffelgrass germplasm as either tolerant or susceptible are correct, then it should be possible to select for spittlebug-tolerant lines without affecting dry matter production.

Observations of tolerant and susceptible genotypes indicate that the plant structure of tolerant lines was more open, allowing light to penetrate to the ground. This open canopy structure may be a major factor contributing to a lower preference for this germplasm by the spittlebug. Research at Campo Cotazatla, Mexico has indicated pastures of Pangola digitgrass (*Digitaria decumbens* Stent). which were clipped at heights of 10 to 20 cm had lower populations of insects compared to those pastures which exceeded 20 cm (Enkerlin and Morales, 1979).

Evaluations at Monterrey, Mexico indicate that differences exist within the genus Cenchrus for tolerance to spittlebug. From evaluations in South Texas, it appears that tolerance may be incorporated into buffelgrass without sacrificing dry matter productivity. Current research in this area needs to focus on specific mechanisms of resistance (i.e., plant pubescence, canopy

TABLE 2. VISUAL RANKING RATINGS OF SPITTLEBUG DAMAGE ON BUFFELGRASS PLANTS UNDER CAGES, MONTERREY, MEXICO 1975

Entry	Damage Rating[1]
Susceptible	
28	4
Common	5
Tolerant	
35	2
58	2.5
66	2
68	2

[1] 1 = No damage; 2 = slight damage; 3 = stunted, yellow leaves; 4 = few green leaves; 5 = no green leaves.

TABLE 3. YEARLY RAINFALL TOTALS, WESLACO 1979-81

Month	1979	1980	1981
		Inches	
Jan.	0.70	0.11	3.10
Feb.	0.82	1.34	0.67
Mar.	0.08	0.10[1]	1.81
Apr.	1.72	0.11	3.33
May	1.01	2.53	6.29
June	3.80	0.00	2.37
July	0.80[1]	0.42[1]	3.88
Aug.	4.44	5.84	4.01
Sept.	3.89	1.38	2.46
Oct.	0.40	2.56	3.85
Nov.	0.42	2.42	0.37
Dec.	3.04	0.56	0.24
Total	21.12	17.37	32.38

[1] Supplemental irrigation - 2 inches.

TABLE 4. DRY MATTER PRODUCTION ON SPITTLEBUG TOLERANT GERMPLASM 1979-81

Entry	1979	1980	1981
		Pounds/Acre	
Susceptible			
28	10,399	18,657	19,699
Common	9,634	17,030	18,652
Tolerant			
35	9,804	23,454	22,172
58	8,787	17,934	19,101
66	5,643	14,725	18,689
68	9,465	17,083	18,538
LSD (0.05)	1,788	3,618	3,087
CV (%)	13.2	13.2	10.5

structure, etc.) and the potential for enhancing these characters in buffelgrass.

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Small Grain for Silage or Hay Variety Test

J. C. READ AND R. M. JONES

Summary

Twenty-nine cultivars of small grain were tested during the 1983-84 growing season. Yields ranged from 4.2 to 1.1 tons dry matter per acre and protein content ranged from 7 to 12 percent. The 10 oat cultivars had the lowest yields due to winter kill, and there were differences in the amount of damage among them. Nora had the least damage while Cornado had the greatest.

Introduction

Most small grain forage tests that have been conducted recently have attempted to simulate grazing by clipping several times throughout the growing season. Yet there is a considerable amount of small grain that is preserved as hay and silage. Use of small grains for silage is on the increase in Texas, especially among dairymen. This test was conducted to determine the cultivars of small grains best suited for use as hay or silage.

Procedure

Twenty-nine small grain cultivars including 10 oats, seven triticales, two ryes, and 10 wheats were planted October 17, 1983 on Windthorst fine sandy loam at Stephenville at a rate of 100 lb/A in a randomized block design with four replications. Plots were 17-feet long with four rows spaced 15 inches. Nine feet of the center two rows were harvested for yield on April 30, 1984. Samples were taken at harvest, ovendried at 65°C, and used to determine nitrogen content. Nitrogen was determined using Kjeldahl procedure. Fertility consisted of 80-80-80 applied preplant and disked in and top-dressed February 22, 1984 at a rate of 80-0-0 for total of 100-80-80.

KEYWORDS: Wheat/oats/triticale/rye.

Results and Discussion

Dry matter production of the 10 wheats ranged from 4.1 to 3.0 tons/A (Table 1). The nine top cultivars were not significantly different. Only Vona had significantly lower yield among the wheats. Of the seven triticales tested, only the highest yield of 4.2 tons/A for ARCCO Mix 4 was significantly better than the lowest production of 3.5 tons for Grazer II (Table 1). There were no differences in the yield of the two ryes that were tested. No significant differences were recorded among the top 17 cultivars tested.

Dry matter production of the oats ranged from 2.3 to 1.1 tons/A (Table 1). This low yield was due to winter kill which ranged from 73 to 74 percent kill. In general, the higher the winter kill, the lower the yield.

TABLE 1. DRY MATTER PRODUCTION AND PROTEIN CONTENT OF SMALL GRAINS HARVESTED FOR SILAGE AND PERCENT WINTER KILL OF OATS

Species	Cultivar	Yield tons/A	Protein content percent	Winter kill percent
Triticale	ARCCO Mix 4	4.2 A*	8.3 B-H**	0
Wheat	Lanocta	4.1 AB	8.2 B-H	0
Wheat	McNair - 1003	4.0 AB	9.1 A-D	0
Wheat	TXO-73-93	4.0 AB	7.3 F-H	0
Wheat	Scout-66	3.9 AB	8.7 A-G	0
Wheat	Coker-68-15	3.9 AB	8.4 B-H	0
Triticale	ARCCO Mix 2	3.9 AB	7.6 C-H	0
Rye	Elbon	3.8 AB	6.9 H	0
Triticale	ARCCO Mix 3	3.7 ABC	7.4 E-H	0
Wheat	TAM-105	3.7 ABC	8.1 B-H	0
Wheat	Tex Red	3.7 ABC	8.3 B-H	0
Triticale	ARCCO Mix 1	3.7 ABC	8.1 B-H	0
Rye	Wintermore	3.7 ABC	7.1 GH	0
Wheat	Coker-916	3.7 ABC	7.3 GH	0
Triticale	Double Crop 1	3.5 ABC	7.8 B-H	0
Triticale	Nutriseed 1-18	3.5 ABC	8.5 A-H	0
Wheat	Coker-762	3.5 ABC	9.0 A-E	0
Triticale	Grazer II	3.5 BC	8.2 B-H	0
Wheat	Vona	3.0 C	8.6 A-G	0
Oat	Okay	2.3 D	9.3 AB	9
Oat	Nora	2.1 DE	9.2 A-C	4
Oat	Four-Twenty-Two	2.0 DE	7.5 D-H	40
Oat	Coker 227	2.0 DE	8.0 B-H	29
Oat	Harpool-883	1.9 DE	9.2 A-D	60
Oat	Coker-234	1.9 DE	8.9 A-F	40
Oat	Big Mac	1.7 DEF	8.5 A-H	49
Oat	Walken	1.6 EF	11.6 A	8
Oat	Mesquite	1.6 EF	10.0 A	41
Oat	Cornado	1.1 F	8.9 A-F	73

**Percentages followed by a common letter are not significantly different (0.05 level), Duncan's Multiple Range Test.

Crude protein ranged from 11.6 percent for Walken oat and 6.9 percent for Elbon rye (Table 1). Because there was only one harvest date, this range was probably due more to plant maturity than to species or cultivars.

Ryegrass and Oat Variety Trials in Southeast Texas

G. W. EVERS

Summary

Ryegrass variety trials were conducted during 1982-83 and 1984-85 and an oats variety trial in 1982-83 at the Angleton Research Station. In the earlier ryegrass trial TX-R-80-4, TX-R-80-T, and TX-R-81-T breeding lines had the best combination of early and total forage production. There were only minor differences between oat cultivars. Marshall and TX-R-84-1 ryegrass were the most productive in the 1984-85 trial.

Introduction

Annual ryegrass is the primary species used for temporary winter pasture in southeast Texas. It is tolerant of water-logged soils during the winter which are characteristic of the area. Seed burial is not necessary for establishment which makes it the leading choice for overseeding warm season perennial pastures. Oats are frequently mixed with ryegrass on the better drained soils to increase early forage production. Variety trials of oats and ryegrass were established at Angleton to identify the most productive cultivars for the Upper Gulf Coast of Texas.

Procedure

Oat and ryegrass cultivars were seeded at 90 and 25 lb/A, respectively on a Lake Charles clay. The 1982-83 trials were established on September 17, 1982 and fertilized with a 50-60-0 at planting and 50 lb of nitrogen/A after each of the first three cuttings. The 1984-85 study was planted on November 8, 1984 and fertilized with 50-60-0 at planting and 50 lb of nitrogen/A after each of the first two cuttings. Plots were 4 x 15 feet and consisted of six 8-inch rows. Experimental design was randomized block with four replications.

KEYWORDS: Ryegrass/forage yield/oats.

Results and Discussion

There were no significant differences between oat cultivars in forage production at the first harvest or total yield (Table 1). In the 1982-83 ryegrass test TX-R-81-T, Marshall, Shannon, TX-R-80-T, TX-R-80-4, and Georgia Reseeding had the best early production with over 1,000 lb/A by the first harvest (Table 2). TX-R-80-4, TX-R-80-T, TX-R-81-T, TX-R-81-1, Florida 80, and Gulf were the most productive for the season. In the 1984-85 ryegrass trial there was little difference between cultivars with Marshall and TX-R-84-1 being the most productive (Table 3).

TABLE 1. OATS VARIETY TEST AT ANGLETON 1982-83

Variety	Dec. 9	Jan. 26	Mar. 2	May 3	Total
	Pounds of Dry Matter/Acre				
Coker 422	1,217 a[1]	868 b	1,312 a	3,093 a	6,489 a
Big Mac	1,469 a	1,001 ab	1,376 a	2,589 a-c	6,435 a
Mesquite	1,341 a	930 ab	1,322 a	2,780 ab	6,373 a
Coker 234	1,528 a	1,066 a	1,372 a	2,346 bc	6,312 a
New Nortex	1,189 a	1,123 a	1,303 a	2,676 a-c	6,291 a
Coronado	1,616 a	930 ab	1,242 a	2,207 c	5,994 a

[1]Yields within a column followed by the same letter are not significantly different, Duncans Multiple Range Test, 0.05 level.

TABLE 2. RYEGRASS VARIETY TEST AT ANGLETON 1982-83

Variety	Dec. 9	Jan. 26	Mar. 2	May 3	Total
	Pounds of Dry Matter/Acre				
TX-R-80-4	1,000 a-c[1]	1,464 ab	1,680 a-c	3,138 a	7,282 a
TX-R-80-T	1,052 ab	1,318 ab	1,673 a-c	3,179 a	7,221 a
TX-R-81-T	1,132 a	1,309 ab	1,633 bc	3,057 a	7,131 ab
TX-R-81-1	748 cd	1,260 ab	1,698 a-c	3,097 a	6,803 a-c
Florida 80	789 bc	1,346 ab	1,892 a	2,751 ab	6,778 a-c
Gulf	740 cd	1,287 ab	1,617 bc	2,955 ab	6,599 a-d
Marshall	1,089 a	1,287 ab	1,488 c	2,527 bc	6,390 b-d
Georgia Re.	1,002 a-c	1,337 ab	1,770 ab	2,201 cd	6,309 c-e
Common	511 d	1,118 b	1,792 ab	2,527 bc	5,948 d-f
Shannon	874 a-c	1,356 ab	1,562 bc	1,814 de	5,606 ef
Ninak	1,072 a	1,569 a	1,689 a-c	1,141 f	5,471 f
Urbana	799 bc	1,416 ab	1,605 b-c	1,467 ef	5,288 f

[1]Yields within a column followed by the same letter are not significantly different, Duncans Multiple Range Test, 0.05 level.

TABLE 3. RYEGRASS VARIETY TEST AT ANGLETON 1984-85

Variety	Jan. 8	Mar. 8	Apr. 3	May 3	Total
	Pounds of Dry Matter/Acre				
Marshall	997 a[1]	1,907 a	1,484 a	943 b	5,331 a
TX-R-84-1	1,118 a	1,770 ab	1,332 a	1,083 ab	5,303 a
Common	1,084 a	1,593 ab	1,271 ab	982 b	4,930 a
Florida 80	1,381 a	1,607 ab	715 c	1,130 ab	4,833 a
Gulf	803 a	1,539 b	1,089 b	1,241 a	4,672 a

[1]Yields within a column followed by the same letter are not significantly different, Duncan's Multiple Range Test, 0.05 level.

Small Grain and Ryegrass Forage Variety Tests, 1983-84

L. R. NELSON, S. L. WARD, AND C. CREEKMUR

Summary

Small grain winter annuals are often grazed out in Texas to overwinter cattle. Information on which varieties of oats, wheat, rye, and ryegrass procedure the highest forage yields is valuable for cattlemen. To simulate grazing, tests were clipped several times to compare varieties for forage yield at various times during the growing season and for total yield. Separate tests were conducted for oats, rye, ryegrass, and wheat. It is important to consider forage distribution throughout the growing season and not only total forage yield. Early fall and winter forage production may be of more value to a forage program than forage produced in April or May.

Introduction

These trials were conducted to determine which varieties produce optimal forage yields in East Texas. A second objective was to compare experimental and newly released lines with recommended varieties to determine their adaptation to East Texas growing conditions.

Procedure

Rye, wheat, ryegrass, and oats were planted in separate tests on Septemebr 12, 1983 at Overton, Texas. The ryegrass variety test was planted on October 11 at a different location. Seed was replanted into six-row plots spaced 8 inches apart, 10 feet in length. The four center rows were harvested at a height of about 2 inches with a flail-type harvester. Fertilizer application consisted of a preplant application at a rate of 24-96-96 (N-P_2O_5-K_2O) lb/A and a split nitrogen application of 100 lb on September 26, 1983 and 60 lb on February 26, 1984 for a total N application of 184 lb/A. Individual small grain forage tests were harvested when there was sufficient forage to cut. Normally, this would be when the forage was from 8 to 10 inches tall. No serious disease or insect pests were observed in these tests.

Limited moisture in September reduced ryegrass stands. Wheat, oat, and rye emergence was good and stands persisted. Rainfall amounts in inches by months were: September - 1.2; October - 2.8; November - 3.8; December - 4.3; January - 1.8; February - 7.2; March - 2.9; April - 1.6; and May - 2.7. A temperature of 4°F was recorded on December 26 and 10°F was recorded on January 23. During this cold period, the soil froze to a depth of about 10 inches which was very unusual.

Results and Discussion

Forage yield data are presented in Tables 1-4. Highest mean yields in 1983-84 were produced by ryegrass followed by wheat, rye, and oats. All oat varieties were

KEYWORDS: Wheat/oats/rye/ryegrass/winter annuals.

TABLE 1. RYEGRASS FORAGE VARIETY TEST (A) PLANTED EARLY (SEPTEMBER 12) AT OVERTON, TEXAS 1983-84

Variety	Harvest Dates Nov. 17	Dec. 13	Mar. 16	Apr. 27	Total Yield
	Pounds Dry Matter/Acre				
Marshall	2,374	945	434	2,093	5,847
Florida 80	2,093	868	485	2,221	5,668
Gulf	2,349	1,124	435	1,685	5,592
TX-R-80-4 Exp.	1,405	1,021	562	2,196	5,184
Tetrablend 444	1,659	1,021	562	1,915	5,158
Shannon	1,889	945	485	1,736	5,055
TNT	1,940	1,072	434	1,481	4,928
Montgomery Exp.	1,225	843	664	2,195	4,927
TX-R-80-T Exp.	1,251	946	511	2,068	4,826
TERLI	1,634	1,098	588	1,328	4,647
Victoria (perennial)	638	639	357	2,579	4,212
Common	817	766	511	1,966	4,060
Mean	1,606	945	502	1,955	5,009
LSD (10% level)	660	217	NS[1]	589	771
CV	34	19	29	25	13

RYEGRASS FORAGE VARIETY TEST (B) PLANTED LATE (OCTOBER 11) AT OVERTON, TEXAS

Variety	Harvest Dates Dec. 12	Mar. 16	Apr. 17	Yield
	Pounds Dry Matter/Acre			
Tetrablend 444	1,608	792	1,608	4,099
Marshall	1,404	919	1,583	3,096
TNT	1,506	919	1,430	3,855
TX-R-80-T	1,225	919	1,710	3,855
Gulf	1,558	816	1,430	3,803
Shannon	1,609	741	1,430	3,779
Gulf	1,601	766	1,353	3,728
TX-R-80-4	1,302	1,047	1,353	3,702
Montgomery Exp.	1,353	766	1,353	3,651
Florida 80	1,405	1,098	1,075	3,577
Common	1,430	868	1,252	3,550
TERLI	1,149	715	1,251	3,115
Mean	1,430	864	1,417	3,711
LSD (10% level)	261	NS[1]	289	NS[1]
CV	15	44	1.7	13

Seeding rate = 48 lb/A.

Fertilizer application: Preplant 400 lb/A of 6-24-24 (N, P_2O_5, K_2O). Topdressed (urea) 100 lb N/A on September 26 and 60 lb N/A on February 26, 1984. Total N = 184 lb/A.

[1]NS = no significant differences in yield between varieties this harvest date.

Severe winter-kill occurred on most varieties during December. This resulted in uneven winter-kill within varieties and between varieties and increased the variability of the study.

The stands on the early planting date (September 12) were somewhat erratic due to dry conditions and the test was replanted, however, the data are presented for both tests.

TABLE 2. WHEAT VARIETY FORAGE TEST AT OVERTON, TEXAS 1983-84

Variety	Harvest Dates					Total
	Nov. 10	Dec. 9	Feb. 23	Mar. 16	Apr. 9	Yield
	Pounds of Dry Matter/Acre					
Florida 302	1,277	1,047	536	2,145	332	5,337
Grazerblend II (Triticale)	1,098	894	588	1,864	613	5,055
McNair 1003	1,251	945	919	1,225	204	4,545
HW-3022 (Rohm & Haas)	1,634	894	639	817	358	4,340
TAM106	1,124	817	818	1,200	255	4,214
Northrup King 812	1,251	919	817	996	128	4,110
HW-3006 (Rohm & Haas)	1,532	919	613	766	255	4,084
Rosen	1,123	894	919	970	179	4,084
Coker 916	919	868	817	1,200	230	4,034
Coker 68-15	1,328	945	562	919	281	4,034
Southern Belle	843	843	843	1,250	230	4,008
Bradford	1,124	894	613	919	358	3,907
Coker 762	868	843	894	1,098	204	3,906
TX-73-009	996	843	766	817	179	3,803
Terral-81-17	1,328	817	639	817	153	3,753
Texred	1,021	817	690	1,123	162	3,753
Delta Queen	996	868	868	664	255	3,651
TX-75-213	1,098	894	664	741	255	3,651
Mit	919	868	664	843	204	3,498
Florida 301[1]	1,251	843	0[1]	0	128	2,221
Mean	1,149	883	693	1,029	245	3,999
LSD (10% level)	314	125	138	762	104	783
CV	23	12	16	62	35	16

Planted on September 12, 1983. Seeding rate = 120 lb/A.
Fertilizer application: Preplant 400 lb/A of 6024024 (N, P_2O_5 and K_2O).
Topdressed (urea) 100 lb N/A on September 26 and 60 lb N/A on February 26, 1984. Total N = 184 lb/A.
[1]Florida 301 was severely winter-killed in December.

TABLE 3. RYE FORAGE VARIETY TEST AT OVERTON, TEXAS 1983-84

Variety	Harvest Dates					Total Yield
	Nov. 10	Dec. 8	Feb. 21	Mar. 19	Apr. 9	
Wintergrazer 70	1,405	817	1,098	1,149	178	4,647
Noble Foundation-142	1,251	893	970	1,047	281	4,443
Grazerblend II	1,302	791	485	1,200	636	4,415
Noble Foundation-214	1,277	868	1,047	1,072	127	4,391
Bonel	1,174	842	996	1,021	154	4,188
Noble Foundation-91	1,174	766	996	1,098	129	4,163
GI-85	1,200	893	1,021	715	127	3,957
Curley Grazer 2000	1,353	817	970	511	178	3,830
Maton	817	817	1,072	944	76	3,727
Vitagrazer	1,072	842	1,430	281	25	3,651
FBISRR Florida Exp.	1,455	562	178	306	154	2,656
Elbon	102	76	128	0	51	358
Mean	1,132	749	866	779	177	3,702
LSD (10% level)	286	152	253	219	150	654
CV	21	17	24	23	70	14

Planted on September 12, 1983. Seeding rate = 120 lb/A.
Fertilizer application: Preplant 400 lb/A of 6-24-24 (N, P_2O_5 and K_2O).
Topdressed (urea 100 lb N/A on September 26 and 60 lb/A on February 22. Total N = 184 lb//A.

killed by winter freeze damage in December and were not harvested thereafter. Ryegrass was severely damaged, however all varieties did recover and forage was harvested in March. The September 12 planting of ryegrass was superior to the October planting even though the late planting had better stands. This was due to the fall growth and November 17 harvest. The cold weather in December and January greatly reduced winter forage production of ryegrass and favored varieties with good winterhardiness (such as Marshall).

Forage production of wheat varieties was fairly stable through the season even in December. Some interaction in seasonal forage production and varieties can be observed (Table 2). Grazerblend II triticale produced high

TABLE 4. OAT FORAGE VARIETY TEST AT OVERTON, TEXAS 1983-84

Variety	Harvest Dates Nov. 11	Dec. 12	Total Yield
	Pounds Dry Matter/Acre		
Coker 234	2,017	945	2,962
Four-twenty-two	2,067	894	2,961
TX 81C707[1]	2,017	919	2,936
Mesquite	1,915	945	2,860
TX 82c[1]	1,966	868	2,834
Big Mac	1,915	894	2,809
TX 82663171	1,976	792	2,767
Walken	1,787	970	2,757
Harpool 833	1,889	843	2,732
TX 81C705[1]	1,864	868	2,732
Coker 227	1,736	919	2,655
Fal-501	1,812	792	2,604
Fla-502	1,588	1,021	2,579
Bob	1,506	817	2,324
Mean	1,859	892	2,751
LSD (10% level)	299	147	336
CV	13	14	10

Planted on September 12, 1983. Seeding rate = 120 lb/A.

Fertilizer application: Preplant 400 lb/A of 6-24-24 (N, P_2O_5 and K_2O). Topdressed (urea) 100 lb N/A on September 26 andd 60 lb N/A on February 26, 1984. Total N = 184 lb/A.

*All varieties winter-killed in late December due to extreme cold.

[1]Experimental variety, seed is not available.

yields compared to most wheat varieties. Rye forage production was somewhat lower than normally expected. Seed germination of the variety Elbon was very bad and resulted in its low forage production.

The oat yields were very high for the November harvest date, however the winterfreeze damage killed all varieties in late December 1984.

When making comparisons between varieties within a table, difference between varieties of less than the LSD are probably due to chance only and should not be considered as important. Furthermore, data from 1 year may be misleading because of unusual weather conditions. Therefore, these data should only be used to give an indication of varietal differences. Recommendations should be made using at least 3 years of data.

Response of Two Pearl Millets to Water

D. J. UNDERSANDER

Summary

Millex and Tift 23B pearl millets were planted under a gradient irrigation system at Bushland, Texas in 1984. The range in water available for crop growth was 13.4-17 acre-inches. Over this range of water use the total dry matter yield of Millex ranged from 6,150-17,480 lb/A while the dry matter yield of Tift 23B ranged from 2,600-13,110 lb/A. Tift 23B yielded less than Millex at all levels of irrigation, however the decrease in yield with declining water was similar. Additionally, the number of heads per length of row greatly decreased with Tift 23B as water declined but not with Millex.

Introduction

Pearl millet is generally raised in climates subject to periods of severe plant water stress. Thus, a knowledge of how this crop responds to decreased water availability is important. Further, a knowledge of genotypic differences in crop water response curves would be very useful to both the plant breeder and the farmer to select and produce the hybrids best suited to their needs. Therefore, the objective of this study was to compare two pearl millet cultivars under varying levels of water to determine crop water response curves for each.

Procedure

The study was conducted on a Pullman clay loam soil at Bushland, Texas in 1984. The plot area was land planed, disked, fertilized, swept, and bedded up prior to planting. Nitrogen and phosphorus fertilizer were applied to nonlimiting levels. Propazine was applied for weed control at the rate of 2 lb/A. The pearl millets (Millex and Tift 23B) were seeded on May 23, 1984. After establishment, gradient sprinkler irrigations were applied throughout the season whenever soil water content in the most heavily irrigated area (3 feet from the sprinkler) fell below 70 percent available as determined by a neutron probe. Neutron tubes, 10 feet deep, were placed at distances of 3, 13, 23, 33, and 43 feet from the sprinkler. Water collections at the same locations were made for each irrigation and rainfall occurrence to determine total water applied. Plant height measurements and total plant dry matter yield were taken August 30, 1984.

Results and Discussion

The dry matter yield range for Millex was from 17,480 lb/A on the adequately watered area to 6,150 lb/A on the driest treatment (Fig. 1). The comparable dry matter yield range for Tift 23B was from 13,110-2,600 lb/A. Millex is a hybrid and, as such, would be expected to show more vigor and yield potential than Tift 23B which is a pure line. The slopes of the two lines were not significantly different, indicating similar responses to water for the two pearl millet types. However, Millex consistently produced more yield per unit of water than did Tift 23B.

Plant height responses to water (Fig. 2) were similar to the yield differences. Millex was taller than Tift 23B

KEYWORDS: Penninsetum americanum/water stress/water use/biomass.

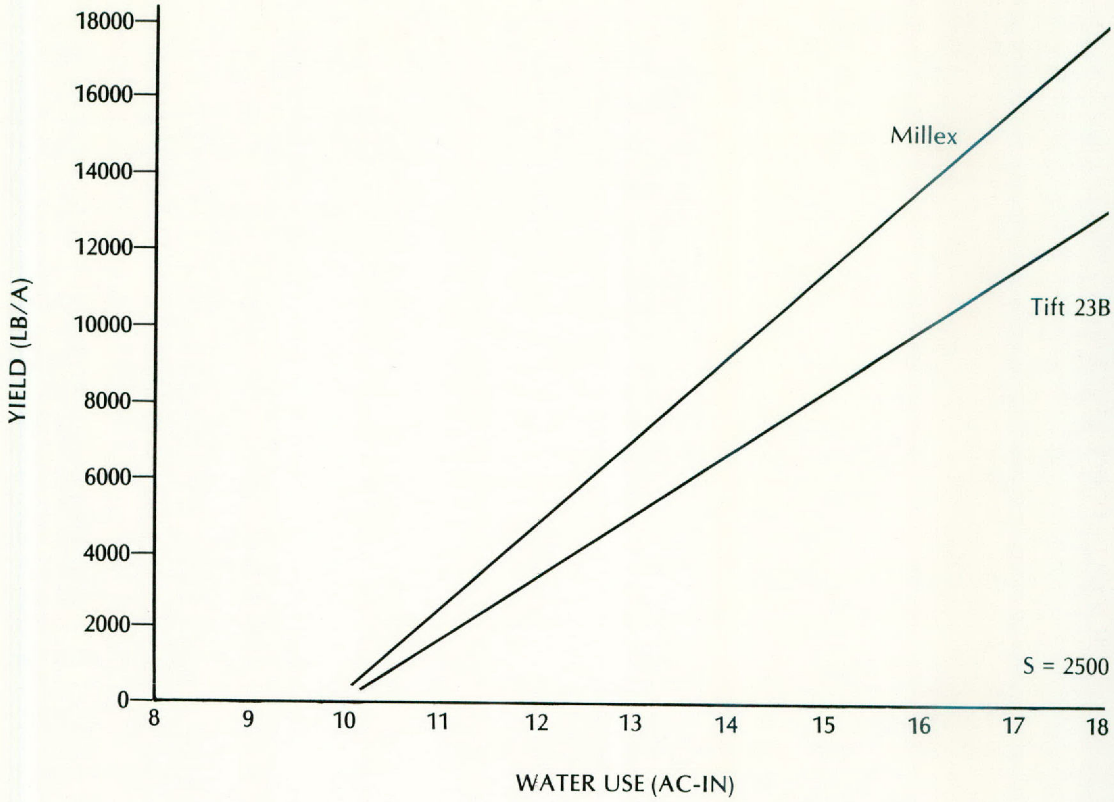

Figure 1. Yield of Pearl Millet at Different Water Levels.

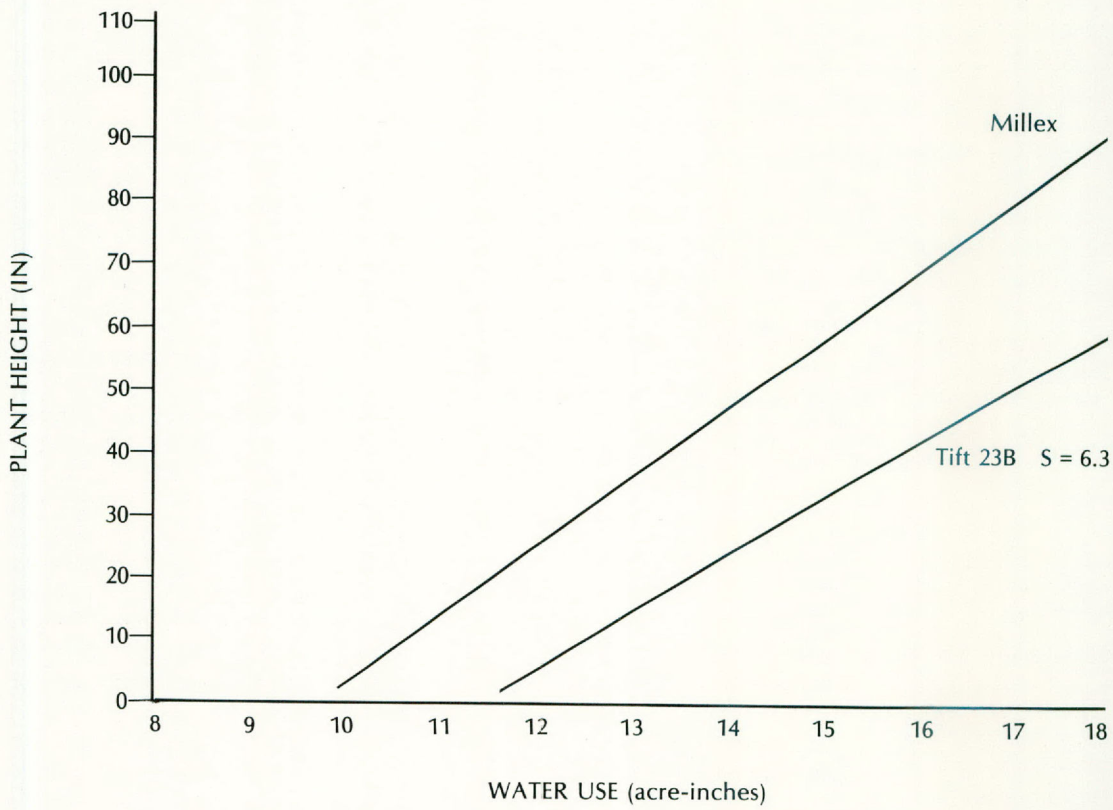

Figure 2. Plant Height of Pearl Millet at Different Water Levels.

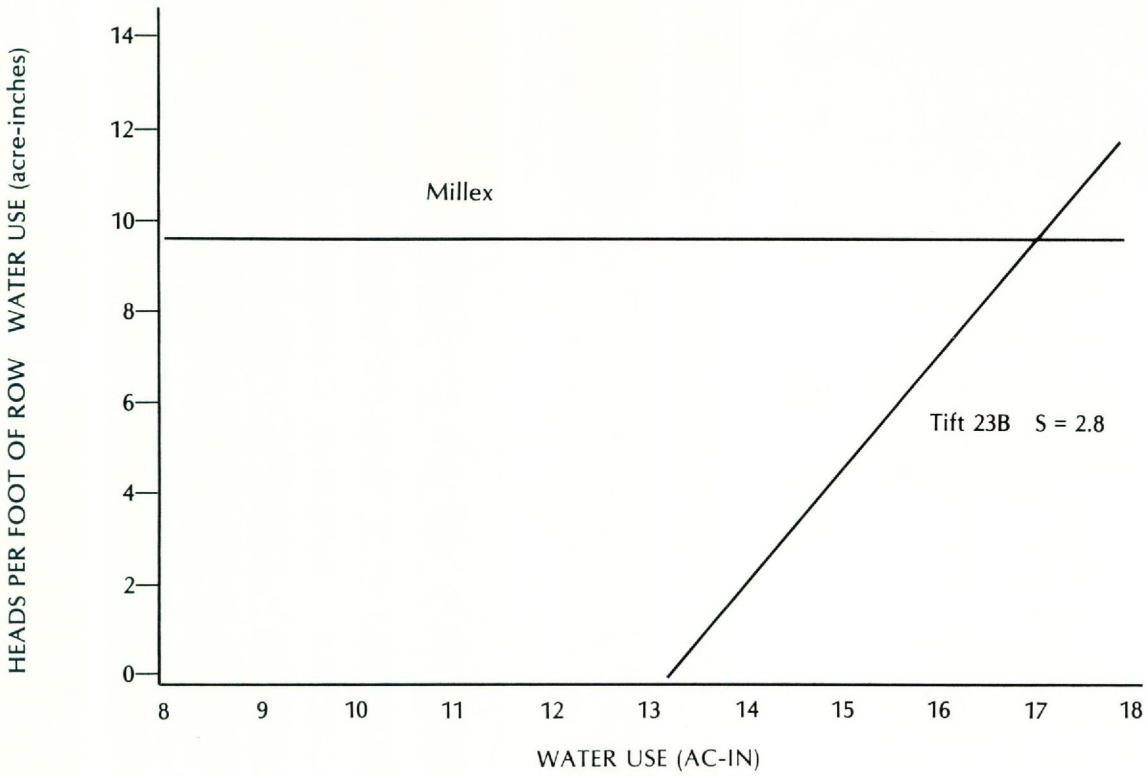

Figure 3. Number of Heads of Pearl Millet at Different Water Levels.

and demonstrated a greater increase in height with added water than Tift 23B.

Grain yields were not taken, however, number of heads were measured for each plot. Tift 23B showed a severe depression in number of heads with declining water (Fig. 3). In Millex, number of heads did not decline with decreasing water.

Performance of Corn Hybrids for Silage in the West Cross Timbers

R. M. JONES AND J. C. READ

Summary

Dry matter yields of 20 corn hybrids ranged from 4.9 to 6.9 tons/A under irrigation and from 1.3 to 2.0 tons/A dryland with no statistically significant differences among hybrids. Hybrids grown dryland were harvested at early tasseling due to drought. Crude protein content of irrigated hybrids cut at soft dough ranged from 6.5 to 7.5 percent, ear weight percent ranged from 23.2 to 40.2, and ear height ranged from 27 to 45 inches. The soft dough stage of maturity was a relatively good index of dry matter percentage for most hybrids. Failure to show statistical differences in yield and ears per hundred plants was partially due to differences in plant population.

KEYWORDS: Silage/ production/ yields/ West Cross Timbers.

Introduction

The value of corn silage for lactating dairy animals is well known. Renewed interest in the use of corn silage by dairymen of the West Cross Timbers has resulted from the recognition of this fact and the availability of equipment for handling silage from harvest to feeding. Since corn has not been grown in the area for many years, silage production is dependent upon knowledge of corn hybrid performance under limited irrigation as well as dryland conditions. Hybrid differences in dry matter production, crude protein content, plant maturity, and ear weight are of interest to the potential grower who must profitably produce corn silage. Potential growers in the area include producers of irrigated peanuts whose acreage has been steadily reduced by government controls. Corn might also be grown for silage under dryland conditions by seeding about the time of final frost to take advantage of the rainfall pattern for the area. The objectives of this test were to determine differences in yield, crude protein content, maturity, ear weight, and ear percentage of selected corn hybrids.

Procedure

An irrigated test and a dryland test were located on a Windthorst fine sandy loam soil and separated by a buffer area of corn 70-feet long and the width of each test. Fertilizer was broadcast and incorporated with a tandem disk 2 weeks prior to seeding. Urea, ammonium nitrate, and 18-46-0 were applied separately to provide a total of 173 and 60 lb nitrogen and phosphorus (P_2O_5), respectively. Seeding rate was adjusted according to percentage seed germination and an estimated 10 percent death loss to provide 20,000 and 24,000 plants/A, respectively, for the dryland and irrigated tests. The tests were seeded on March 20 by hand metering preweighed seed packets into a funnel placed into the seed spout of a John Deere Flexi-Planter with double-disk openers. Dual 8E herbicide was sprayed broadcast at the rate of 2 pt/A within 1 day after seeding.

Twenty corn hybrids in each test were arranged in a randomized complete block design with four replications. Plots were 9 feet (three rows) wide and 20 feet long.

The irrigated test receivea 12 acre-inches of irrigation and 6.1 inches of rainfall between planting and harvest. Water was applied once at the rate of 3.0 acre-inches and five times at the rate of 1.8 acre-inches by releasing water from gated pipe into furrows using gravity flow down a 0-1 percent slope.

The dryland test received only 4.95 inches of rainfall from March 20 to June 20; therefore, the test was harvested on June 20 when most hybrids were in the early tasseling stage. Plants were cut 3 inches above ground level from the middle 15 feet of the center row of each plot.

Plants in the irrigated test were cut as kernels of each hybrid reached the soft dough (dent) stage of maturity. Plants were cut 3 inches above ground level from the middle 10 feet of the center row of each plot. Ears were removed with the shuck attached; stalks (with leaves) and ears counted and weighed. Stalks and ears were randomly selected as subsamples for dry matter determinations and crude protein analysis. Ears and stalks were recombined for the subsamples in the same proportion as existed for the harvested row. Plants and ears were cut into 8-inch pieces to facilitate drying, which initially was in outdoor bins made of quarter-inch hail screen. Final drying was accomplished in a forced-draft oven at 70°C. Crude protein was determined by the macro-Kjeldahl method using samples ground to pass a 1 mm screen.

Results and Discussion

Although yields of irrigated corn ranged from 4.9 to 6.9 tons dry matter/A (Table 1), differences were not statiscally significant due to high variation (coefficient of variation = 26.7 percent). Sources of variation may be in application of irrigation water and in differences in plant population. Regardless of variation most hybrids produced between 5.1 and 5.9 tons dry matter/A, which, adjusted to 35 percent dry matter, is equivalent to 14.6 and 16.9 tons of forage at the proper water content for quality silage.

Crude protein content ranged from 6.5 to 7.5 percent (Table 1). Protein content of 'WAC 918' and 'TX-34' was significantly greater than that of 'H-890', 'PX-83', 'G4673-A' and 'SX-2434'.

Fresh weight of ears in the shuck as a percentage of the total weight ranged from 23.2 to 40.2 (Table 2). Percentage ear weight of WAC 918, '7251', and Pio.3165' was significantly greater than 'RA-1502', 'RX-962W', and 'Pio.3192'.

Height of ear from ground level to the base of the ear shank ranged from 26.5 to 45 inches (Table 2). Ear height of TX-34, 'GSC-2355', and '8990' was significantly greater than RA-1502, SX-2434, WAC-918 and Pio.3192.

Number of ears per hundred plants ranged from 71 to 123, but differences were not statistically significant (Table 3). Forty-one percent of the variation was due to plant population.

The grain of all hybrids reached soft dough between 111 and 118 days after planting (Table 3). The soft dough stage was used as an index to 35 percent dry matter content, but actual percentages ranged from 27.4 to 38.8 (Table 1). Therefore, days to harvest may vary slightly from those found in this study. The five hybrids having more than 35 percent dry matter had a statistically greater percentage dry matter than those eight hybrids with less than 31 percent. The standard deviation for dry matter content was 2.7 percent, while mean of all

TABLE 1. DRY MATTER YIELD, PERCENTAGE, AND CRUDE PROTEIN CONTENT OF IRRIGATED CORN HYBRIDS GROWN FOR SILAGE

Hybrid	Company	Dry Matter[1] Tons/A	Dry Matter[1] Percent	Crude Protein[1] Percent
H-890	Horizon	6.9 a	38.8 a	6.5 b
Pio. 3165	Pioneer	6.3 a	34.6 abcde	6.7 ab
Pio. 3192	Pioneer	5.9 a	30.5 efgh	7.2 ab
RA-1505	Ring Around	5.9 a	32.1 cdefg	6.7 ab
G4673-A	Funk	5.9 a	31.1 defgh	6.5 b
G4507-A	Funk	5.8 a	31.3 defgh	7.2 ab
GSC-2355	Gro Agri	5.7 a	29.9 fgh	6.9 ab
XL-72 aa	DeKalb-Pfizer	5.7 a	34.1 bcdef	7.2 ab
RA-1604	Ring Around	5.6 a	35.0 abcde	7.1 ab
8990	Paymaster	5.5 a	29.8 fgh	6.8 ab
NS-212	Gro Agri	5.4 a	37.9 ab	7.1 ab
RX-962-W	Asgrow	5.4 a	35.8 abc	7.4 ab
XL-73	DeKalb-Pfizer	5.4 a	30.6 efgh	7.0 ab
TE-6996	Taylor-Evans	5.3 a	33.4 cdef	7.1 ab
RA-1502	Ring Around	5.3 a	29.7 fgh	6.7 ab
PX-83	Northrup King	5.3 a	27.4 h	6.5 b
7251	Paymaster	5.2 a	36.2 abc	6.8 ab
TX-34	TAES (Harper)	5.2 a	35.5 abcd	7.5 a
WAC-918	SeedTec	5.1 a	30.4 efgh	7.5 a
SX-2434	Browning	4.9 a	28.5 gh	6.5 b

[1]Values within the same column followed by the same letter are not statistically different at the 0.05 probability level, Duncan's Multiple Range Test.

TABLE 2. EAR WEIGHT AND EAR HEIGHT OF IRRIGATED CORN HYBRIDS

Hybrid	Ear Weight[1] (percent)	Ear Height[2] (inches)
H-890	35 abc	36 abc[3]
Pio. 3165	39 ab	33 abcde
Pio. 3192	23 d	27 f
RA-1505	38 abc	36 ab
G4673-A	36 abc	32 cde
G4507-A	37 abc	34 abcde
GSC-2355	31 abcd	37 a
XL-72 aa	33 abc	34 abcde
RA-1604	35 abc	34 abcde
8990	30 bcd	36 ab
NS-212	34 abc	33 abcde
RX-962-W	29 bcd	35 abc
XL-73	32 abcd	32 bcde
TE-6996	38 abc	34 abcde
RA-1502	29 cd	31 de
PX-83	30 abcd	34 abcd
7251	39 ab	33 bcde
Tx 34	38 abc	45 a
WAC-918	40 a	27 f
SX-2434	35 abc	30 ef

[1]Mean weight per acre of fresh cut ears (in shuck) divided by the mean total fresh weight per acre times 100.

[2]Measured from ground level to base of ear shank.

[3]Values within a column followed by the same letter are not statistically different at the 0.05 probability level, Duncan's Multiple Range Test.

TABLE 3. PLANT POPULATION, EAR COUNT, AND DAYS TO SOFT DOUGH OF IRRIGATED CORN HYBRIDS

Hybrid	Plant Population[1] (1,000's/A)	Ear Count (per 100 plants)	Days to[2] Soft Dough
Pio. 3192	29.0 a	88 a	111
8990	28.3 ab	78 a	113
Px-83	27.6 ab	84 a	113
SX-2434	27.2 ab	84 a	114
RA-1502	26.9 ab	76 a	114
G4507-A	26.5 ab	90 a	114
G4673-A	26.1 ab	87 a	115
XL-72 aa	25.8 ab	85 a	115
Pio. 3165	25.4 ab	95 a	118
WAC-918	25.4 ab	93 a	113
GSC-2355	25.0 ab	94 a	114
H-890	25.0 ab	92 a	118
TE-6996	24.7 ab	95 a	115
Rx-962-W	24.0 ab	71 a	118
XL-73	24.0 ab	86 a	113
RA-1604	24.0 ab	93 a	115
RA-1505	23.6 ab	97 a	115
NS-212	22.9 abc	83 a	118
7251	21.8 bc	87 a	118
Tx 34	17.1 c	123 a	118

[1]Values followed by the same letter are not statistically different at the 0.05 probability level, Duncan's Multiple Range Test.

[2]Number of days from planting to soft dough of kernels.

hybrids was 32.6 percent. Since ears were checked daily to determine when soft dough was reached, this variation may be near the minimum.

Dryland yields ranged from 1.3 to 2.0 tons dry matter/A (Table 4). No statistical differences were found among hybrids. The test average was 4.1 tons per acre less than that for the irrigated test, which indicates the value of supplemental irrigation for corn in this area. Rainfall for the dryland test was approximately 11 inches below the 45-year average for the period.

TABLE 4. DRY MATTER YIELDS OF CORN HYBRIDS GROWN DRYLAND[1]

Hybrid	Dry Matter[2] (tons/A)
GSC-2355	2.0 a
G4507 A	2.0 a
RA-1604	2.0 a
8990	2.0 a
TE-6996	2.0 a
NS-212	1.9 a
G-4673 A	1.8 a
Rx-962-W	1.7 a
RA-1502	1.7 a
Tx-34	1.7 a
Pio. 3192	1.7 a
XL-73	1.7 a
XL-72 aa	1.6 a
PX-83	1.6 a
WAC-918	1.6 a
H-890	1.5 a
SX-2434	1.5 a
Pio. 3165	1.4 a
RA-1505	1.3 a
7251	1.3 a

[1]Test was harvested prematurely at approximately tassel stage due to drought.

[2]Values followed by the same letter are not statistically different at the 0.05 probability level, Duncan's Multiple Range Test.

Plant population in the irrigated test ranged from 17,100 to 29,000 plants/A despite attempts to assure a population of 24,000 plants/A for all hybrids (Table 1). The linear regression of plant population on dry matter yield per acre resulted in the equation: tons dry matter = 18.1-0.49 x plant population per acre in thousands. The coefficient of determination (r^2) was 0.83 indicating that 83 percent of the variation in dry matter yield was due to differences in plant population. Therefore, plant population may be more important than the hybrid when yield is the criterion for selection.

Comparison of Corn and Sorghum Hybrids Grown for Silage Under Irrigated and Dryland Environments

R. M. JONES AND J. C. READ

Summary

Four sorghum and six corn hybrids were grown under irrigated and dryland conditions on Windthorst

KEYWORDS: Corn hybrids/sorghum hybrids/yields/ West Cross Timbers/irrigated/dryland.

fine sandy loam. Irrigated corn and sorghum yields ranged from 3.7 to 5.4 and from 8.1 to 9.7 tons dry matter/A, respectively. There were significant differences in forage yield and crude protein percentage among corn and sorghum hybrids. Yield, crude protein content, and daily dry matter accumulation were significantly higher for sorghum than for corn under all conditions. Daily dry matter accumulations of T-E 6996 corn and three of the sorghum hybrids were the same under irrigation. Corn yields were significantly higher under irrigation, but sorghum yields were not.

Introduction

Dairymen in the West Cross Timbers of Texas have been increasingly interested in the use of corn silage due to improved handling methods, milk production value, and the potential for local production of acceptable forages for silage. Generally, corn has been shown to have a higher energy value and better performance than forage sorghum when fed to beef or dairy cattle. However, the rainfall and irrigation potential in the area may favor production of forage sorghum. Currently, alfalfa is used extensively in dairy rations and the conversion to the use of either corn or sorghum silage will ultimately depend upon profitability. The purpose of this study was to compare the productive potential, crude protein content, and in vitro dry matter digestibility of selected corn and forage sorghum hybrids under both irrigated and dryland conditions.

Procedure

Irrigated and dryland test sites on Windthorst fine sandy loam were separated by a buffer area of sweetcorn 82-feet wide to insure that irrigation water was not wind-blown or drained onto the dryland site. Six hybrids of corn (*Zea mays* L.) and four of sorghum [*Sorghum bicolor* (L.) Moench] were included in each test. Both sites were tilled and prepared in the same manner. Urea and 18-46-0 were applied March 8, 1984 at the rate of 270 and 130 lb/A, respectively, to provide a total of 148 lb/A nitrogen and 60 lb/A phosphorus (P_2O_5). Seeding rates were adjusted for germination and anticipated mortality to provide corn and sorghum populations of 24,000 and 72,600 plants/A, respectively. Corn and sorghum were seeded March 21 and April 27, respectively, in plots 9-feet (3 rows) wide and 15-feet long. Plots were arranged in a modified randomized complete block design so that corn and sorghum hybrids were separately grouped on the same side of each of the four replications in each test. Grouping facilitated the application of Dual 8E herbicide to the corn. The herbicide was applied broadcast at the rate of 2 pt/A within 24 hours after seeding. Weed control in the sorghum was by cultivation; the corn plots were also cultivated to maintain uniform conditions.

Irrigation water was applied through a solid-set sprinkler system. When plant height was sufficient to intercept the stream of water from the sprinkler nozzle, taller riser pipe was substituted. Water was then discharged over the crop canopy from a height of 7.5 feet above ground level. The corn plots received a total of 9.25 acre-inches of water (early applications of 0.75 and 1.5 inches and seven applications of 1.0 inch). Rainfall received by both the irrigated and dryland tests was 6.0 inches. A total of 14.48 inches of irrigation water was applied to the sorghum test, while rainfall contributed an additional 6.2 inches. Sorghum grown dryland also received 6.2 inches of rainfall. The average rainfall for the period of these tests is approximately 11.5 and 13.0 inches, respectively, for corn and sorghum.

Plants were cut 3 inches from ground level when the kernels reached the soft dough stage; however, dryland corn was cut at milk stage (roasting ear) because of leaf firing. Ten feet of plants were cut from the middle of the center row of each plot. Plants were weighed and cut into 8- to 10-inch sections; subsamples were taken for dry matter determination and laboratory analyses. Subsamples were first air dried in bins made of quarter-inch hail screen; final drying was done at 70°C in a forced draft oven. Dry plant material was ground to pass a 1 mm screen and analyzed for crude protein by the Kjeldahl method. In vitro dry matter digestibility analyses were not completed in time for this report.

Results and Discussion

Dry matter yields of corn hybrids ranged from 3.7 to 5.4 tons/A, while sorghum yields ranged from 8.1 to 9.7 tons/A under irrigation (Table 1). Yields of corn grown dryland ranged from 2.6 to 3.2 tons/A while sorghum yields ranged from 6.6 to 8.3 tons/A. Irrigated corn yields were significantly greater than dryland yields, but there was no significant difference between yield of irrigated and dryland sorghum. There was no statistical differences in yields of corn hybrids grown dryland or in sorghum hybrids grown under irrigation. Dry matter yield of irrigated corn hybrid 'T-E 6996' was significantly greater than the yield for 'NS-212'; crude protein percentage was not significantly different (Table 1). Yields of sorghum hybrids 'FS-25a+' and 'Pio.923' grown dryland were significantly greater than yields of 'Silo Fill 35' or 'FS 455', but protein content was not different among the four hybrids. Although yields of irrigated sorghum hybrids were not significantly different, the crude protein content was significantly greater where dry matter yield was lower. Crude protein content of irrigated T-E 6996, 'Pay. 7251', and NS-212 was significantly greater than that of 'Pio. 3165'. Sorghum yields were significantly greater than corn yields under both irrigated and dryland conditions.

Daily dry matter accumulation (DDMA) for sorghum and corn hybrids grown irrigated and dryland was primarily a function of the yield since most hybrids for each group were harvested on the same day (Table 2). However, DDMA for Silo Fill 35 harvested 9 days earlier than Pio. 923. This was significantly less than Pio. 923 under dryland conditions, but not different under irrigation. DDMA for irrigated T-E 6996 corn was significantly greater than for NS-212 and was a function of the yield. DDMA of sorghum hybrids was significantly greater than that of corn hybrids under both irrigated and dryland environments.

TABLE 1. DRY MATTER YIELD AND CRUDE PROTEIN CONTENT OF CORN AND SORGHUM HYBRIDS GROWN UNDER IRRIGATED AND DRYLAND CONDITIONS

		Irrigated*		Dryland*	
Hybrid	Company	DM[1]	CP[2]	DM[1]	CP[2]
Corn					
T-E 6996	Taylor-Evans	5.4 b	7.3 ab	3.2 c	8.6 a
Pio. 3165	Pioneer	4.8 bc	6.5 c	2.8 c	7.4 b
G4507 A	Funk	4.5 bc	7.1 abc	2.6 c	7.4 b
RA 1505	Ring Around	4.1 bc	7.0 bc	3.2 c	7.1 b
Pay. 7251	Paymaster	4.0 bc	7.3 ab	3.0 c	7.2 b
NS 212	Gro Agri	3.7 c	7.7 a	2.8 c	8.2 a
Sorghum					
FS-25a+	DeKalb-Pfizer	9.7 a	4.0 e	8.3 a	5.3 c
Pio. 923	Pioneer	8.8 a	3.9 e	8.4 a	5.3 c
Silo Fill 35	Ring Around	8.1 a	5.2 d	6.6 b	5.3 c
FS 455	Cargill	8.5 a	4.7 d	7.1 b	5.5 c

*Values in the same column followed by the same letter are not statisticaly different at the 0.05 probability level, Duncan's Multiple Range Test. Irrigated corn yields were greater than dryland yields (P=0.01). Differences in yield of dryland and irrigated sorghum were nonsignificant; but interaction between moisture regime and sorghum hybrid was significant (P=0.01).

[1]Tons per acre dry matter.

[2]Percent crude protein.

Dry matter accumulations per acre-inch of water (DMAAI) were different except for corn hybrids grown dryland (Table 2). DMAAI of FS-25a+ sorghum was significantly greater than for Silo Fill 35 sorghum and all corn hybrids. DMAAI of irrigated T-E 6996 corn was equivalent to that of sorghum hybrids Pio. 923, FS 455, and Silo Fill 35. Sorghum hybrids produced significantly greater DMAAI than corn hybrids under dryland conditions. The DMAAI for FS-25a+ and Pio. 923 grown dryland was significantly greater than that of FS 455 and Silo Fill 35.

Relatively high values of DMAAI indicate greater efficiency in conversion of water to dry matter (Table 2). The values of DMAAI for dryland sorghum average almost three times the DMAAI for irrigated sorghum and would be expected where yield differences between irrigated and dryland are small and water application differences are large. Dryland sorghum yields were statistically the same as irrigated yields; this indicates there might have been a limiting factor, such as nitrogen, under irrigated conditions and/or that dryland sorghum was more efficient than irrigated sorghum in water utilization. This may also be true for corn.

TABLE 2. DRY MATTER PRODUCTION AND DAYS TO HARVEST FOR CORN AND SORGHUM GROWN UNDER IRRIGATED AND DRYLAND CONDITIONS

	Irrigated[1]			Dryland[1]		
Hybrid	DM/Day[2]	DM/Acre-inch[3]	Days[4]	DM/Day[2]	DM/Acre-inch[3]	Days[4]
Sorghum						
FS-25a+	143 a	1,027 a	135	123 ab	2,669 a	135
Pio. 923	130 a	846 ab	135	125 a	2,705 a	135
FS 455	136 a	824 abc	126	104 b	2,272 b	136
Silo Fill 35	128 a	778 bcd	126	104 b	2,106 b	126
Corn						
T-E 6996	92 b	705 bcde	118	62 c	1,080 c	104
Pio. 3165	81 bc	621 cdef	118	53 c	915 c	104
G 4507 A	76 bc	584 def	118	51 c	877 c	104
RA 1505	70 bc	538 ef	118	62 c	1,068 c	104
Pay. 7251	68 bc	521 ef	118	58 c	1,005 c	104
NS-212	63 c	483 f	118	54 c	938 c	104

[1]Values within the same column followed by the same letter are not statistically different at the 0.05 probability level, Duncan's Multiple Range Test.

[2]Dry matter accumulation in pounds per acre per day.

[3]Dry matter production in pounds per acre-inch of water.

[4]Days from planting to soft dough, except dryland corn was cut at milk stage due to leaf firing.

Forage Sorghum Performance Test

J. C. READ AND R. M. JONES

Summary

Twenty forage sorghums for silage production were tested for dry matter production and protein content at

TABLE 1. DRY MATTER PRODUCTION, PROTEIN CONTENT, AND NUMBER OF DAYS FROM PLANTING TO HARVEST OF SILAGE TYPE FORAGE SORGHUMS

Cultivar	Seed Source	Yield Tons/A	Protein Content percent	Days from Planting to Harvest
FS-25a+	DeKalb	7.8 a	5.0 h-j	133
HW-5574	Funk	7.3 ab	4.5 j	143
Hi-Energy	SeedTec	7.1 a-c	6.0 c-g	98
Cow Vittles	Conlee	7.0 a-c	4.8 ij	133
TE Yieldmaker	Taylor Evans	6.7 a-c	5.2 g-j	133
Pioneer-923	Pioneer	6.5 a-d	5.4 f-j	133
G102-F	Funk	6.5 a-d	5.8 d-i	98
FS 455	Cargil	6.2 a-e	5.8 d-i	98
Pioneer-911	Pioneer	6.2 b-e	6.5 b-d	143
Titan-R	Asgrow	5.9 b-f	5.5 e-j	124
Silo Fill 35	Ring Around	5.8 b-f	5.2 g-j	98
NK-405	Northrup King	5.7 c-f	5.1 g-j	122
NK-300	Northrup King	5.1 d-f	5.8 d-h	115
FS 351	Paymaster	5.0 d-f	5.8 d-h	115
Silomaker	Taylor Evans TE	4.8 ef	5.0 g-j	122
FS-5	DeKalb	4.5 fg	6.4 b-e	102
FS-1a+	DeKalb	3.3 gh	7.1 ab	88
811A-GB	Ring Around	3.1 h	7.0 ab	88
H-84D	Horizon	2.9 h	7.7 a	88
H-101G	Horizon	2.4 h	6.9 a-c	88

Stephenville under dryland conditions. Production varied from 7.8 to 2.4 tons/A and protein content varied from 7.7 to 4.5 percent. The number of days from planting to harvest varied from 88 to 204. In general, the earlier maturing cultivars had lower yields and higher protein, but there are exceptions to this.

Introduction

There has been a renewed interest in the use of silage by the Texas dairyman. Corn silage is considered to be superior to sorghum silage under dryland conditions, but production is risky because of frequent summer drought. This study was undertaken to determine the performance of silage type forage sorghums marketed in the Stephenville area.

Procedure

Twenty silage type forage sorghums were planted on April 27, 1984 at a rate of five plants per row feet in Windthorst fine sandy loam soil. Plots consisted of three rows spaced 3 feet, 15-feet long arranged in a randomized block design with four replications. Prior to planting, fertilizer was applied to the plot area at a rate of 148-60-0, N-P_2O_5-K_2O/A, and disk-incorporated. On May 3, 1984, 0.75 inches of irrigation water was applied to promote germination.

Ten feet of the center row were harvested at the soft dough stage of maturity to determine dry matter production per acre. Samples were taken, ovendried at 70°C, ground to pass a 20-mesh screen, and used to determine crude protein using Kjeldahl procedures.

Results and Discussion

No significant differences were observed among the top eight cultivars (Table 1). The four lowest yielding cultivars were the earliest maturing but had the highest protein content. Protein content for the test varied from 7.7 to 4.5 percent. In general, there was a negative relationship between yield and protein content. Also, the later maturing cultivars had the highest yield.

KEYWORDS: Silage production/sorghum bicolor/protien.

Forage Yield and Crude Protein Content of Sudan-Sorghum Hybrids

R. M. JONES

Summary

Yields of sudan-sorghum hybrids ranged from 1.78 to 4.53 tons dry matter/A at 25-50 percent booting with few statistical differences among 20 hybrids. Yields at second booting ranged from 0.7 to 1.2 tons/A, but were not statistically different. Crude protein content ranged from 5.9 to 9.4 percent and 6.7 to 9.3 percent, respectively, in forage of the first and second cutting with statistical differences among hybrids. Most hybrids reached first booting 55 to 63 days after seeding. Regrowth reached boot stage in 35 to 43 days. Rainfall was below normal for this study.

Introduction

Hybrids of sorghum and sudangrass are available to the producer in vast numbers and with appreciable

KEYWORDS: Sudan-sorghum hybrids/forage yield/feed.

variation in seed price. Previous studies have shown variation in yield and crude protein content of these hybrids. Since they are used for hay and grazing for beef and dairy animals in much of Texas, it is important to know yield potential and quality. The objective of this study was to determine forage yield, crude protein, and in vitro dry matter digestibility for locally available hybrids of varying seed price.

Procedure

Twenty hybrids of *Sorghum bicolor* (L.) Moench were seeded on Windthorst fine sandy loam on May 4, 1984 to provide a population of 12 plants per foot of row. Plots were 15.5-feet long with four rows spaced 15 inches. Four replications were used in a randomized complete block design. The test area was fertilized March 8 with 130 and 270 lb/A of 18-46-0 and urea, respectively, to provide a total of 148-60-0 lb/A N-P_2O_5-K_2O).

Each hybrid was harvested when 25 to 50 percent of the plants reached boot stage; all replications of each hybrid were cut on the same day. Plants were cut with a machete from 10 feet of each of the two row centers at a height of 3 inches. Harvested plants were weighed and subsamples taken and dried at 70°C for dry matter determination. The entire plot area was subsequently mowed to a height of 3 inches and all plant material removed. Yield of regrowth was determined the same as for the first cutting except that drought conditions forced earlier harvest. Two replications were cut 3 to 14 days prior to booting when it appeared that the plots might be desiccated by lack of rainfall and never reach boot stage. Plants in the two remaining replications were harvested when 5-10 percent were booting. Although the mean yield of the latter cutting was 0.24 tons/A greater than the earlier cutting and the mean crude protein content was 1.54 percent lower, the date effect was not statistically analyzed.

Crude protein was determined by the Kjeldahl method. In vitro dry matter digestibility determinations were not completed for this report.

Results and Discussion

Dry matter yields ranged from 1.78 to 4.53 and from 0.7 to 1.2 tons/A in the first and second harvests, respectively (Table 1). 'Thrifty Grazer', 'SX-17+', and 'Ribbon Grazer' produced statistically higher yields than 'Trudan 8' at the first cutting. There were no other significant differences among hybrids. Yields of regrowth were not significantly different. SX-17+ produced 4.53 tons dry matter/A at the first cutting, but remained longer in the vegetative stage than other hybrids and did not reach boot stage again.

Crude protein content ranged from 5.9 to 9.4 percent and from 6.7 to 9.7 percent in forage of the first and second harvests, respectively (Table 1). 'Kow Kandy' and Trudan 8 forage exceeded 9 percent crude protein content at the first cutting and was statistically greater than SX-17+ and 'Cadan 99B'. Crude protein content of Trudan 8 and 'Dine-A-Mite' exceeded 9 percent at the second cutting being statistically greater than Kow Kandy, 'Cattle King', 'Grow-N-Graze', 'HS-301A', and Ribbon Grazer. Crude protein of Trudan 8 was also significantly greater than that of 'TE Chieftan-A', 'Stockman's pride', and 'MorGain III'. Hybrids with relatively high crude protein content generally had relatively lower yields.

TABLE 1. DRY MATTER YIELD AND CRUDE PROTEIN CONTENT OF SUDAN-SORGHUM HYBRIDS

	Tons Dry Matter Per Acre[1]		Percent Crude Protein[1]	
Hybrid	**1st Cut**	**2nd Cut**	**1st Cut**	**2nd Cut**
SX-17+	4.53 a	[2]	5.9 d	[2]
Thrifty Grazer	3.44 a	1.1 a	8.4 abc	8.7 abcd
Ribbon Grazer	2.95 ab	1.2 a	8.6 abc	7.9 cde
XSG-13	2.85 abc	1.0 a	8.4 abc	8.8 abc
Kow Kist	2.77 abc	1.0 a	8.1 abc	8.8 abc
Cattle King	2.77 abc	1.1 a	7.9 bc	6.7 e
Sugraze	2.76 abc	1.0 a	8.2 abc	8.4 abcd
Cadan 99B	2.63 abc	0.8 a	7.3 c	8.6 abcd
Kow Kandy	2.54 abc	0.7 a	9.4 a	7.4 de
Grow-N-Graze	2.52 abc	1.0 a	8.4 abc	7.9 cde
MorGain III	2.50 abc	0.9 a	8.5 abc	8.1 bcd
TE Haygrazer II	2.48 abc	0.9 a	8.7 ab	8.7 abcd
Got-Cha	2.44 abc	0.9 a	8.4 abc	8.5 abcd
Dine-A-Mite	2.42 abc	0.8 a	8.8 ab	9.3 ab
TE Chieftan-A	2.40 abc	0.7 a	8.9 ab	8.3 bcd
DoMoR	2.36 abc	0.7 a	8.3 abc	8.7 abc
Stockman's Pride	2.34 bc	0.8 a	8.4 abc	8.2 bcd
Cattle Grazer	2.29 bc	1.0 a	8.3 abc	8.9 abc
HS-301A	2.09 bc	0.9 a	8.3 abc	7.9 cde
Trudan 8	1.78 c	1.0 a	9.1 ab	9.7 a

[1]Values within a column followed by the same letter are not statistically different at the 0.05 probability level. Date effects for the second harvest were not analyzed.

[2]SX-17+ had no regrowth.

Days from planting to 25-50 percent booting ranged from 55 for Trudan 8 to 88 for SX-17+ (Table 2). All other hybrids reached booting between 59 and 63 days after planting. Regrowth of Trudan 8 reached boot stage 35 days from the first cutting. Other hybrids reached the second booting between 40 and 43 days following first harvest. SX-17+ did not reach boot stage after the first cutting.

Rainfall was abnormally low during the period of this study. Consequently, 1.5 acre-inches of irrigation was applied on June 15 in order to prevent firing of leaves and to stimulate growth. For the first cutting Trudan 8 received 2.78 inches, SX-17+ received 4.88, and all others received 3.4 inches of rainfall. If the test had received the average rainfall of the past 45 years, SX-17+ would have received 9.49 inches and all others would have received approximately 7.29 inches. For the second cutting, Trudan 8 received 2.10 inches of rainfall because of earlier maturity, while other hybrids received only 1.65 inches.

TABLE 2. NUMBER OF DAYS REQUIRED TO REACH BOOTING STAGE OF HAY TYPE SUDAN-SORGHUM HYBRIDS

Sorghum Hybrid	Seed Company	Days to Booting: First Cut	Second Cut*
Trudan 8	Northrup King	55	35
TE Chieftan-A	Taylor-Evans	59	41
Got-Cha	Harpool	59	41
Dine-A-Mite	Conlee	59	42
Cattle King	Lewis Barker	59	42
TE Haygrazer II	Taylor-Evans	60	40
Ribbon Grazer	Crop Seed	60	42
MorGain III	Conlee	60	42
Stockman's Pride	R.C. Young	60	43
Sugraze	R.J. Riley	60	42
XSG-13	Pioneer	60	40
DoMoR	Conlee	61	42
Thrifty Grazer	Crop Seed	61	41
Cattle Grazer	KanTex	61	40
Grow-N-Graze	George Warner	61	42
HS-301A	Harpool	61	40
Kow Kandy	R.C. Young	62	41
Kow Kist	Harper	62	41
Cadan 99B	Browning	63	40
SX-17+	DeKalb-Pfizer	88	—

*Mean days for two replications cut in late vegetative state and two replications cut at approximately 10 percent booting.

Performance of Forage Sorghum Hybrids in Lower South Texas

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M. A. HUSSEY, AND B. E. CONRAD

Summary

Sixteen commercial cultivars consisting predominately of sorghum x sudangrass hybrids were evaluated for their potential forage production during 1984. Total seasonal yields ranged from 8,014 lb/A to 20,239 lb/A for two harvests. Crude protein percentage averaged 9.0 and 9.2 percent respectively for the two harvests. Stalk borer (*Eoreuma loftini* [Dyar]) damage was observed in all entries and mean number of larvae per tiller differed according to genotype. Attempts to relate larval numbers with selected plant morphological characters failed to account for a significant amount of the total variation.

Introduction

Forage sorghums are widely grown throughout the South. Because of their drought tolerance and potential to produce large quantities of dry matter, they are generally utilized in South Texas as a hay crop to supplement native ranges. In this region, little information exists as to the yield potential or quality of sorghum x sudangrass hybrids. Variety tests from Angleton (Evers, 1975), Beaumont (Evers et al., 1972), and College Station (Holt, 1965) have reported that yields of 3,500 to 16,000 lb/A are possible depending on rainfall and nitrogen fertility.

The objectives of this study were to determine the yield potential and protein content of commercially available sorghum x sudangrass hybrids in South Texas, and to determine the susceptibility of these hybrids to insect or disease.

KEYWORDS: Sorghum x sudangrass/forage yield/crude protein/rice borer/*Eoreuma loftini.*

Procedures

Seed of sixteen forage sorghum hybrids and one millet (Table 1) were planted on March 14, 1984 at a rate of 20 lb pure live seed (PLS)/A on a Willacy fine sandy loam. The entries were arranged in a randomized complete block design with four replications and fertilized with 50 lb nitrogen (N)/A at planting and at the beginning of the regrowth period.

Supplemental irrigation was applied at planting and 4 weeks after the first harvest to alleviate uneven tillering due to moisture stress during regrowth.

Two harvests were made for yield by harvesting a 3.3-foot section from the center row of each plot. To estimate yield, harvests were made when the plants were in the soft dough stage of development while forage quality samples were obtained at early head emergence.

Estimates of borer (*Eoreuma loftini* [Dyar]) damage were made by taking a 10-tiller sample per plot. Sampling was destructive as whole tillers were harvested, split longitudinally, and number of borer larvae recorded. Tiller density, tiller diameter, and tiller height measurements were made on the center row of each plot and related to larval numbers per tiller.

TABLE 1. SORGHUM X SUDANGRASS YIELD AND CRUDE PROTEIN, 1984 HARVEST

Variety	Yield (lb/A)	Crude Protein percent[1]
NK Trudan 8	13,768	9.02
Pioneer 877F	13,728	8.55
Asgrow Beefbuilder	13,365	8.00
Funk HW5574	11,788	—
R.C. Young Sweet Chew DMR	11,636	8.64
DeKalb SX 17	11,425	7.32
King 6 1 DR	11,207	9.60
King Sugart Sweet	11,167	8.88
DeKalb FS25A	10,870	8.25
Funk HW5111	10,672	8.36
TE Goldmaker T	10,626	9.45
Pogue Honeygraze II	10,501	8.50
Pioneer XSG21	9,887	9.52
Funk FP-4	8,837	8.82
Warner 2 Way DR	7,979	9.21
Bamert Dixe Haygrazer Millet	7,009	11.94
Bamert Early Sumac	6,587	9.41
Mean	10,650	8.97
LSD (0.05)	2,576	

[1]Expressed as whole plant percent.

Results

Total dry matter production ranged from 8,014 lb/A to 20,239 lb/A (Tables 1 and 2). This production greatly exceeded yields reported for forage sorghum hybrids from other locations in Texas (Jones and Read, 1982 and 1984; Evers, 1975; and Conrad, 1976), even though total rainfall during the growing season at Weslaco was below normal (Table 3).

While yields exceeding 20,000 lb/A were obtained in 1984, some cultivars performed better during the first growing period than during the regrowth period indicating the potential of a cultivar x season interaction for yield (Tables 1 and 2). Limited rainfall after the first harvest may have contributed to a lower yield of certain entries for the second cutting. Stand densities during regrowth were considerably less than during the initial growing period.

Whole plant crude protein averaged 9.0 and 9.2 percent for harvest 1 and 2 respectively, and agrees with values reported previously for sorghum hybrids (Jones and Read, 1984). The single millet entry in the test 'Dixie Haygrazer Millet' was consistently higher in crude protein (11.9 and 13.3 percent) than the sorghum hybrids for both harvest dates.

The yield of pearl millet was consistently less than most of the sorghum sudangrass cultivars although it exceeded the yield of 'early summac' (Red Top Cane) and slightly exceeded the performance of millets in other Texas locations (Evers et al., 1972).

Damage attributed to borers (*E. loftini* [Dyar]) was observed during both harvests in 1984. During the second harvest, the planting was sampled to quantify the level of borer infestation (Table 2). While some cultivars appreared to be more resistant, larvae were recorded from all entries including pearl millet. Attempts to relate larval numbers (level of infestation) with morphological characteristics of the plants were unsuccessful. Plant height accounted for the largest amount of variation (Table 3). The inclusion of tiller density, tiller diameter, and tiller growth stage into the model did little to improve the overall fit (Table 4).

TABLE 2. SORGHUM X SUDANGRASS YIELD, CRUDE PROTEIN, AND BORER RATINGS FOR SEPTEMBER 1984 HARVEST

Variety	Yield (lb/A)	Crude protein percent[1]	Rice borers (in 10 tillers)
Asgrow Beefbuilder	6,874	7.98	1.25
Funk HW5111	5,868	6.48	2.50
Dekalb SX17	5,577	7.56	1.25
Funk HW5574	5,490	8.25	3.75
Warner 2 Way DR	5,043	9.44	3.75
Pioneer SXG21	4,845	10.07	3.00
Pioneer 877F	4,152	11.04	2.25
DeKalb FS25A	3,592	—	3.00
King Sugar Sweet	3,438	8.06	2.25
Pogue Honeygraze II	3,257	9.53	5.25
RC Young Sweet Chew DMR	3,227	8.97	3.50
Funk FP-4	2,928	8.98	6.75
King 61DR	2,647	9.13	4.50
Bamert Dixe Haygrazer Millet	2,460*	13.37	1.00
TE Goldmaker T	2,075	8.47	5.00
NK Trudan 8	1,907	11.23	2.00
Bamert Early Sumac	1,427	8.55	4.00
Mean	3,896	9.19	3.24
LSD (0.05)	1,896		

[1]Expressed as whole plant percent.

*Only 1 replication was harvested.

TABLE 3. RAINFALL, TEMPERATURE, AND CLASS A PAN EVAPORATION AT WESLACO (MARCH 1 TO SEPTEMBER 15, 1984)

	Temp. (°F) max.	min.	Rainfall inches	Evaporation inches
March	82	61	0.09*	4.76
April	89	66	0.01	5.23
May	89	71	2.48	6.22
June	93	74	0.60	7.04
July	94	75	0.83*	6.81
August	96	75	0.73	7.51
September	85	71	2.79	2.85
Total			7.53	40.42

*Supplemental irrigation—3.0 inches.

TABLE 4. RELATIONSHIP BETWEEN BORER SUSCEPTIBILITY (LARVAE/TILLER) AND SELECTED PLANT MORPHOLOGICAL CHARACTERISTICS

Dependent variable	Independent variable	R^2
Larvae/tiller	Tiller density (NUM)	0.004
	Tiller diameter (SDM)	0.082
	Growth stage (GS)	0.104
	Tiller height (HT)	0.270*
	NUM HT GS SDM	0.281*

*Indicates significance at 0.05 level.

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Performance of Alfalfa Cultivars in the Brazos River Bottom near College Station

E. C. HOLT AND S. SIMECEK

Abstract

A test involving 26 cultivars was initiated in fall 1983 to evaluate yields and stand persistence. Yields varied from 5.8 to 7.5 tons with a total of six cuttings in 1984. Baron, Vanguard, 555, Florida 77, Southern Special, and Hi-Phy were in the highest yielding group. Treatment for alfalfa weevil damage was required in late March. The soybean looper damaged foliage in early November with some apparent differences among cultivars.

Introduction

Alfalfa is well adapted to the Brazos River Bottom soils. Production of 7 to 8 tons of hay with one or two irrigations is usually obtained. Yields without irrigation may be somewhat less depending on rainfall during the growing season. Several cultivars appear to be well adapted. Stand persistence of 3 years is common in experimental plots and more than 3 years appears possible with the best cultivars.

Procedure

Twenty-six cultivars (see list in Table 1) were planted on October 5, 1983 in plots consisting of five 12-inch rows, 20-feet long with six replications. The plot area was prefertilized with 0-60-60 which was disk-incorporated. The area also was treated with pre-emergence herbicide (Balan) prior to planting at the rate of 3 qt/A. Alfalfa weevil damage became apparent in late March and the plots were sprayed with Furadan on March 27. Soybean looper damage occurred in early November but no treatment was applied. The plot area was irrigated at 3 inches per application on April 30, September 20 and September 26-27, 1984. The plots were harvested six times in the early bloom stage.

Results

Yield data are given in Table 1. Yields ranged from a high of 7.5 to 5.8 tons/A. The highest yielding named cultivars were Baron, Vanguard, Florida 77, Southern Special, and Hi-Phy. The first cutting averaged more than 2 tons, the second cutting about 1.5 tons, and the third and fourth cuttings about 1 ton each.

Soybean looper damage occurred in early November and the plots were cut before reaching the early bloom stage because of the increasing damage. There appeared to be differences among cultivars in the degree of damage, thus observations on the degree of damage were recorded (Table 2). The data on damage were variable with a wide range among cultivars.

TABLE 1. YIELD OF ALFALFA VARIETIES IN THE BRAZOS RIVER BOTTON NEAR COLLEGE STATION, 1984

Entry No.	Cultivar	Apr. 17	May 28	June 26	Aug. 2	Sept. 11	Nov. 8	Total
		Date of Harvest						
		Pounds of Dry Forage Per Acre						
22	N-27	4,922	3,295	2,044	1,889	1,434	1,405	14,989 a[1]
23	N-29	4,431	3,230	1,996	2,133	1,449	1,437	14,776 a-b
7	Baron (Certified)	4,305	2,953	1,932	2,303	1,763	1,520	14,776 a-b
9	Vanguard	4,386	3,388	1,620	1,903	1,394	1,746	14,437 a-c
2	555	3,735	3,240	1,974	2,287	1,476	1,392	14,104 a-d
3	Fla 77	4,040	3,002	1,886	1,856	1,657	1,591	14,032 a-d
11	Southern Special	4,062	3,251	1,908	2,103	1,292	1,348	13,964 a-d
1	XAN 21-1-0042-24R	3,573	3,053	1,939	2,225	1,680	1,393	13,863 a-e
17	Hi-Phy	3,997	3,400	1,702	1,876	1,217	1,643	13,835 a-e
24	77-8 Cab	4,313	3,232	1,571	1,927	1,258	1,412	13,713 b-e
20	Saranac	4,238	3,732	1,659	1,479	1,222	1,339	13,669 b-e
18	Cimarron	4,056	3,208	1,736	1,713	1,282	1,515	13,510 c-f
5	Kanza	3,786	2,896	1,895	1,974	1,501	1,427	13,479 c-f
6	Vancon	4,258	3,176	1,646	1,866	1,056	1,455	13,457 c-f
13	Apollo (Certified)	4,186	3,098	1,524	1,840	1,341	1,361	13,350 c-f
25	WL Southern Special	3,666	2,923	1,959	2,006	1,316	1,427	13,297 c-f
12	WL-318	3,740	3,186	1,754	1,920	1,013	1,594	13,207 d-f
14	Armor (Certified)	4,083	3,292	1,489	1,590	1,210	1,536	13,200 d-f
26	Siriver Lucerne (Aust.)	3,718	2,684	1,915	1,722	1,451	1,597	13,087 d-g
8	Team	4,582	3,106	1,440	1,575	897	1,315	12,915 d-g
4	Raidor	4,243	3,331	1,395	1,661	932	1,351	12,913 d-g
19	Defender	4,069	3,078	1,443	1,607	905	1,612	12,714 e-g
15	Arc	3,942	3,014	1,321	1,710	1,061	1,254	12,302 f-h
21	Williamsburg	3,722	2,990	1,383	1,499	972	1,445	12,011 g-h
10	Weevlchek	3,584	2,934	1,487	1,648	970	1,336	11,959 g-h
16	Classic	4,047	2,403	1,313	1,469	902	1,373	11,507 h

[1]Total yields followed by a common letter are not significantly different (P 0.05), Duncan's Multiple Range.

KEYWORDS: Alfalfa/hay production/yield/cultivars/stand.

TABLE 2. SOYBEAN LOOPER DAMAGE ON ALFALFA CULTIVARS IN LATE FALL 1984

Entry Number	Cultivar	Percent Damage
10	Weevlchek	12 a[1]
4	Raidor	18 a
9	Vanguard	25 ab
24	77-8 Cab	27 ab
18	Cimarron	27 ab
3	Florida 77	28 ab
17	Hi-Phy	28 ab
8	Team	29 ab
21	Williamsburg	30 ab
14	Armor	31 ab
19	Defender	31 ab
20	Saranac	35 ab
13	Apollo	37 ab
16	Classic	42 ab
6	Vancor	43 ab
15	Arc	46 bc
12	WL-318	47 bc
25	WL Southern Special	52 bc
2	555	56 c
11	Southern Special	60 cd
5	Kanza	60 cd
23	N-29	64 cd
7	Baron	76 d
22	N-27	76 d
26	Siriver (Australia)	78 d
1	XAN 21-1-0042-24R	79 d

[1]Values followed by a common letter are not significantly different, Duncan's Multiple Range Test. C.V. = 42.2 percent.

Stands were uniform in 1984. If differences in stand survival occur in later years they will be recorded and reported.

Seasonal Production of Alfalfa and Red Clover, 1982-85

G. R. SMITH AND C. GILBERT

Summary

Fourteen alfalfa and two red clover varieties were evaluated for seasonal forage production and stand persistence at Overton from 1982 to 1985. Seedling year total yields of alfalfa ranged from 5,720 to 3,947 lb dry matter per acre (DM/A). Second year yields of alfalfa ranged from 5,913 to 4,453 lb DM/A. Red clover yields in the seedling year were 5,075 and 5,009 lb DM/A for the varieties Kenland and Kenstar, respectively. Red clover yields in the second year fell to 3,885 and 3,515 lb DM/A for Kenland and Kenstar, respectively. By the beginning of the third production season, stands of both red clover varieties were less than 6 percent and only six alfalfa varieties had stands greater than 20 percent. The range in stand for these six alfalfas was 27.5 to 53.8 percent for Weevilchek and Vancor, respectively.

KEYWORDS: Alfalfa/red clover/forage production/persistence.

Introduction

Alfalfa is a warm-season perennial legume used primarily for hay in high summer rainfall regions of the United States or in areas where irrigation water is available. Alfalfa is not generally grown on the sandy, acid soils of the southern region due to high fertility/lime requirements, pest problems, and lack of stand persistence. Red clover is sometimes used in the southern region as a late-producing, cool-season annual. In mid-south areas like Kentucky, red clover lives through the summer and often produces well for 2-3 years. Red clover is classified as a biennial. Our objectives in this study were : (1) to measure, under sod-seeding conditions with no herbicides or irrigation, the seasonal dry matter yield of alfalfa and red clover; (2) to determine the potential stand longevity for these two legume species; and (3) to assess potential pest problems with alfalfa and red clover.

Procedure

Fourteen alfalfa varieties and two red clover varieties were drilled into a native sod (common bermudagrass and *Paspalum setaceum* Michx.) in 5x7-foot plots October 13, 1982. A small plot drill with six double disk openers was used to place the seed at a one-half inch depth. Soil pH was 6.8 (0-6 inches) and soil test ratings of phosphorus and potassium were low and very low, respectively. Prior to planting, 450 lb/A of 0-20-20 were applied to the Sawtown fine sandy loam soil. Four hundred and fifty pounds of 0-20-20 fertilizer were also applied in September 1983 and in October 1984. The grass was mowed to 2 inches prior to sod-seeding. Alfalfa was seeded at 20 lb/A and *Rhizobium* type A inoculant was applied at 1 oz/lb of seed. Seeding rate for the red clover was 14 lb/A and *Rhizobium* type B inoculant was applied at 1 oz/lb of seed. Peat inoculant was supplied by the Nitragin Company. Pelgel solution was used as an adhesive to stick inoculant to the seed.

Due to the infestation of alfalfa weevil larvae, this experiment was sprayed with Sevin 805 (1.5 lb/A) five times. Furadan 4F (1 pt/A) was also applied in March 1984 and March 1985.

The alfalfa and red clover lines were arranged in a randomized complete block design with four replications. The experiment was harvested to 3 inches with a rotary mower when the alfalfa was in approximately one-tenth bloom. Plot fresh weights were recorded in the field. Subsamples were weighed, dried at 70°C for 48 hours, and weighed again. Percent dry matter of subsamples was used to calculate dry matter yield per acre.

A percent stand rating was taken at the beginning and end of each season. Plot weights were not recorded from the first harvest in 1983 due to high weed infestations.

Results and Discussion

Forage production of the sodseeded alfalfa (Table 1) ranged from 5,720 to 3,997 lb DM/A for Southern Special and WL-512, respectively, during the 1982-83 season. The variety Florida 77 was the second highest in yield at 5,565 lb DM/A. Florida 77 started with only 80 percent stand but sustained no stand loss during the first year. Stand losses ranged from 14 to 35.3 percent during the first season for Southern Special and Vancor, respectively. Forage production for the red clover during the first season (Table 1) was 5,364 lb DM/A for Kenland and 5.075 lb DM/A for Kenstar. Stand loss between the second and fourth cut were 5.3 percent for Kenland and 2.0 percent for Kenstar.

During the second season (1983-84) the first and fourth replications were eliminated because of stand loss. Total production during the 1983-84 season ranged from 5,913 to 4,453 lb DM/A for Apollo and Classic, respectively (Table 2). Over the season, Florida 77 came in third with a yield of 5,659 lb DM/A. Stand ratings taken June 6, 1985 showed a range of 32.2 percent loss for Vancor to a 77.5 percent loss for Florida 77. Production on the red clovers for the second season was 3,885 lb DM/A for Kenland and 3,515 lb DM/A for Kenstar. The red clover varieties started the 1984 season with a stand percent of 89.5 for Kenland and 94.8 for Kenstar, but neither made regrowth after the second cut.

Both alfalfa and red clover have the potential to produce high quality forage with no nitrogen fertilizer inputs. This late spring/summer forage production is highly dependent upon rainfall and for the alfalfa, timely insect control. Rainfall at Overton for the months of June-September during the seedling year of this experiment was close to the 17-year average of 13 inches. In the second year (1984), for the same time period, total rainfall was 5.7 inches. This resulted in severe stand losses ranging from 100 to 47 percent (Table 3). Once established, alfalfa appears more drought tolerant than red clover on the sandy soils of East Texas. Well distributed summer rainfall is required to insure the summer survival of red clover in East Texas.

Although alfalfa endured low soil moisture better than red clover, alfalfa weevil and three-cornered alfalfa hopper were major pests on the alfalfa in this study. Alfalfa weevil larvae were noted feeding in terminal buds whenever spring growth of alfalfa started. Application of Sevin at 1.5 lb/A gave only marginal control

TABLE 1. SEASONAL PRODUCTION OF ALFALFA AND RED CLOVER AT OVERTON, TEXAS , 1982-83

Variety	Harvest Date[2] June 16	July 19	Aug. 23	Total
	Pounds Dry Matter Per Acre			
Southern Special	2,005	2,399	1,316	5,720 a[1]
Florida 77	1,831	2,457	1,277	5,565 ab
Kenland Red Clover	2,053	2,184	1,127	5,364 ab
Kenstar Red Clover	2,055	1,966	1,054	5,075 ab
Apollo	1,823	2,170	1,016	5,009 ab
Vanguard	2,048	2,146	782	4,976 ab
Arc	2,092	1,958	884	4,934 ab
Cimarron	1,978	2,056	857	4,891 ab
Weevilchek	1,917	2,111	848	4,876 ab
Classic	1,835	1,960	838	4,633
Team	1,878	1,770	811	4,459 ab
Vancor	1,762	1,843	769	4,374 ab
Saranac AR	1,663	1,781	881	4,325
Defender	1,755	1,834	570	4,159 a
Hi-Phy	1,566	1,868	697	4,131 a
WL-512	1,625	1,821	551	3,997 a

C.V. = 24.4 percent

[1] Test planted October 13, 1982.

[2] Yields followed by the same letter are not significantly different using LSD (0.05).

TABLE 2. SEASONAL PRODUCTION OF ALFALFA AND RED CLOVER AT OVERTON, TEXAS, 1983-84

Variety	Harvest Date[1] Apr. 17	May 25	June 21	July 24	Total
	Pounds Dry Matter Per Acre				
Apollo	2,129	2,121	995	668	5,913 a[2]
Vancor	2,021	2,088	990	633	5,732 a
Florida	1,990	1,984	981	704	5,659 ab
Cimarron	1,925	2,048	727	648	5,348 abc
Hi-Phy	1,820	1,784	823	645	5,072 abc
Southern Special	1,529	1,950	811	619	4,909 abc
Team	1,794	1,796	615	480	4,685 abc
Saranac AR	1,697	1,644	708	561	4,610 abc
Weevilchek	1,500	1,814	713	558	4,585 abc
Classic	1,519	1,710	693	531	4,453 abc
Kenland Red	2,380	1,505			3,885 bc
Kenstar Red	2,142	1,373			3,515 c
Vanguard[3]					
Arc[3]					
Defender[3]					
WL-512[3]					

C.V. = 17.1 percent

[1]Planted October 13, 1982.

[2]Yields followed by the same letter are not significantly different using LSD (0.05).

[3]Stands were too low to evaluate for yield.

TABLE 3. STAND DECLINE OF SOD-SEEDED ALFALFA AND RED CLOVER THROUGH TWO PRODUCTION SEASONS AT OVERTON, TEXAS

Variety	June 16, 1983	Aug. 23, 1983	Apr. 12, 1984	June 7, 1985
	Percent Stand			
Kenland Red	98.3	93.0	89.5	2.8
Kenstar Red	98.0	96.0	94.8	5.0
Apollo	90.3	71.3	90.8	35.0
Arc	95.3	68.8	0.0	0.0
Cimarron	93.5	62.5	87.5	37.0
Classic	86.0	62.5	85.0	29.5
Defender	74.3	51.3	0.0	0.0
Florida 77	80.0	81.0	88.0	10.5
Hi-Phy	80.0	47.8	79.5	28.8
Saranac AR	83.8	50.0	72.5	19.5
Southern Special	93.3	79.3	81.0	15.8
Team	88.3	57.5	76.3	20.0
Vancor	90.3	55.0	86.0	53.8
Vanguard	89.5	65.0	0.0	0.0
Weevilchek	91.3	62.5	78.8	27.5
WL-512				
WL-512	73.8	46.3	0.0	0.0

Mean of two evaluators and four replications.

and required multiple treatments to control the alfalfa weevil. Three-cornered alfalfa hopper damage was observed in July 1982 and was contolled by Sevin at 1.5 lb/A. Furadan 4F at 1 pt/A controlled alfalfa weevil with one application.

Forage legumes, either reseeding annuals or persistent perennials, are need to increase quality and/or decrease nitrogen fertilizer inputs for warm-season pastures and hay across the southern region. Research at Overton indicates that alfalfa and red clover have the seasonal growth patterns and forage production potential to partially meet these needs in East Texas. However, neither legume species maintained an acceptable stand after a low rainfall summer and alfalfa required intensive insect control to maintain production. Further research with alfalfa and red clover is required to determine their place in East Texas forage systems.

Seasonal Forage Production of Annual Clovers

G. R. SMITH AND C. GILBERT

Summary

Thirty-four varieties or experimental lines of annual clover were evaluated for seasonal forage production at Overton from 1983 to 1984. Sixteen entries of subterranean (sub) clover were evaluated as reseeding stands on plots established in 1981. Yields of reseeding sub clover ranged from 3,206 to 1,349 lb dry matter (DM/A). Eighteen annual clover varieties of arrowleaf, crimson, rose, ball, and berseem were evaluated with total yields from three harvests ranging from 4,411 to 1,189 lb DM/A.

Introduction

Forage quality and cool-season production can be improved by the use of annual clovers in forage systems. The forage legume breeding program at Overton evaluates commercial varieties, experimental germplasm, and breeding lines of clovers and other legumes each year. These experiments provide current information on commercial varieties and comparisons with new varieties, breeding lines, and plant introductions. The objectives of these experiments were: (1) to determine seasonal dry matter yield of annual clover varieties and experimental lines, and (2) to determine reseeding ability of sub clover varieties and experimental lines.

KEYWORDS: Annual clover/sod-seeding/ forage production/reseeding.

Procedure

Eighteen annual clovers were drilled into a native sod (common bermudagrass and *Paspalum setaceum*) in 5x7-foot plots on October 14, 1983. A small plot drill with six double disk openers, spaced 9 inches apart, was used to place the seed at one-half inch depth. Soil pH (0-6 inches) was 6.8. Prior to planting, 450 lb/A of 0-20-20 fertilizer were applied to the Sawtown fine sandy loam soil. The grass was mowed to 2 inches prior to sod-seeding. The annual clovers were arranged in a randomized complete block design with four replications. These plots were harvested at 2.25 inches with a rotary mower.

The 16 reseeding varieties of sub clover were established in 6x12-foot plots on a prepared seedbed September 17, 1981. Two foot borders were left between plots to help prevent mixing. Soil pH was 7.1. Fertilizer was applied September 8, 1983 to the Bowie fine sandy loam soil at 450 lb/A (0-20-20). Previously, these plots were fertilized at planting and in fall 1982 with 450 lb/A 0-20-20. Summer growth of grass and weeds was removed by mowing at 2 inches. The sub clover lines were arranged in a randomized complete block design with four replications. Only two replications were harvested in the 1983-84 season due to winter freeze injury. Entries were harvested with a rotary mower at 1.25 inches.

Seeding rates and *Rhizobium* inoculants for each clover species in both experiments are shown in Table 1. Peat inoculant, supplied by the Nitragin Company, was applied at the rate of 1 oz/lb of seed. Pelgel solution was used as an adhesive to stick inoculant to the seed. Sub samples from both experiments were weighed, dried at 70°C for 48 hours, and weighed again. Percent dry matter of subsamples was used to calculate dry matter yield per acre.

Results and Discussion

Total production in the sod-seeded annual clover test ranged from 4,411 to 1,189 lb DM/A for Chief crimson and CH-N crimson clover, respectively (Table 2). The annual clovers produced more in May with the exception of Autauga, Tibbee, Dixie crimson, and Kondinin Rose clover which peaked in April. Tibbee, Autauga, and Chief crimson were the highest yielding at the first harvest. Arrowleaf clover yields in 1983-84 were lower than expected (Table 3). Total rainfall during March, April, and May 1984 was 5 inches below the 17-year average. This low soil moisture condition was a factor in reducing arrowleaf clover yields at the last harvest in May.

TABLE 1. SEEDING RATES AND *RHIZOBIUM* INOCULANT USED IN EVALUATION OF ANNUAL CLOVERS

Species	Seeding Rate	Inoculant Type[1]
	Pounds Per Acre	
Arrowleaf	14.2	O
Crimson	19.6	R
Subterranean	19.6	WR
Rose	19.6	WR
Berseem	19.6	R
Ball	3.5	B

[1]Supplied by the Nitragin Company, Milwaukee, Wisconsin

TABLE 2. SEASONAL PRODUCTION OF ANNUAL CLOVERS AT OVERTON, TEXAS, 1983-84

Variety	Harvest Date			Total
	Mar. 19	Apr. 12	May 11	
	Pounds Dry Matter Per Acre			
Chief[3]	564	1,914	1,933	4,411 a[1]
Wilton Rose	293	1,472	2,113	3,878 ab
Autauga[3]	797	1,752	915	3,464 abc
Tibbee[3]	872	1,595	838	3,305 abc
287973 Rose	151	1,121	1,978	3,250 abc
RRPS-5[2]	265	666	2,123	3,054 abc
Dixie[3]	522	1,487	1,029	3,038 abc
Kondinin Rose	548	1,241	1,014	2,803 abcd
Meechee[2]	117	430	2,249	2,796 abcd
Syn 4[2]	174	658	1,891	2,723 bcd
Yuchi[2]	256	659	1,657	2,572 bcd
Syn 2[2]	87	489	1,912	2,488 bcd
Syn 3[2]	78	650	1,738	2,466 bcd
Amclo[2]	103	756	1,472	2,331 bcd
Segrest Ball	0	392	1,565	1,957 cd
Common Ball	0	373	1,500	1,873 cd
Bigbee Berseem	124	360	751	1,235 d
CH-N[3]	175	447	567	1,189 d

C.V. = 21.1 percent

[1]Yields followed by the same letter are not significantly different at the 0.01 level using Student Newman-Keuls Multiple Range Test.

[2]Arrowleaf clover.

[3]Crimson clover.

TABLE 3. SEASONAL PRODUCTION OF RESEEDING SUBTERRANEAN CLOVER AT OVERTON, TEXAS, 1983-84

Variety	Harvest Date		Total
	Mar. 28	May 14	
	Pounds of Dry Matter/Acre		
209924	2,132	1,074	3,206 a[1]
Woogenellup	2,040	970	3,010 a
Tallarook	1,683	1,233	2,916 a
Miss. Ecotype	1,344	1,301	2,645 a
239907	1,213	1,363	2,576 a
319146	1,057	1,474	2,531 a
Nangeela	1,259	1,175	2,434 a
291917	768	1,629	2,397 a
311499	744	1,571	2,315 a
168638	636	1,586	2,222 a
311498	660	1,455	2,115 a
184962	858	1,230	2,088 a
209927	588	1,350	1,937 a
Mt. Barker	578	1,392	1,970 a
319145	463	886	1,349 a
Nungarin[2]	0	0	0

C.V. = 18.4 percent.

[1]Yields followed by the same letter are not significantly different at the 0.05 level using Student Newman-Keuls Multiple Range Test.

[2]Did not reseed in 1981-82.

Production of sub clover varieties and lines in their second reseeding stand ranged from 3,206 to 1,349 lb DM/A for line 209924 and 319145, respectively. The reseeding sub clover test was harvested twice with P.I. 209924 and Woogenellup as the highest producers during the March harvest. The experimental line 209924 yielded higher during both the 1982-83 and the 1983-84 seasons than in this year.

In late December 1983, extreme cold temperatures were recorded (three consecutive nights below 10°F). Performance of both the reseeding sub clover and the newly established annual clover test was diminished by these adverse conditions. However, even with these conditions, no clover lines in these tests were rated as winter-killed.

Clover Establishment and Growth at Different pH Levels

G. W. EVERS

Summary

Arrowleaf, berseem, crimson, rose, subterranean, white clovers, and alfalfa were grown at a pH of 4, 5, 6, 7, and 8. Potting material was a coarse sand that was washed with a 1.0 nitrogen (N) hydrochloric acid solution. Nutrient solutions were adjusted with sodium hydroxide or sulfuric acid to the desired pH level. Data recorded were time interval from planting to seedling emergence, seedling survival, and dry weight per pot. Alfalfa required a pH of 6 or higher with optimum growth at pH 7 and 8. Arrowleaf was the most sensitive clover to pH with optimum establishment and growth at pH of 6. A minimum pH of 6 was required by rose and white clovers. Berseem, crimson, and subterranean clovers were the most tolerant of pH with poor survival and growth at pH of 4 only.

KEYWORDS: Clover/soil pH/clover establishment.

Introduction

Soil pH is critical for plant growth because it determines nutrient availability and uptake by plants. Plant species vary in their ability to extract nutrients and grow at different pH levels. Some plant species may be soil pH specific for optimum growth while others do well over a wide pH range. Clovers are being used more in pastures in the southeastern United States because they extend the grazing season, provide the highest quality forage, and add nitrogen to the soil. Information is lacking on the effect of soil pH on growth of clover species used in the southeastern United States. A greenhouse study was conducted at the Angleton Research Station to examine the effect of pH on the growth of major forage legume species.

Procedure

The study began February 9, 1984. Coarse sand was washed with a 1.0 nitrogen (N) hydrochloric acid solution to remove all carbonates from the potting material. This resulted in an inert potting material so that the pH levels could be maintained by adjusting the nutrient solution to the desired pH levels. Twenty to 25 seeds per pot were planted of Yuchi arrowleaf, Bigbee berseem, Dixie crimson, La. S-1 white, Mt. Barker subterranean, Kondinin rose clovers, and Florida 77 alfalfa. Each species was inoculated with their respective *Rhizobium* bacteria before planting using the Pelinoc-Pelgel system. All pots were watered once or twice daily to keep the potting material moist. The pH of the nutrient solutions were checked every day and were adjusted with 0.5 nitrogen sodium hydroxide or 0.5 nitrogen sulfuric acid to a pH of 4, 5, 6, 7, or 8. Because of the daily watering, the *Rhizobium* bacteria were washed out of the sand which resulted in very poor nodulation. Therefore, nitrogen was added to the nutrient solutions beginning March 1. Pots with more than 12 seedlings were thinned to 12 per plot. Data recorded were emergence of first seedlings, number of surviving seedlings, and plant dry weight per pot. The study was terminated April 9, 1984.

Results

The number of days between planting and emergence of first seedling is reported in Table 1. Alfalfa was the most sensitive legume species with no seedlings emerging at a pH of 4 and 5. Emergence of arrowleaf clover was twice as fast at a pH of 6 and 7 than the other pH levels. A pH of 4 delayed emergence of white and rose clover. Emergence of berseem, crimson, and subterranean clovers appear to be unaffected by pH.

Seedlings in about one-third of the pots needed to be thinned to 12. Alfalfa had an excellent stand at the three highest pH levels (Table 2). The best arrowleaf stand was at pH 6 with fair stands at pH or 7 and 8. A pH of 4 and 5 drastically reduced the seedling survival of arrowleaf, white and rose clover. Survival of other clovers was only reduced at a pH of 4.

TABLE 1. EFFECT OF pH ON THE NUMBER OF DAYS FROM PLANTING TO EMERGENCE OF FIRST CLOVER SEEDLING OF VARIOUS CLOVER SPECIES

Clover	pH 4	5	6	7	8
			Days		
Alfalfa	—	—	4	4	4
Arrowleaf	16	16	8	9	17
Berseem	6	4	4	4	4
Crimson	6	5	4	4	5
Subterranean	5	5	5	5	5
Rose	32	5	5	7	5
White	21	9	6	7	6

TABLE 2. EFFECT OF pH ON CLOVER SEEDLING EMERGENCE AND SURVIVAL

Clover	pH 4	5	6	7	8
			Seedlings/Pot		
Alfalfa	0	0	12.0	12.0	12.0
Arrowleaf	2.3	2.7	10.7	6.0	6.7
Berseem	8.3	12.0	12.0	11.0	12.0
Crimson	5.7	11.0	12.0	11.0	12.0
Subterranean	7.3	12.0	12.0	12.0	12.0
Rose	0.7	3.3	9.7	8.0	7.3
White	1.7	2.0	11.0	10.0	12.0

The dry weight of clover per pot is reported in Table 3. Alfalfa growth was best at pH of 7 and 8 although seedling stands were the same at the three highest pH treatments. Optimum arrowleaf and white clover growth was at a pH of 6 with moderate growth at a higher pH and very little growth at a lower pH level. Rose clover did best at the highest pH levels with growth decreasing as the pH decreased. Maximum berseem growth was at a pH of 7. Crimson and subterranean clover did well at all pH levels except 4.

Discussion

There was a wide variation in response of the different forage legumes to pH. Alfalfa required a pH of 6 or higher for seedling survival with optimum growth at pH 7 and 8. It appears that raising the soil pH from 6 to 7 or higher with lime would be profitable on alfalfa. Arrowleaf and white clover were the most sensitive clovers to pH as demonstrated by the dramatic increase in growth from a pH of 5 to 6. However, in contrast with the other clovers, growth was reduced at a higher pH. The delayed emergence and poor seedling survival of arrowleaf at the pH 4 and 5 may be a factor in the sometimes poor reseeding of this clover in the fall. A pH of 6 is essential for satisfactory production of both clovers.

Although berseem clover grew at all pH levels, the best performance was a pH 7. Crimson and subterranean clovers are adapted to the widest pH range with poor performance only at the pH 4 level. Rose clover would require a pH of 7 or higher for satisfactory yields.

Effect of pH on Rhizobium survival and nodulation could not be determined because of the daily flushing of the pots with nutrient solution. Nitrogen was not a

TABLE 3. EFFECT OF pH ON WEIGHT OF CLOVER

Clover	pH 4	5	6	7	8
	Grams/Pot				
Alfalfa	0	0	2.3	3.3	3.7
Arrowleaf	0.3	0.3	3.0	2.0	1.5
Berseem	1.2	1.7	2.0	2.3	1.2
Crimson	1.7	3.7	3.7	3.3	4.0
Subterranean	0.5	2.6	2.6	2.6	3.0
Rose	0.7	1.3	2.0	2.7	2.7
White	0.3	0.5	1.7	1.5	1.3

limiting factor to clover growth since it was added to the nutrient solution 19 days after the study began. Under field conditions, the legume plant relies on the *Rhizobium* bacteria for nitrogen through the symbiotic relationship. Although the legume may be adapted to a particular pH level, the *Rhizobium* may not, which will result in poor plant growth because nitrogem is limiting.

Forage Quality Evaluations for Mt. Barker Subterranean and Bigbee Berseem Clovers

H. LIPPKE AND G. W. EVERS

Summary

Forage samples were harvested biweekly during March, April, and May 1984 from previously uncut subplots of Bigbee berseem and Mt. Barker subterranean clovers as well as from subplots which were mowed in early March. Forage quality, as measured by content of neutral detergent fiber and in vitro dry matter disappearance, was higher for the subterranean clover than for the berseem clover. Typically, forage quality declined with time. There was no clear difference in quality in favor of forage harvested from the subplots that were mowed. The absolute difference between these clovers in grazing situations cannot be inferred from these data.

Introduction

Bigbee berseem clover was released jointly by the Mississippi Agricultural and Forestry Experiment Station and the Agricultural Research Service, USDA in March 1984. Relatively little is known about its management and utilization. A small-plot study was conducted to compare the forage quality of Bigbee berseem with Mt. Barker subterranean clover from February through May.

KEYWORDS: Bigbee berseem clover/Mt. Barker subterranean clover/grazing situations.

Procedure

Bigbee berseem and Mt. Barker subterranean clovers were drilled in strips 4 x 50 feet, October 13, 1983 on a Norwood silt loam. Sixty lb/A of phosphorus and potassium were applied at planting. Experimental design was a split, split-plot with four replications. Twenty-five feet of each strip were left uncut and the other 25 feet were cut to a 2-inch height on March 8. The 25-foot strips were further divided into nine sub-plots. The center (16 x 24 inches) of a subplot was harvested every 2 weeks beginning February 7 and March 21 on the unmowed and mowed strips, respectively. Subplots from the mowed strip provided samples with a higher proportion of new growth than samples harvested on the same day from unmowed subplots. This design provided samples of forages of two ages over the growing season.

The samples were dried on open pans at 60°C and ground in an intermediate Wiley mill fitted with 1-mm screen. Neutral detergent fiber (NDF) and in vitro dry matter disappearance (IVDMD) after 6 days of fermentation were determined for each sample harvested on March 8 and thereafter.

Results and Discussion

The NDF and IVDMD values by clover species, mowing treatment, and date are shown in Tables 1 and 2, respectively. Values for IVDMD provide only a ranking. In vivo digestibility values will be about 15 percent units lower. All two-way and the three-way interactions were statistically significant. However, examination of the tables and testing the main effects

TABLE 1. NEUTRAL DETERGENT FIBER VALUES FOR BERSEEM AND SUBTERRANEAN CLOVERS

Date	Berseem Mowed	Berseem Unmowed	Subterranean Mowed	Subterranean Unmowed
	Percent			
Mar. 8	—	41.1	—	32.9
Mar. 21	45.4	41.4	37.5	31.2
Apr. 5	43.4	48.7	32.4	36.9
Apr. 18	46.7	48.3	39.3	38.9
May 2	50.6	53.2	42.7	43.9
May 16	49.8	50.8	47.5	50.1
May 30	63.7	69.7	58.1	58.3

TABLE 2. IN VITRO DRY MATTER DISAPPEARANCE VALUES FOR BERSEEM AND SUBTERRANEAN CLOVERS

Date	Berseem Mowed	Berseem Unmowed	Subterranean Mowed	Subterranean Unmowed
	Percent			
Mar. 8	—	89.0	—	93.6
Mar. 21	89.1	86.4	91.7	90.6
Apr. 5	86.6	79.6	90.3	88.7
Apr. 18	80.2	78.0	88.2	85.5
May 2	74.9	71.1	81.0	79.4
May 16	71.9	69.1	75.3	75.8
May 30	61.9	58.1	69.8	68.7

with interaction sums of squares as the error term shows that the subterranean clover clearly has a higher quality forage than does the berseem clover. Also, there are clear differences due to cutting date. The effect of the mowing treatment was ambiguous, although the subplots mowed on March 8 tended to yield higher quality forage. The IVDMD values for berseem clover dropped sharply with the onset of rapid growth in April, again at the initiation of flowering in early May, and finally at the completion of flowering in late May. Subterranean clover showed more rapid declines in IVDMD values at the onset of flowering and again at senescence. The significance of these values for grazing situations cannot be predicted. There is a high probability that the difference in qualities of herbage consumed from these two clovers would be less under grazing.

Rose Clover Evaluation and Selection

G. R. SMITH

Summary

Nineteen rose clover plants were selected from a spaced plant nursery in 1982-83 based on ratings for maturity and forage potential. Progeny from these selections were compared in replicated rows to parental lines and commercial checks in 1983-84. Ten superior rose clover lines were identified for further testing. All 10 lines were rated as better forage types than the commercial varieties. All 10 lines were also later in maturity than Kondinin and Hykon and ranged from slightly earlier to slightly later in maturity than Wilton.

Introduction

Rose clover (*Trifolium hirtum* All.) is a winter-annual legume adapted to a wide range of soil types. Rose produces seed similar in size to crimson clover with a high percentage of very persistent hard seed. No major disease or insect pests have been noted on rose clover in Texas. Presently, Hykon and Kondinin are the only certified commercial varieties widely available. Both of these varieties are too early in maturity to take full advantage of our growing season in East Texas. Wilton rose clover is no longer available as certified seed, but the 'Wilton' type can be purchased as California common rose clover.

Objectives of the rose clover breeding program at Overton are: (1) development of highly productive, late maturing (mid-May) rose clovers; and (2) maintenance of persistent hard seed and pest resistance traits in new germplasm.

KEYWORDS: Rose clover/reseeding/breeding/selection.

Procedures

Three hundred and eight seedlings of rose clover were transplanted to a spaced plant field nursery on November 15, 1982. Rose clover variety Wilton and plant introductions 287973, 311483, 287975, and 311485 were the germplasm base for this nursery. Soil pH was 6.8 (0-6 inches). Soil test ratings of phosphorus and potassium were low and very low, respectively. Prior to transplanting, 450 lb/A of 0-20-20 were applied to the Sawtown fine sandy loam soil. In early January 1983, plants showing winter freeze injury (23 percent of the nursery) were removed. In March and April the remaining plants were rated for maturity and forage potential. Based on these ratings, 18 rose clovers lines were identified for further evaluation (Table 1).

These 19 selections and their parental lines were planted at Overton in 3-ft rows on October 26, 1983. Seeding rate was 0.5 g/row of inoculated (Nitrogen type WR with Pelgel) seed. Experimental design was a randomized complete block with two replications. Two evaluators rated the rose clover lines for stand, maturity, and forage potential in March and April 1984. Ten superior lines were identified (Table 2). Seed were harvested at maturity and a subsample was hand-cleaned for hard seed determination. Percent hard seed was measured by placing 200 seed from each line on moist germination paper in petri dishes (50 seed/dish, four dishes). The germination paper was checked daily and kept moist with deionized water. After 10 days unimbibed seed were counted as hard seed (Table 2).

TABLE 1. ROSE CLOVER SINGLE PLANT SELECTIONS FROM 1982-83 NURSERY

1982-83 Nursery ID	Origin	April 29, 1983 Maturity[1]	April 29, 1983 Forage Potential[2]
B19	Wilton	2	4
E12	Wilton	2	4
H18	311483	2	5
I2	Wilton	2	4
R12	Wilton	2	4
H4	311483	2	4
A1	287973	3	5
A2	287973	3	5
D3	311485	2	3
D17	311485	3	5
D19	311485	3	5
E3	Wilton	3	5
F20	287973	3	5
H1	311483	3	5
H7	311483	2	3
J3	287973	3	5
M13	311485	3	5
M16	311485	2	3
015	287973	3	5
Range		2-5	1-5

[1]1 = vegetative; 2 = early bud; 3 = late bud; 4 = early bloom; 5 = full bloom.
[2]5 = very leafy, vigorous plant; 1 = very stemmy, low vigor.

TABLE 2. ROSE CLOVER SELECTIONS, PARENTAL LINES, AND CHECKS FROM 1983 to 1984 SEEDED ROWS

1983-84 Entry No.	1982-83 Nursery ID	Origin	Vigor[1]	April 26, 1984 Stand[2] Percent	Maturity[3]	Height[4] inches	Hard Seed[5] Percent
17	H7	311483	4.1	99	2.7	8.5	81.0
18	J3	287973	4.4	98	3.0	10.5	59.5
21	F20	287973	4.1	91	3.0	9.0	70.5
22	015	287973	4.8	96	3.0	11.5	76.7
23	D3	311485	4.6	92	2.5	10.0	66.7
24	D17	311485	4.3	97	3.0	9.5	68.7
26	M13	311485	5.0	99	3.0	12.0	66.0
27	M16	311485	4.4	96	2.7	10.5	66.0
13	R12	Wilton	3.8	92	1.7	5.5	75.2
14	H18	311483	3.7	81	2.0	7.5	54.5
1	—	Wilton	2.3	45	2.2	4.0	82.7
2	—	Hykon	1.1	56	5.0+	4.5	88.0
3	—	Kondinin	1.4	67	5.0+	6.0	88.2
4	—	287973	4.0	96	2.7	9.0	75.0
5	—	311485	4.3	83	3.0	11.0	75.7
6	—	287975	3.7	89	3.7	8.0	76.5
7	—	311483	3.5	74	3.0	9.0	77.5

[1]5 = vigorous, leafy plant; 1 = stemmy, low vigor plant (mean of two evaluators and two replications.

[2]Mean of two evaluators and two replications.

[3]1 = vegetative, 5 = full bloom (mean of two replications).

[4]Mean of two replications.

[5]Mean of four replications.

Results and Discussion

Five hundred and twenty-three annual clover plant introductions were evaluated by Shipe and Rouquette at Overton in 1976-77 for stand establishment, seedling vigor and growth rate. From these original plant introductions rose clover was identified as one of several clovers with potential for improvement and use in Texas. This species is primarily self-pollinated but the percentage of outcrossing is enough (5 percent) for variation to occur within and among lines.

The final 10 selections made from the 1984 seeded rows consist of three lines from P.I. 287973, four lines from 311485, two lines from 311483 and one line from Wilton. In general, these 10 selections were rated better than the commercial varieties for vigor or forage potential and were later in maturity than Hykon or Kondinin. The selections ranged from slightly earlier to slightly later than the variety Wilton. Hard seed percentage ranged from 81 to 54 percent for the selections and 88 to 82 percent for the commercial varieties (Table 2).

Further testing is in progress to determine the relative persistence of hard seed produced by the rose clover selections and commercial varieties. Observation trials are in progress at eight locations in Texas to determine adaptation and forage potential of the 10 rose clover selections compared to commercial varieties. Seasonal forage production studies and seed increases of the rose clover selections are in progress at Overton. Animal production on reseeding stands will be the final test for one or two of these rose clover selections. With good seed increases, grazing evaluations can begin in 1985 or 1986.

Micropropagation of *Leucaena Leucocephala* ([Lam] de Wit)

C. A. BOOGHER AND M. A. HUSSEY

Summary

Auxillary buds of *Leucaena leucocephala* were cultured in vitro on a modified Murashige and Skoog basal media (MS). Cultures utilizing MS media or MS supplemented with IAA produced single shoots and normal root development. MS supplemented with BAP + NAA produced multiple shoots and no roots; and after transfer to MS + IBA + K, abnormal roots. High levels of 2,4-D (3 mg/l) prevented both shoot and root formation. Survival of plantlets after transfer to soil was significantly lower in those cultured in MS supplemented with growth regulators. Plantlets cultured on MS produced the greatest number of normal transplants and were not significantly different from those obtained by standard horticultural practices.

Introduction

Members of genus *Leucaena* have received much attention in the past 5-10 years as multi-use leguminous trees with potential for biomass, forage, and timber production (Hill, 1971; National Research Council, 1984). In South Texas, three species of Leucaena (*L.*

KEYWORDS: Tissue culture/growth regulator/regeneration/rooting frequency.

leucocephala, L. pulverulenta, and *L. retusa*) have become naturalized and may offer some potential as a forage resource for semi-arid rangelands.

While some problems are associated with the genus, sufficient genetic variability appears to exist for future improvements. This will potentially involve interspecific hybridization; however, while interspecific crosses are possible (Sorenson and Brewbaker, 1984), the progeny are generally poor seed producers or partially sterile. Therefore, a rapid and efficient technique for the propagation of superior germplasm is needed.

Procedures

Two-month old greenhouse-grown plants of *Leucaena leucocephala* (cv K 28 and K 67) were used as explant sources. Stem sections about 10-20 mm long containing single auxillary buds were removed, washed with detergent, washed 1 minute in 70 percent alcohol, rinsed in sterile distilled water, and then placed in a 20 percent v/v solution of household bleach (1 percent NaOCl) for 25 minutes in a laminar flow hood. After several rinses in sterile water, material was left to air-dry for 15 minutes before transfer.

Media were prepared using standard Murashige-Skoog salt solutions (Murashige and Skoog, 1962) to which 20 g/l sucrose and 7 g/l agar (Difco Bacto Agar) were added. Four treatments were used:

1. MS: Basal media + O growth regulators.
2. MS + 2,4-D: Basal media + 3 mg/l 2,4-Dicholorphenoxyacetic acid.
3. MS + IAA: Basal media + 3 mg/l Indole-3-acetic acid.
4. MS + BAP + NAA: Basal media + 3 mg/l 6-Benzylaminopurine and 0.6 mg/l-Naphthalene-acetic acid.

Fifty replicates were used for each genotype-treatment combination. Sections were transferred aseptically to 20 x 150 mm culture tubes containing 20 ml of media and incubated at 30° ± 1°C with a 16-hour photoperiod (1.4J cm^{-2} sec^{-1}) for 6 weeks. Cultures were then evaluated for shoot and root production.

Cultures producing rooted plantlets were inoculated with rhizobia (Nitrogen-Leucaena Spec. 1) and transferred to a soil medium. Shoots from MS + BAP + NAA were transferred to a rooting medium as described by Goyal et al. (1985) containing 3 mg/l Indole-3-butyric acid (IBA) and 0.05 mg/l Kinetin (K). Rooted plantlets from this medium were also transferred to soil. Surviving transplants were counted after 6 weeks.

Results and Discussion

A high percentage of shoot production was observed in all treatment groups with the exception of Treatment 2 (3 mg/l 2,4-d), in which few cultures exhibited shoots (Table 1). A single shoot and root were produced from explants on Treatments 1 (MS) and 3 (MS + IAA). Growth in both treatments appeared normal, with bud break occurring within 7 days and rooting within 21 days. The apparent ineffectiveness of IAA to elicit a response may have been due to the instability of IAA (Dunlap and Kresovich, pers. comm.).

TABLE 1. COMPARISON OF FREQUENCIES OF ROOT AND SHOOT FORMATION OF CULTURED AXILLARY BUDS OF TWO VARIETIES OF LEUCAENA LEUCOCEPHALA IN DIFFERENT MEDIA TYPES

Media	Genotype	Explants producing shoots percent	Means/number shoots/explant	Explants producing roots percent
MS	K 67	100	1	37
MS	K 28	91	1	46
MS + 2, 4-D	K 67	3	1	0
MS + 2, 4-D	K 28	5	1	0
MS + IAA	K 67	100	1	34
MS + IAA	K 28	92	1	37
MS + BAP + NAA	K 67	67	5.9	0 (*44)
MS + BAP + NAA	K 28	80	6.3	0 (*46)

*After transfer to rooting medial, MS + IBA mg/1 + K 0.05 mg/1.

Multiple shoots were formed with Treatment 4 (MS + NAA + BAP), as 57 shoots were produced per bud (Table 1). Histological examination of the axillary buds has indicated that multiple meristems are located in this region (Hussey and Boogher, unpubl.), therefore multiple shoot production is a function of alleviating apical dominance versus *de novo* production of new shoots.

Transfer of shoots from Treatment 4 to rooting medium resulted in the production of highly branched and thickened roots. While the rooting success in this treatment was similar to that observed for Treatments 1 and 3, ultimate plant survival was greatly reduced (Table 2).

The total number of intact plants recovered from soil was greatest for Treatment 1 (Table 2). While Treatment 3 produced shoots and roots which appeared normal, fewer transplants were recovered.

With the high costs associated with in vitro propagation, and the relatively poor rooting response; it appears that in vitro propagation offers little advantage over traditional horticultural propagation techniques. The direct rooting of vegetative cuttings in a mist bed, has been demonstrated to be more successful than in vitro methods (Hu and Liu, 1981).

TABLE 2. PLANTLETS RECOVERED FROM DIFFERENT MEDIA TREATMENTS AFTER TRANSFER TO SOIL

Media	Genotype	Percent Recovered
MS	K 28	46.2
MS	K 67	41.7
MS + IAA	K 28	22.2
MS + IAA	K67	12.5
MS + IBA + K	K 28	7.7
MS + IBA + K	K 67	0

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Response of Ryegrass to Rates of Limestone and Phosphorus

V. A. HABY, J. V. DAVIS, AND A. T. LEONARD

Summary

Ryegrass response to limestone and phosphorus was evaluated on a strongly acidic (pH 4.5) Lilbert loamy fine sand testing low in phosphorus, calcium, and magnesium and very low in potassium. Limestone treatments of 0, 600, and 3,400 lb/A were applied in early July 1983. Phosphorus treatments were applied at this same time at rates of 0, 30, 61, 92, 123, 245, and 491 lb P_2O_5/A. The existing stand of Coastal bermudagrass was mowed to a 2-inch length and Marshall ryegrass was seeded in rows 9 inches apart in November.

The first harvest of ryegrass was clipped April 16, 1984 and the second was taken May 22, 1984. Limestone increased ryegrass yields from 1,135 to 2,701 and 3,346 lb/A at the 0.3 and 1.7 tons/A rate, respectively, the first cutting and from 1,647 to 1,818 and 2,032 lb/A the second cutting. Phosphorus increased ryegrass yields from 3,677 lb to 5,023 lb/A over the two harvests.

Introduction

According to soil test summaries, the percentage of soils testing below pH 5.2 was 2 percent in 1967, but had increased to 12 percent testing below pH 5.0 in 1982. Liming these very strongly acidic soils to near neutrality may cause reduced crop yields. Soils containing sufficient exchangeable aluminum, when limed, can produce hydroxy aluminum precipitates, which, along with soluble aluminum, present effective and extensive surfaces to precipitate added phosphorus, making it unavailable to plants. Large applications of phosphorus can overcome deficiencies by saturating these new reactive surfaces. This study was designed to evaluate the extent of phosphorus fixation, to calibrate the phosphorus soil test to ryegrass response, to determine the residual effect of limestone and phosphorus applications, and to study the interactions of limestone and phosphorus as they affect grass response.

KEYWORDS: Lilbert loamy fine sand/limestone-phosphorus interactions/soil pH.

Procedure

A Lilbert loamy fine sand was selected for this study. It is an East Texas benchmark soil, which means that it occupies a large acreage. This soil was selected because it had a surface 6-inch depth pH of 4.5, phosphorus, calcium, and magnesium levels of 8,200, and 30 ppm, respectively, and a very low 60 ppm potassium level. Three rates of limestone 0, 0.3, and 1.7 tons/A were applied as major plots in a split-plot statistical design. Phosphorus rates of 0, 30, 61, 92, 123, 245, and 491 lb of P_2O_5/A were applied over the limestone treatments as split plots. Eight replications of each treatment were applied. Nitrogen and potash were applied as urea and muriate of potash at rates of 150 and 260 lb/A, respectively, in 1983. The existing grass was mowed and all treatments were roto-till incorporated. Two harvests of Coastal bermudagrass were made in 1983.

Marshall ryegrass (30 lb/A) and Mt. Barker subterranean clover (20 lb/A) were each seeded into one-half the research area (four replications) on Nov. 4, 1983. The ryegrass was fertilized on Dec. 6, 1983 and Feb. 3, 1984 with 60 lb N/A from urea. The sub clover was not fertilized.

Ryegrass yields were evaluated statistically by analysis of variance using MSUSTAT on a microcomputer.

Results and Discussion

The severe cold temperatures in mid-to-late December 1983 killed the young sub clover seedlings and the Coastal bermudagrass. The Coastal bermudagrass was resprigged over the plot area on May 25, 1984, and the remaining growing season was devoted to managing the plot area to get the Coastal bermudagrass to recover to a full stand. Therefore, no yield data are available for this grass in 1984. A reasonable stand of Coastal bermudagrass was obtained and limestone and phosphorus treatments will be evaluated by Coastal bermudagrass yields in 1985.

Marshall ryegrass survived the winter cold and produced up to 3 tons of ovendry grass in the highest lime-

TABLE 1. RESPONSE OF RYEGRASS TO LIMESTONE RATES APPLIED TO A pH 4.5 LILBERT LOAMY FINE SAND

Limestone	Yield, dry weight		
Rate	Harvest 1	Harvest 2	Total
Tons/A	Pounds/Acre		
0	1,135 a[1]	1,647 a	2,783 a
0.3	2,701 b	1,818 a	4,518 b
1.7	3,346 b	2,032 a	5,378 c

[1]Yield data within columns followed by the same letter are not significantly different, statistically, at the 95 percent probability level.

TABLE 2. RESPONSE OF RYEGRASS TO PHOSPHORUS RATES APPLIED TO AN 8 PPM, LOW PHOSPHORUS, LILBERT LOAMY FINE SAND

Phosphorus rate	Yield, dry weight		
	Harvest 1	Harvest 2	Total
lbs P_2O_5/A	Pounds/Acre		
0	2,097 a[1]	1,580 a	3,677 a
30	2,105 a	1,685 ab	3,790 a
61	2,209 a	1,766 abc	3,975 ab
92	2,417 a	1,769 abc	4,186 abc
123	2,637 a	2,065 bc	4,702 bc
245	2,441 a	1,791 abc	4,232 abc
491	2,852 a	2,171 c	5,023 c

[1]Yield data within columns followed by the same letter are not significantly different, statistically, at the 95 percent level.

stone and phosphorus treated plots. Yield data were taken on April 16, and May 22, 1984. Ryegrass responses to limestone treatments are presented in Table 1.

Dry matter yield was increased nearly 1,600 lb/A at the first harvest by application of 0.3 tons of limestone per acre, and by an additional 650 lb when the limestone rate was increased to 1.7 tons per acre. Ryegrass responses to limestone rates were not significantly different at the second harvest, but total yields were. A total ryegrass response of 1,735 lb was produced by the 0.3 ton rate of limestone, compared to nearly 2,600 lb of grass produced by the 1.7 ton per acre rate. The 0.3 ton rate of limestone reduced the toxic effects of the pH 4.5 Lilbert soil during the first season, but was not enough limestone to completely overcome the acidity. In addition, the 0.3 ton rate of limestone will not have the lasting effect, especially where high rates of nitrogen are applied to Coastal bermudagrass.

Ryegrass yield responses to phosphorus rates are shown in Table 2.

Dry matter yield continued to increase as the phosphorus rate increased up to 491 lb P_2O_5/A, but the ryegrass yield response at this high rate was not significantly greater, statistically, than the 4,186 lb/A yield at the 92 lb P_2O_5/A rate.

Yield results in Tables 1 and 2 are averages over all phosphorus rates and limestones rates, respectively, and do not reflect the differences which occurred due to individual treatments. These differences are illustrated in Figures 1 and 2. Generally, the application of agricultural limestone is thought to increase the efficiency of fertilizers, and this can be seen in Figure 1. One example to point out is the effect of the 0, 0.3, and 1.7 ton rates of limestone on the response of ryegrass to the 123 lb rate of P_2O_5. Grass yield at the zero limestone and 123 lb P_2O_5/A rate was 2,920 lb of DM/A. When the limestone rate was increased to 0.3 ton/A, yield increased to 5,107, and at 1.7 tons of limestone/A, yield increased to 6,078 lb of ryegrass/A. When adequate phosphorus was applied (245 and 491 lb P_2O_5/A) the 0.3 ton/A limestone rate appeared to be sufficient for the first year of production.

Figure 2 illustrates the same data by comparing the effect of fertilizer phosphorus on the efficiency of limestone. When an inadequate rate of limestone was applied, the efficiency of that limestone for grass production was improved as the rate of fertilizer phosphorus increased. This response is indicated by the bars representing the 0.3 ton/A rate of limestone. As the rate of P_2O_5 increased from 0 to 123 lb/A, grass yield increased from 3,450 lb to 5,107 lb. At the 491 lb P_2O_5/A rate, 0.3 tons of limestone helped produce 5,624 lb ovendry grass per acre.

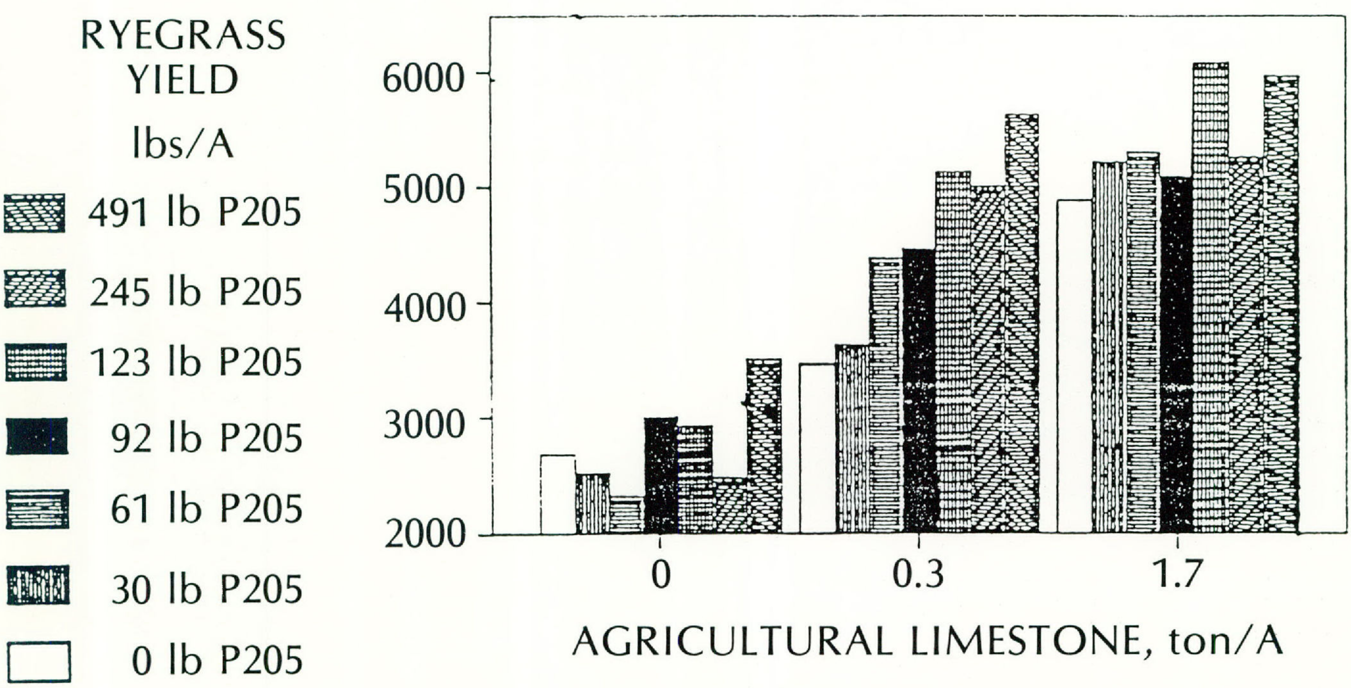

FIGURE 1. Agricultural limestone increases fertilizer phosphorus efficiency.

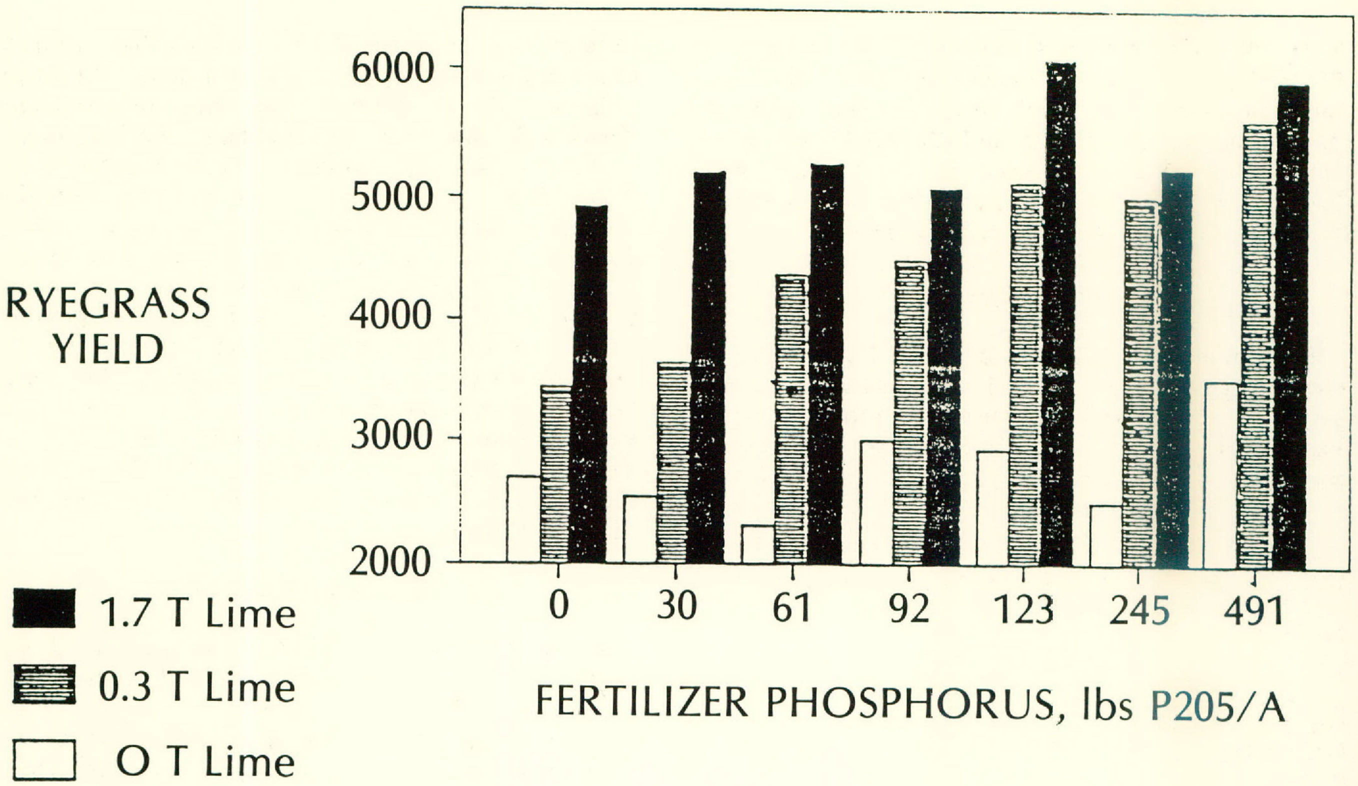

Figure 2. Fertilizer phosphorus increases limestone efficiency.

Nitrogen Fertilizer Source Study on Coastal Bermudagrass

W. B. ANDERSON AND J. M. DRWAL

Summary

Nitrogen fertilizer sources, (ammonium nitrate [AN], ammonium sulfate [AS], urea, and urea-ammonium nitrate solution [UAN]) were field tested on Bermudagrass (*Cynodon dactylon* L.) to determine nitrogen efficiency. Additionally, urea was supplemented with $CaCl_2$ to determine if $CaCl_2$ would protect urea from ammonia volatilization loss. Individual experiments were initiated successively throughout the growing season on two diverse soils to encompass the differing environmental conditions which might influence NH_3 volatilization. The clay soil was Brazos River Bottom Ships clay series (calcareous). The sand soil was a Lufkin fsl series (an acid fine sandy loam).

Urea fertilization consistently resulted in higher yields of Coastal bermudagrass than the other nitrogen sources tested. The relative ranking of nitrogen sources was:

For yield (urea > urea + $CaCl_2$ > AN = AS > UAN).

For nitrogen uptake (urea + $CaCl_2$ > urea > AS > UAN).

It appears that $CaCl_2$ tended to enhance nitrogen uptake somewhat. The higher yields resulting from surface applications of urea fertilizer over the other nitrogen sources throughout the growing season indicate no serious risk of nitrogen loss from urea.

KEYWORDS: Nitrogen volatilization/bermudagrass yield/urea/nitrogen uptake.

Introduction

Urea has gained importance among nitrogen fertilizers in recent years because of its low cost per unit. However, because of numerous studies citing decreased plant response (yield and nitrogen uptake) to urea as a nitrogen fertilizer, especially when surface applied, producers are hesistant to use this source in situations where fertilizers cannot be incorporated into the soil. Considerable nitrogen losses have been reported in laboratory work under conditions favoring rapid urea hydrolysis and build up of NH_3 in the soil. Recent laboratory and greenhouse work has shown that $CaCl_2$ and other soluble salts are effective in reducing nitrogen loss from surface applied urea. The objectives of this study were: (1) to determine the effectiveness of urea in the field as a nitrogen fertilizer compared with other nitrogen sources commonly used for bermudagrass production in the local area, and (2) to field test $CaCl_2$ applied with urea as a means of reducing volatile NH_3 loss over a range of soil and environmental conditions existing in the College Station, Texas area.

Procedure

Field plots were established at two locations with contrasting soil types. Table 1 describes some of the physical and chemical characteristics of the two soils. Experiments were conducted in successive periods throughout the 1984 growing season. A total of eight experiments were staggered throughout the season to encompass the varying environmental conditions which influence NH_3 volatilization losses from urea as compared with other nitrogen fertilizers. Fertilizer treatments, rates, and application methods are listed in Table 2. Each fertilizer treatment and the control were replicated four times in a randomized block design within each experiment. Repeated experiments were established to vary the potential volatilization time period between fertilizer application and first significant rainfall (>0.1 inch). This criteria was used to estimate days of potential volatilization for each experiment. Plots were fertilized to initiate individual experiments and harvested when bermudagrass reached maturity. After harvesting, samples were dried, ground, and chemically analyzed for nitrogen content using a common micro Kjeldahl method.

TABLE 1. SOIL PHYSICAL AND CHEMICAL CHARACTERISTICS

Soil Series	Lufkin	Ships
Texture	fine sandy loam	clay
pH (1:1 H_2O)	4.9	7.8
Organic matter content, %	1.3	2.5
CEC, cmol/kg	1.5	38.5
N, ppm	10.7	15.2
P, ppm (NH_4OAc, EDTA)	15.5	103.3
K, ppm (NH_4OAc)	129.0	504.4

TABLE 2. FERTILIZER TREATMENTS

Treatment	N Rate (lb/A)	Form	Application Method
Ammonium Nitrate (AN)	100	dry pelleted	surface broadcast
Ammonium Sulfate (AS)	100	dry pelleted	surface broadcast
Urea	100	dry pelleted	surface broadcast
Urea-ammonium Nitrate (UAN)	100	liquid	surface band
Urea + $CaCl_2$[a]	100	liquid	surface band
Control	0		

[a]$CaCl_2$ applied at 0.25 Ca^{+2} : 1 N ratio.

Results and Discussion

Each trial (by date) in Table 3 must be considered as a separate individual experiment because of environmental conditions differ with date and time period which would affect growth and nitrogen fertilizer efficiency. Thus, yield comparisons between nitrogen sources in a column are valid because of the same growing conditions during that growing period. However, other growing periods had considerably different environmental conditions. The Brazos River Bottom location had supplemental irrigation available whereas the Wellborn location was dependent on rainfall (dryland). The Wellborn site yields were considerably reduced by drought conditions.

Statistical analysis of bermudagrass dry matter yield for the two soil types is included in Table 3. The values of bermudagrass yield are the means of four treatment replications.

The urea treatments gave the highest yields in all trials compared to the other nitrogen sources. Although the yields were always highest, this superiority was statistically significant only in a few of the trials. Apparently, nitrogen losses do not differ much among the nitrogen

TABLE 3. YIELD OF COASTAL BERMUDAGRASS AS INFLUENCED BY N FERTILIZER SOURCE

		Experimental Locations							
		Brazos River Bottom Clay Soil						Wellborn Sand Soil Dryland	
N Sources	Fertilized Volatile days[1]	Apr. 6 1	Apr. 16 24	June 29 1	July 5 22	Aug. 22 2	Aug. 24 1	Apr. 13 35	Apr. 23 25
	N rate (lb/A)	Dry matter (Pounds per Acre)							
Control	0	1,589d[2]	2,078d	1,690d	1,807c	1,033c	1,027c	662b	721d
Ammonium Nitrate	100	3,102c	3,982bc	5,314ab	3,274b	2,796ab	2,919b	2,571a	2,892b
Urea	100	4,309a	4,600ab	5,794a	3,480ab	3,400a	3,794a	2,466a	2,399c
Urea + $CaCl_2$	100	3,981ab	5,116a	5,304ab	3,910a	3,101ab	3,526a	2,792a	3,469a
Urea Ammonium Nitrate	100	2,908c	3,434c	4,828b	3,429b	2,438b	2,807b	2,444a	2,658bc
Ammonium Sulfate	100	3,465bc	4,337b	4,152c	3,688ab	2,507b	2,948b	3,176a	2,608bc

[1]Days that ammonia volatilization loss might occur between fertilizer application and first significant rainfall occurrence.

[2]Values are the means of four replications. Values within a column with the same letter are not significantly different by Duncan's Multiple Range Test (p = 0.05).

TABLE 4. THE NITROGEN UPTAKE BY COASTAL BERMUDAGRASS FROM DIFFERENT NITROGEN FERTILIZER SOURCES

		Experimental Locations							
			Brazos River Bottom Clay Soil					Wellborn Sand Soil Dryland	
N Sources	Fertilized Volatile days[1]	Apr. 6 1	Apr. 16 24	June 29 1	July 5 22	Aug. 22 2	Aug. 24 1	Apr. 13 35	Apr. 23 25
	N rate (lb/A)	Nitrogen uptake (Pounds per Acre)							
Control	0	16c[2]	20d	14e	14c	12c	12c	7b	8c
Ammonium Nitrate	100	29b	37bc	45bc	28b	38ab	37b	40a	42b
Urea	100	39a	41bc	47ab	32b	45a	51a	37a	36b
Urea + $CaCl_2$	100	42a	51a	51a	43a	47a	54a	42a	56a
Urea Ammonium Nitrate	100	28b	34c	41cd	30b	34b	36b	37a	38b
Ammonium Sulfate	100	33b	42b	36d	38a	34b	40b	44a	37b

[1]Days that ammonia volatilization loss might occur between fertilizer application and first significant rainfall occurrence.

[2]Values are the means of four replications. Values within a column with the same letter are not significantly different by Duncan's Multiple Range Test (p = 0.05).

sources. An overall consideration of yields from the several trials shows little statistically significant differences between the nitrogen sources.

The nitrogen uptake by Coastal bermudagrass as influenced by nitrogen sources is shown in Table 4. The nitrogen uptake values were highest in almost every trial from the urea treatments. The addition of $CaCl_2$ with urea seemed to enhance nitrogen uptake even further. These results corroborate the yield data as evidence that nitrogen losses are not occurring from urea more than from the other nitrogen sources.

Response of Coastal Bermudagrass to a High Sulfur Content Sulphate of Potash-Magnesia

V. A. HABY, J. V. DAVIS, AND A. T. LEONARD

Summary

Coastal bermudagrass response to a sulfur-magnesium treatment combination was evaluated on a Gallime fine sandy loam soil containing 8.3 and 24.2 ppm sulfur (S) amd magnesium (Mg), respectively, in the 0 to 6-inch depth. Rates of 0, 40, 80, and 120 lb S/A and 0, 2.95, 5.89, and 8.8 lb Mg/A were applied to the same plots as a 57 percent S content sulphate of potash-magnesia. Nitrogen, phosphorus, and potassium were equalized over all plots initially at rates of 100, 100, and 250 lb of N, P_2O_5, and K_2O/A, respectively, and nitrogen at the rate of 100 lb/A was applied after each cutting. Three harvests of grass were made. Yields averaged 5,004, 2,715, and 5,237 lb dry matter per acre at each cutting, respectively, and totaled an average of 12,950 lb/A for the three cuttings. The S-Mg combination treatment had no statistically significant effect on yield of grass.

KEYWORDS: Fertilizer rates/sulfur/magnesium/soil test.

Introduction

Coastal bermudagrass response to sulfur has been reported in East Texas on the Darco, a deep sandy loam soil. However, shallower soils such as the Cuthbert have not shown this response. Soil test levels of magnesium in the surface 6-inch depth are usually reported as medium to low. This study was initiated to evaluate response of Coastal bermudagrass to a combined treatment of sulfur and magnesium on a Gallime fine sandy loam.

Procedure

A Gallime fine sandy loam soil having a surface pH of 5.1 was selected for this study. This soil contained 8.3 and 24.2 ppm sulfur and magnesium, respectively, in the surface 6-inch depth. Rates of S were 0, 40, 80, and 120 lb/A and were broadcast onto the surface of 10 x 20 plots. Magnesium levels were not equalized over all plots, but were allowed to increase as the S rate increased. Sulphate of potash magnesia containing 8.4 percent K_2O, 4.2 percent Mg, 8.4 percent sulfate-S and a total of 57 percent S was the fertilizer material used to vary the sulfur rate. Potassium treatment was equalized on all plots at 250 lb K_2O/A. Nitrogen and phosphorus (P_2O_5) were each applied at 100 lb/A, initially. Nitrogen at 100 lb/A was applied after each of the first two cuttings. Yield samples were taken in July, August, and November.

Results and Discussion

Responses of Coastal bermudagrass to the sulfur-magnesium rates are indicated in Table 1. Yields by

TABLE 1. EFFECT OF SULFUR-MAGNESIUM COMBINATION RATES ON YIELD OF COASTAL BERMUDAGRASS

Treatment	Yield of Coastal bermudagrass dry matter			
S-Mg	Harvest 1	Harvest 2	Harvest 3	Total
lb/A	Pounds/Acre			
0-0	4,860	2,517	5,161	12,530
40-2.95	4,590	2,835	5,079	12,500
80-5.89	5,217	2,638	5,614	13,460
120-8.80	5,348	2,871	5,094	13,310
Mean	5,004	2,715	5,237	12,950
L.S.D (p = 0.10)	N.S.	N.S.	N.S.	N.S.
C.V. $\sqrt{S^2/x}$ $\bar{X}$ 100	12.7	13.7	8.8	6.2

treatment were not significantly different, statistically. This indicates that available S and Mg were in adequate supply in the soil, if not in the top 6 inches, possibly in the lower depths. Sulfur and magnesium in the harvested grass have not been analyzed.

Fluid Fertilization for Forages

V. A. HABY, J. V. DAVIS, AND A. T. LEONARD

Summary

A series of experiments were designed to evaluate the use of fluid fertilizations on Coastal bermudagrass. Studies include evaluation of urea-ammonium nitrate (UAN-32 percent nitrogen) band spacings, methods of application, comparison with other nitrogen sources and combinations of UAN with sulfur and boron, and combinations of UAN with phosphorus, potassium, and magnesium with different methods of application. Rates of nitrogen were 40, 80, and 120 lb/A at each application in the band spacing, method of application, and the nitrogen-source comparisons.

Yield reductions due to dribble band spacings up to 28 inches failed to occur. Coastal bermudagrass outgrew early streaking caused by dribble banding UAN up to 28 inches apart. Urea-ammonium nitrate was equally effective as a broadcast spray compared to dribble banding at 14 inches between bands. However, when UAN was combined with phosphorus, potassium, and magnesium, dribble banding produced significantly greater yields than broadcasting these same nutrient combinations. At a low production site, all nitrogen sources and combinations produced equal yields when averaged over all nitrogen rates. At the higher production site, ammonium nitrate produced similar yields compared to UAN plus ammonium sulfate and to ammonium sulfate. Ammonium nitrate produced equal yields compared to ammonium sulfate and both treatments were better than UAN. Urea produced less grass than did ammonium nitrate. Sulfur and boron mixed with UAN had no significant effect on yield. Nitrogen rates up to 120 lb/A at each application produced significant yield increases compared to 80 lb nitrogen/A.

KEYWORDS:Nitrogen/phosphorus/potassium/sulfur/magnesium/calcium/zinc/boron/molybdenum/band spacing/method of application/nitrogen source/nitrogen rate.

Introduction

Fluids represent less than 5 percent of the fertilizer market in East Texas, with almost none used on forage crops. Coastal bermudagrass is the major forage crop produced. Data from several states indicate that urea-ammonium nitrate (UAN) can be an effective nitrogen fertilizer for increasing forage yields. Evaluations include the response of Coastal bermudagrass to UAN band spacings, methods of application, nitrogen sources with and without sulfur and boron, and to suspension treatments combining UAN with phosphorus, potassium, and magnesium.

Procedure

Research efforts are directed at determining the most efficient method of application of UAN and nutrient combinations on Coastal bermudagrass. Fertilizer treatments were begun after the first hay cutting was removed in May. From this time, a drought allowed only three hay cuttings. The experiments are divided into four phases.

Phase one - band spacing. Band spacings of 7, 14, 21, and 28 inches were evaluated using three rates of UAN-N, 40, 80, and 120 lb/A. Each nitrogen rate was applied three times during the growing season for total fertilizer nitrogen rates of 120, 240, and 360 lb/A. The nitrogen rates and band spacings were applied in a randomized complete block experimental design. All treatments were replicated three times at two research locations. One was on a Gallime fine sandy loam (Wilson site). The other was on a Sawtown fine sandy loam (Florey site). Both are fine-loamy siliceous, thermic Glossic Paleudalfs.

Phase two - placement. Urea-ammonium nitrate was broadcast sprayed onto the soil surface, band applied to the soil surface, and band applied 1 to 2 inches below the soil surface following the first hay cutting in early spring, and after each of the next two harvests. Rates of nitrogen were 120, 240, and 360 lb/A split-applied three times during the growing season at 40, 80, and 120 lb per application. A 14-inch band spacing was utilized for the band treatments. The experimental design was a randomized complete block with three replications of each treatment.

Phase three - nitrogen source. Nitrogen source comparisons were initiated for proper evaluation of fluid fertilizers. Calcium-urea was tested as a combination of $CaCl_2$ and urea on a 1:2 Ca:N equivalent basis with 15 percent nitrogen in solution. Sulfur was applied with UAN-N in N:S ratios of 2.5, 5, and 7.5. Boron was applied at 0.4 lb/A each time nitrogen was applied. Fluids were compared with urea, ammonium sulfate, and ammonium nitrate for their effects on Coastal bermudagrass yield and quality. Four rates of nitrogen from each source, 0, 120, 240, and 360 lb/A, split-applied as in phases 1 and 2, were evaluated in a randomized complete block design with each treatment replicated three times. All fluid nitrogen treatments were applied at the 14-inch band spacing. Granular nitrogen-sources were broadcast.

Phase four - method of phosphorus, potassium, and magnesium application. Combinations of UAN (80 lb/A) with and without phosphorus (22 lb/A), potassium (60 lb/A), and magnesium (12 lb/A) were applied after each cutting. A randomized complete block experimental design with three replications of each treatment was utilized.

Established Coastal bermudagrass hay meadows were selected for this research. Each site was characterized chemically by soil analysis for available plant nutrients and soil properties listed below:

	Ph	P	K	Ca	Mg	S	Zn	Fe	Mn	Cu	B
					Pounds/Acre						
Gallime	5.1	16	100	435	48	7	1.3	236	84	1.7	.39
Sawtown	5.0	20	86	457	17	9	1.7	113	79	0.8	.18

	Soil type	C.E.C. meg/100 g
Gallime (Wilson site)	fsl	6.3
Sawtown (Florey site)	fsl	3.9

Overall rates of 100 lb P_2O_5 and 160 lb K_2O) were applied to all plots in phases one, two, and three to eliminate a deficiency of these nutrients. Zinc (5.0 lb/A) and molybdenum (0.1 lb/A) were applied to all plots in phase three except for plots designed to be zinc and molybdenum check plots. On October 2, 1984, 200 lb K_2O/A were applied to all plots in phases 1, 2, and 3. The label rate of 2,4-D amine was applied to control Curley dock on the Gallime soil in early June. The final harvest was made in late November on the Wilson site and in early December on the Florey site.

Results and Discussion

First year results from three applications of fertilizers and three harvests are presented in Tables 1 through 6. Table 1 illustrates the yield response of Coastal bermudagrass to dribble banded rates of UAN applied at four band spacings and three nitrogen rates on the Sawtown (Florey site) and Gallime (Wilson site) soils. Harvest 1 and the Florey site indicates that the 21-inch band spaced UAN treatment was less effective than 7, 14, and 28 inches averaged over nitrogen rates, but this difference disappeared in the second harvest. All band spacings produced statistically equal yields of dry matter at the Wilson site, and total yields at both sites indicate no difference due to distances of 7 to 28 inches between dribble bands. This was evident even at the individual rates of nitrogen on both sides.

The growth habit of Coastal bermudagrass stolons (runners) allows them to grow across a fertilizer band and continue growing into the space between bands, while translocating nutrients from the band area to the tip of the new growth. Streaking is observed within a day following application, regardless of the band spacing. This occurs first as a yellowing of existing vegetation that is contacted by the dribble band of UAN. New dark green grass growth later defines the band and a pale green nitrogen deficiency exists between bands. The grass outgrows this deficiency. The narrower the band spacing, the faster this occurs, until even the 28-inch band spaces are grown over between 3 and 4 weeks following fertilizer application when the grass is growing vigorously. The fertilizer band streaks will remain until harvest if the grass is not vigorously growing due to a stress condition.

A yield limiting factor existed at the Florey site because the 120 lb nitrogen rate did not produce grass yields greater than the 80 lb rate. Although the trend toward greater yields existed, the precision of this trial was not sufficient to detect a difference of 700 lb of grass per acre. The 120 lb nitrogen/A rate produced significantly more grass than the 80 lb rate at the Wilson site, but the response curve was leveling at 120 lb nitrogen/A.

Broadcast spraying nitrogen as UAN was equally as effective as dribble banding the UAN on the surface of the grass sod and soil at both sites (Table 2). Attempts to dribble band the UAN below the soil surface were relatively ineffective due to the dense sod and root system of the Coastal bermudagrass growing in these sandy loam soils. The coulters cut about 2 inches deep but could not be forced deeper with the present weight of the applicator. An additional 150 lb per coulter would be needed to force the coulter to cut into the sod deep enough to place the UAN below the soil surface.

The subsurface attempts at dribble banding sometimes placed the UAN just below the soil surface, but most of this treatment was mixed with the loose soil exposed by the coulter and back-swept applicator knife. This placed most of the fluid in direct contact with soil moisture and could cause more rapid hydrolysis and possibly NH_3 volatilization of the urea components of the UAN.

Increasing the nitrogen rate to 120 lb/A significantly increased grass dry matter yields at both sites.

Nitrogen sources and combinations of UAN with sulfur and boron, averaged over all nitrogen rates, were equally effective for grass production through three harvests in 1984 at the Florey site (Table 3). Experimental error at this site limited detection of significant yield differences to more than 984 lb dry matter per acre due

TABLE 1. RESPONSE OF COASTAL BERMUDAGRASS TO DRIBBLE BANDED RATES OF NITROGEN AS UAN APPLIED AT FOUR BAND SPACINGS AND THREE NITROGEN RATES AT TWO SITES, OVERTON, 1984

Florey Site:	Dry Matter Yield by Harvest[1]			
	1	2	3	Total
Band Spacing, inches	Pounds/Acre			
7	3,507 b	3,280 a	1,645 a	8,432 a
14	3,294 ab	3,259 a	1,793 a	8,346 a
21	2,742 a	3,066 a	1,723 a	7,530 a
28	3,166 ab	3,196 a	1,698 a	8,060 a
N Rate (lb/A)				
40	2,599 a	2,828 a	1,468 a	6,895 a
80	3,309 b	3,266 b	1,757 b	8,333 b
120	3,623 b	3,506 b	1,919 c	9,049 b
	Interaction of N-Rate and Band Spacing, Total Yield			
	7	14	21	28
40	7,589	6,201	7,153	6,971
80	8,440	8,416	7,656	8,818
120	9,600	10,420	7,782	8,391
L.S.D. (0.05) = Not Significant				

Wilson Site:	Dry Matter Yield by Harvest[1]			
	1	2	3	Total
Band Spacing, inches	Pounds/Acre			
7	4,837 a	4,070 a	4,325 a	13,230 a
14	4,815 a	4,048 a	4,369 a	13,230 a
21	5,056 a	3,910 a	4,309 a	13,270 a
28	5,050 a	4,022 a	4,247 a	13,310 a
N Rate (lb/A)				
40	4,269 a	3,329 a	3,322 a	10,920 a
80	5,167 b	4,195 b	4,657 b	14,010 b
120	5,383 b	4,513 b	4,959 c	14,850 c
	Interaction of N-Rate and Band Spacing, Total Yield			
	7	14	21	28
40	11,230	9,976	10,080	12,380
80	13,700	14,600	14,410	13,350
120	14,750	15,110	15,320	14,210
L.S.D. (0.05) = 3,336				

[1]Dry matter yields, within individual sites, harvest times, band spacings, or N rates followed by the same letter are not significantly different, statistically, at the 0.05 probability level.

to nitrogen sources. Yield responses to nitrogen rates were significantly increased, statistically, by the 120 lb nitrogen/A rate compared to 80 lb nitrogen/A. Interaction of nitrogen rate with nitrogen source indicates there were no significant total yield differences due to N sources within individual rates of nitrogen.

Coastal bermudagrass dry matter yields from nitrogen sources and combinations at the Wilson site are indicated in Table 4. Yields varied significantly in the first harvest, but there were no statistically significant differences in harvests two or three. Two major separations of nitrogen sources can be made statistically, relative to total dry matter production at the Wilson site. Urea-ammonium nitrate with ammonium sulfate added compared favorably with ammonium sulfate and ammonium nitrate. Other nitrogen sources and combinations with sulfur or boron produced equivalent yields of grass. Urea and UAN produced equivalent yields, but ammonium nitrate produced significantly more grass than either of them, averaged over all nitrogen rates. A statistically significant yield increase occurred between 80 and 120 lb nitrogen/A.

Interactions of nitrogen source by rate of nitrogen indicate no source differences at the 40-lb nitrogen rate. At 80 lb nitrogen/A, ammonium sulfate produced significantly more grass than UAN, UAN without zinc and molybdenum, and calcium-urea. Ammonium nitrate produced more grass than calcium-urea. At the 120 lb nitrogen/A rate, UAN with ammonium sulfate produced comparable yields to ammonium nitrate, and these yields were significantly greater than dry matter produced by ammonium sulfate.

The first two harvests of grass produced by combinations of nitrogen, phosphorus, potassium, and magnesium yielded similiar responses to all combinations at the Florey site (Table 5). At the third harvest, addition of phosphorus increased grass yield significantly compared to treatments without fertilizer phosphorus. Surface dribbling banding these nutrient combinations was significantly better than spray broadcast treatment at this third harvest.

At the Wilson site (Table 6) the poorest producing combination was 80-0-60-0. Addition of phosphorus and magnesium had no effect on yields of grass compared to UAN alone, indicating the soil at this site can supply an adequate amount of these nutrients at this time.

Dribble band application of these nutrient combinations increased yield significantly compared to broadcast spraying.

TABLE 2. RESPONSE OF COASTAL BERMUDAGRASS TO METHODS OF APPLICATION OF UAN NITROGEN AT THREE RATES ON TWO SITES, OVERTON, 1984

Florey Site:	Dry Matter Yield by Harvest[1]			
Method of Application	1	2	3	Total
	Pounds/Acre			
Broadcast spray	3,439 a	3,113 a	1,785 a	8,337 a
Surface dribble banded, 14 inches	3,384 a	3,105 a	1,591 a	8,085 a
Subsurface dribble banded, 14 inches	3,224 a	3,066 a	1,672 a	7,962 a
N Rates (lb/A)				
40	3,110 a	2,619 a	1,432 a	7,166 a
80	3,182 a	3,169 b	1,621 a	7,972 a
120	3,754 a	3,496 c	1,995 b	9,245 b

	Interaction of Method of Application and N Rate, Total Yield		
	40	80	120
Broadcast spray	7,198	8,500	9,311
Surface dribble banded	6,756	8,134	9,364
Subsurface dribble banded	7,543	7,282	9,061
L.S.D. (0.05) = Not Significant			

Wilson Site:	Dry Matter Yield by Harvest[1]			
Method of Application	1	2	3	Total
	Pounds/Acre			
Broadcast spray	3,539 a	4,079 a	4,117 a	11,730 a
Surface dribble banded, 14 inches	3,905 a	4,404 a	4,233 a	12,540 a
Subsurface dribble banded, 14 inches	3,593 a	4,258 a	4,171 a	12,020 a
N Rate (lb/A)				
40	2,787 a	3,280 a	3,080 a	9,147 a
80	3,815 b	4,541 b	4,533 b	12,880 b
120	4,435 c	4,921 b	4,908 c	14,260 c

	Interaction of Method of Application and N Rate, Total Yield		
	40	80	120
Broadcast spray	9,193	12,390	13,610
Surface dribble banded	9,501	13,070	15,040
Subsurface dribble banded	8,748	13,190	14,120
L.S.D. (0.05) = Not Significant			

[1]Dry matter yields, within individual sites, harvest times, methods of application, or N rates followed by the same letter are not significantly different, statistically, at the 0.05 probability level.

TABLE 3. RESPONSE OF COASTAL BERMUDAGRASS TO NITROGEN SOURCES AND SOURCE COMBINATIONS WITH CALCIUM, SULFUR, AND BORON TO NITROGEN RATES OVER ALL SOURCES, AND TO INTERACTIONS OF RATES BY SOURCES, FLOREY SITE, OVERTON, 1984

	Dry Matter Yield by Harvest[2]			
Source of N[1]	1	2	3	Total
	Pounds/Acre			
1	2,965 a	2,996 a	1,267 a	7,228 a
2	3,304 a	3,152 a	1,204 a	7,660 a
3	2,831 a	2,878 a	1,252 a	6,962 a
4	2,830 a	2,984 a	1,274 a	7,089 a
5	2,829 a	2,972 a	1,302 a	7,103 a
6	3,525 a	3,179 a	1,369 a	8,073 a
7	2,925 a	2,951 a	1,343 a	7,219 a
8	3,195 a	3,282 a	1,295 a	7,771 a
9	2,875 a	3,313 a	1,360 a	7,548 a
Rate of N				
0	1,589 a	1,402 a	285 a	3,276 a
40	2,846 b	3,005 b	1,358 b	7,209 b
80	3,647 c	3,785 c	1,721 c	9,152 c
120	4,043 c	4,122 d	1,821 d	9,987 d

TABLE 3. (CONTINUED)

Source of N	Interaction of Source of N by Rate on Total Yield, lb/A Rate of Nitrogen, lb/A		
	40	80	120
1	6,887	9,091	9,657
2	7,155	10,170	10,030
3	6,081	8,849	9,640
4	6,441	9,250	9,387
5	6,773	8,455	9,909
6	9,405	8,769	10,840
7	6,982	8,773	9,847
8	7,917	9,590	10,300
9	7,236	9,415	10,400
L.S.D. (0.05) = Not Significant			

[1](1) UAN; (2) UAN without zinc and molybdenum; (3) UAN + ammonium thiosulfate at 16 lb S/A each application; (4) UAN + ammonium sulfate at 16 lb S/A each application; (5) calcium-nitrogen at a 0.33:1 ratio; (6) UAN + boron at 0.4 lb/A each application; (7) urea; (8) ammonium nitrate; (9) ammonium sulfate.

[2]Dry matter yields, within individual harvests, followed by the same letter are not statistically different at the L.S.D. 0.05 level.

TABLE 4. RESPONSE OF COASTAL BERMUDAGRASS TO NITROGEN SOURCES AND SOURCE COMBINATIONS WITH CALCIUM, SULFUR, AND BORON TO NITROGEN RATES OVER ALL SOURCES, AND TO INTERACTIONS OF RATES BY SOURCES, WILSON SITE, OVERTON, 1984

Source of N[1]	Dry Matter Yield by Harvest[2]			
	1	2	3	Total
	Pounds/Acre			
1	3,948 ab	3,317 a	3,080 a	10,340 ab
2	4,126 abcd	3,134 a	3,065 a	10,320 ab
3	4,039 abc	3,350 a	3,098 a	10,480 abc
4	4,334 cd	3,417 a	3,235 a	10,980 bcd
5	4,169 bcd	3,341 a	3,142 a	10,670 abc
6	3,832 a	3,119 a	3,193 a	10,140 a
7	4,182 bcd	3,189 a	3,326 a	10,690 abc
8	4,877 e	3,410 a	3,304 a	11,590 d
9	4,403 d	3,344 a	3,322 a	11,060 cd
Rate of N				
0	1,825 a	1,270 a	581 a	3,675 a
40	4,108 b	3,113 b	2,799 b	10,020 b
80	5,007 c	4,247 c	4,583 c	13,830 c
120	5,908 d	4,535 c	4,821 d	15,270 d

Source of N	Interaction of Source of N by Rate on Total Yield, lb/A		
	40	80	120
1	9,573	13,070	15,050
2	9,718	12,430	15,470
3	9,221	13,880	15,160
4	9,748	14,160	16,350
5	9,238	14,960	14,830
6	10,000	12,040	14,840
7	10,200	13,780	15,120
8	11,330	14,750	16,590
9	11,140	15,410	14,030
L.S.D. (0.05) = 2,191			

[1](1) UAN; (2) UAN without zinc and molybdenum; (3) UAN + ammonium thiosulfate at 16 lb S/A each application; (4) UAN + ammonium sulfate at 16 lb S/A each application; (5) calcium-nitrogen at at 0.33:1 ratio; (6) UAN + boron at 0.4 lb/A each application; (7) urea; (8) ammonium nitrate; (9) ammonium sulfate.

[2]Dry matter yields, within individual harvests, followed by the same letter are not different statistically atthe L.S.D. 0.05 level.

TABLE 5. RESPONSE OF COASTAL BERMUDAGRASS TO METHODS OF APPLICATION OF UAN-NITROGEN AND COMBINATIONS WITH PHOSPHORUS, POTASSIUM, AND MAGNESIUM, FLOREY SITE, OVERTON, 1984

Fertilizer N - P_2O_5 - K_2O - Mg lb/A[2]	Dry Matter Yield by Harvest[1] 1	2	3	Total
	Pounds/Acre			
80 - 0 - 0 - 0	3,381 a	3,247 a	1,127 a	7,743 a
80 - 22 - 0 - 0	3,035 a	3,263 a	1,402 b	7,700 a
80 - 0 - 60 - 0	2,850 a	2,887 a	1,096 a	6,834 a
80 - 22 - 60 - 0	3,173 a	3,209 a	1,238 ab	7,643 a
80 - 22 - 60 - 12	3,102 a	3,478 a	1,305 ab	7,885 a
Method of Application				
Spray broadcast	3,238 a	3,095 a	1,097 a	7,429 a
Surface dribble banded	3,053 a	3,255 a	1,374 b	7,697 a
Subsurface dribble banded	3,034 a	3,300 a	1,230 ab	7,563 a

Interaction of Method of Application with Fertilizer Grade, Total Yield

Fertilizer Grade[2]	Method of Application Spray Broadcast	Surface Banded	Subsurface Banded
80 - 0 - 0 - 0	7,444	7,908	7,911
80 - 22 - 0 - 0	7,696	8,126	7,279
80 - 0 - 60 - 0	6,854	6,478	7,170
80 - 22 - 60 - 0	7,587	7,564	7,776
80 - 22 - 60 - 12	7,565	8,408	7,680

L.S.D. (0.05) = Not Significant

[1]Dry matter yields within individual harvest times, by fertilizer grade or method of application, when followed by the same letter, are not statistically different at the $p = 0.05$ level of probability.

[2]Actual rates of N, P_2O_5, K_2O, and Mg at each application time.

TABLE 6. RESPONSE OF COASTAL BERMUDAGRASS TO METHODS OF APPLICATION OF UAN-NITROGEN AND COMBINATIONS OF PHOSPHORUS, POTASSIUM, AND MAGNESIUM, WILSON SITE, OVERTON, 1984

Fertilizer N - P_2O_5 - K_2O - Mg lb/A[2]	Dry Matter Yield by Harvest[1] 1	2	3	Total
	Pounds/Acre			
80 - 0 - 0 - 0	4,836 a	3,987 c	3,803 b	12,620 c
80 - 22 - 0 - 0	4,676 a	3,368 b	4,122 c	12,160 bc
80 - 0 - 60 - 0	4,370 a	2,735 a	3,482 a	10,580 a
80 - 22 - 60 - 0	4,627 a	3,172 b	3,646 ab	11,440 ab
80 - 22 - 60 - 12	5,213 a	3,499 b	3,728 ab	12,240 bc
Method of Application				
Spray broadcast	4,419 a	3,187 a	3,478 a	10,960 a
Surface dribble banded	4,791 a	3,348 ab	3,858 b	11,990 b
Subsurface dribble banded	5,023 a	3,522 b	3,934 b	12,470 b

Interaction of Method of Application with Fertilizer Grade, Total Yield

Fertilizer Grade[2]	Method of Application Spray Broadcast	Surface Banded	Subsurface Banded
80 - 0 - 0 - 0	12,030	12,850	12,990
80 - 22 - 0 - 0	11,760	12,790	11,930
80 - 0 - 60 - 0	10,370	10,490	10,880
80 - 22 - 60 - 0	9,596	11,210	13,530
80 - 22 - 60 - 12	11,070	12,610	13,040

L.S.D. (0.05) = Not significant

[1]Dry matter yields within individual harvest times, by fertilizer grade or method of application, when followed by the same letter, are not statistically different at the $p = 0.05$ level of probability.

[2]Actual rates of N, P_2O_5, K_2O, and Mg at each application time.

Alfalfa Variety and Fertility Trials on Brazos Riverbottom Soil

G. W. EVERS

Summary

Sixteen alfalfa cultivars were established October 11, 1983 in the Brazos riverbotton near Angleton. They will be evaluated for forage production and persistence for a 4-year period. During the first full growing season (1984) there was no significant difference between cultivars. Yields ranged from 5 to 6.75 tons of dry matter/acre (A). There was no significant forage production increase from phosphorus, potassium, sulfur, boron, molybdenum, or micronutrients in the fertility trial.

Introduction

Alluvial soils along the Brazos River from Waco, and the Colorado River from Austin, to near the Gulf of Mexico, amount to 800,000 A. Most of these soils are planted to row crops because of their natural high fertility. However, monoculture cropping systems cause an increase in disease, insect, nematode, and weed problems which result in increased production costs and/or lower yields. Alfalfa would fit well into a row crop rotation by reducing pest problems and improving soil structure and fertility. High quality alfalfa hay brings a premium from dairies and horse owners. Present alfalfa acreage on these alluvial soils is estimated between 5,000 and 10,000 A.

An alfalfa variety trial and fertilizer study were established in the Brazos riverbottom 10 miles north of Angleton. The studies will be continued for 4 years to identify the most persistent cultivars, proper fertilizer requirements, and potential management problems.

Procedure

The studies were seeded at 20 lb/A on October 11, 1983 on a Norwood silt loam. Basagran and fusilade were each applied at 0.5 lb/A for broadleaf and grassy weed control, respectively. Experimental design was a randomized block with four replications. The variety trial was fertilized with 60 lb/A of phosphorus and potassium in March 1984. Florida 77 was used for the fertility study. All treatments except the micronutrient treatment were also applied in March. The micronutrients were applied as a spray on February 7 and June 28. Plots were harvested at a 4- to 5-week interval beginning March 21.

Results and Discussion

Variety Study. Forage production for the first growing season ranged from 5 to 6.75 tons of dry matter/A (Table 1) with no significant difference between cultivars at the 0.05 level. The largest yield difference occurred at the first harvest with Baron, Siriver, Cimarron, Southern Special, Hi-ply, and WL-318 being the most productive.

Fertility Study. Analysis of a soil sample collected in October 1983 showed all nutrients except nitrogen to be high or very high. Results from the first full growing season showed no significant yield increase from any of the fertilizer treatments (Table 2). The study will be continued for 3 years to determine if continuous harvesting will result in a response to fertilizer.

TABLE 1. FORAGE PRODUCTION OF ALFALFA VARIETIES IN BRAZOS RIVERBOTTOM NEAR ANGELTON, TEXAS 1984

VARIETY	29 MAR	7 MAY	12 JUNE	12 JULY	16 AUG	27 SEPT	27 NOV	TOTAL
				Pounds of Dry Matter/Acre				
Cimarron	3,168	2,280	2,473	1,496	1,588	1,212	1,304	13,520
Siriver	3,264	2,077	2,228	1,697	1,467	1,226	1,482	13,441
Florida 77	2,376	2,153	2,430	1,754	1,790	1,157	1,634	13,294
Baron	3,644	2,027	2,142	1,495	1,336	1,185	1,332	13,160
Southern Special	2,947	2,048	2,099	1,596	1,576	1,226	1,318	12,810
Raidor	2,281	2,076	2,386	1,265	1,321	1,047	1,537	11,913
555	2,272	1,966	2,344	1,567	1,374	1,061	1,277	11,859
Hi-ply	2,915	1,830	2,300	1,294	1,131	1,033	1,277	11,779
WL-318	2,638	2,034	2,114	1,409	1,140	1,143	1,290	11,768
Weevlchek	2,163	1,913	2,415	1,395	1,241	1,198	1,386	11,711
Armor	1,741	2,064	2,372	1,495	1,557	1,212	1,139	11,581
Classic	1,805	2,014	2,473	1,380	1,456	1,130	1,263	11,519
XAN21	2,250	1,903	2,013	1,510	1,190	1,144	1,386	11,395
Vancor	2,131	1,943	2,243	1,409	958	1,116	1,446	11,246
Saranac	1,941	1,792	2,185	1,366	1,303	1,157	1,428	11,172
Apollo	1,678	1,778	2,214	1,294	978	974	1,022	9,917
L.S.D.								
0.05	1,257	533	680	257	578	327	679	3,687

KEYWORDS: Alfalfa/hay production/fertility.

TABLE 2. FORAGE PRODUCTION OF FLORIDA 77 ALFALFA WITH VARIOUS FERTILIZER TREATMENTS IN THE BRAZOS RIVERBOTTOM NEAR ANGLETON, TEXAS

FERTILIZER TREATMENT	29 MAR	7 MAY	14 JUNE	12 JULY	16 AUG	27 SEPT	27 NOV	TOTAL
				Pounds of Dry Matter/Acre				
0-90-60	1,323	2,166	2,450	2,012	2,264	1,542	1,838	13,595
0-90-120 + A + Micro Nut.	1,225	2,077	2,426	2,039	2,163	1,656	1,933	13,519
0-90-0	1,342	2,076	2,289	1,970	2,137	1,545	1,687	13,046
0-0-120	1,211	1,999	2,376	1,818	2,277	1,628	1,725	13,304
0-45-120	1,212	2,028	2,339	1,942	2,191	1,604	1,682	12,998
0-90-120 + Mo	1,294	1,860	2,466	1,901	2,312	1,553	1,560	12,946
0-90-120 + B + Mo	1,253	2,011	2,481	1,777	2,134	1,596	1,676	12,928
0-45-0	1,199	1,999	2,300	1,860	2,137	1,615	1,731	12,841
0-90-120	1,172	1,957	2,281	1,970	2,087	1,564	1,760	12,791
50-90-120	1,171	2,046	2,244	1,832	2,197	1,498	1,783	12,771
0-90-120 + B	1,267	1,951	2,333	1,956	2,038	1,523	1,687	12,755
0-0-0	1,152	1,881	2,296	1,750	2,245	1,596	1,671	12,591
0-45-60	1,240	1,965	2,200	1,846	2,009	1,506	1,623	12,389
0-0-60	1,155	1,854	2,291	1,763	2,181	1,419	1,635	12,298
0-90-120 + B, Mo, S, Micro Nut.	1,227	1,783	2,203	1,653	2,045	1,578	1,707	12,196
L.S.D. 0.05	252	257	302	279	425	251	245	1,076

Mineral Composition of Forages in a Short Duration Grazing System

L. W. GREENE, R. K. HEITSCHMIDT, AND B. PINCHAK

Summary

Forage samples were collected eight times from May 1981 through November 1984 on a rotational grazing system. Samples were subdivided into live and dead components within the following forage classes: annual grasses, sideoats grama, Texas wintergrass, forbs, and other warm-season grasses. Samples were pooled into two seasonal groupings (March — June and July — December) and analyzed for phosphorus, calcium, magnesium, sodium and potassium concentrations. Annual grasses appeared to have a greater phosphorus concentration in live material and a lower phosphorus concentration in dead material during July — November than March — June. Summarized across species and season of year, phosphorus concentration was 0.108 percent in live material and 0.046 percent in dead material. Forage calcium concentrations ranged from 0.3 to 2.0 percent with concentrations in live material being slightly less in annual grasses, sideoats grama, Texas wintergrass, and other warm-season grasses while greater for other forbs during July — November as compared to March — June. Magnesium concentration of forages was greatest in forbs for both live and dead material. Sodium concentrations in forages were less in live material during July — November than during March - June. Potassium concentration of the live material in all plant species was greater during March — June which corresponds to the more active growing season. Dead material contained relatively low concentrations of potassium in both seasons.

KEYWORDS: Phosphorus/calcium/magnesium/sodium/potassium/short duration grazing.

Introduction

Minerals are required in livestock diets to meet nutritional and metabolic requirements. As changes occur in stages and levels of production, mineral requirements also change. To maximize animal productivity, adequate quantities of minerals need to be provided to grazing livestock. If forage consumed does not meet the animals' requirement for specific minerals, mineral supplementation should be practiced.

As forage growth and development change with the season of the year, mineral composition also changes. This experiment was conducted to determine the mineral composition of five forage-groups, live and dead tissue, during March — June and July — November.

Procedure

Forage samples were collected at the Texas Agricultural Experimental Station Ranch located in the eastern portion of the Rolling Plains near Throckmorton, Texas. Vegetation sample areas were located in four adjacent paddocks of a 16-paddock, cell-designed rotational grazing treatment. Vegetation samples were collected over a 40-month period immediately prior to and after 1-4 day grazing events. All samples were clipped by major species at ground level from within 10 randomly located, 0.25 square meter quadrants. All samples were ovendried and separated into live and dead components. Species and species groups were annual grasses, Texas wintergrass, sideoats grama, other warm-season grasses, and forbs. All estimates were based on 10 subsamples per grazing event; five prior to and five after grazing. Samples were grouped into two seasons (March-June and July-November) and analyzed for phosphorus, calcium, magnesium, sodium, and potassium.

Results and Discussion

Annual grasses (Table 1) appeared to have a higher phosphorus concentration in live material and a lower phosphorus concentration in dead material during July-November than March-June. Phosphorus content for all forages averaged 0.108 percent for liver material and 0.046 percent for dead material. These concentrations are approximately 23 and 54 percent below the requirements of a mature dry cow. Phosphorus supplementation appears essential to maintain maximum animal production and reproductive efficiency. This is true even if it were assumed that the animals only consumed those species with the highest concentration of phosphorus, since the phosphorus concentration in those species was well below the requirements of a mature, dry cow.

Forage calcium concentrations (Table 2) ranged from 0.3 to 2.0 percent. Calcium concentrations in live material were generally greater than for dead material. The highest calcium concentration was in live forbs (1.75 percent). The lowest concentration was in warm season grasses (0.36 percent). Calcium concentrations in all forage classes were of sufficient magnitude to meet nutritional requirments of lactating cows.

Magnesium concentration of forages (Table 3) was highest in forbs. Generally, dead material was lower in magnesium than live material (0.097 versus 0.130 percent). Magnesium concentration in the forage appeared adequate to meet the nutritional requirement for gestating cows. During early- and mid-lactation, magnesium supplementation should be increased to supply approximately 0.2 percent magnesium in the animal's diet.

Sodium concentrations in forages are presented in Table 4. Sodium concentrations were 66, 16, 46, 5, and 30 percent lower in live material of annual grasses, sideoats grama, forbs, Texas wintergrass, and other warm-season grasses, respectively, during July - November than during March - June. Dead material averaged 0.12 percent sodium during the experimental period.

Potassium concentration (Table 5) in live material averaged 2.09 percent and ranged from 1.76 percent in the warm-season grasses to 2.59 percent in forbs. Concentrations in senesced forage material averaged 0.69 percent and ranged from 0.45 percent in warm-season grasses to 1.57 percent in forbs. This suggests that cows which have access only to senesced forage should be supplied with supplemental potassium.

The relative changes of mineral composition discussed in this paper are largely associated with differences between plant species and stage of plant development.

TABLE 1. PHOSPHORUS COMPOSITION OF LIVE AND DEAD FORAGE FOR FIVE PLANT SPECIES DURING TWO SAMPLING SEASONS

Phosphorus, %	March-June	July-November
Live,		
Annual grasses	0.104	0.159
Sideoats grama	0.099	0.089
Forbs	0.102	0.107
Texas wintergrass	0.103	0.104
Warm-season grasses	0.102	0.106
Dead,		
Annual grasses	0.061	0.037
Sideoats grama	0.042	0.039
Forbs	0.044	0.044
Texas wintergrass	0.048	0.044
Warm-season grasses	0.053	0.044

TABLE 2. CALCIUM COMPOSITION OF LIVE AND DEAD FORAGE FOR FIVE PLANT SPECIES DURING TWO SAMPLING SEASONS

Calcium, %	March-June	July-November
Live,		
Annual grasses	0.544	0.460
Sideoats grama	0.459	0.407
Forbs	1.591	2.027
Texas wintergrass	0.435	0.356
Warm-season grasses	0.368	0.333
Dead,		
Annual grasses	0.373	0.389
Sideoats grama	0.431	0.440
Forbs	1.147	0.994
Texas wintergrass	0.443	0.369
Warm-season grasses	0.375	0.374

TABLE 3. MAGNESIUM COMPOSITION OF LIVE AND DEAD FORAGE FOR FIVE PLANT SPECIES DURING TWO SAMPLING SEASONS

Magnesium, %	March-June	July-November
Live,		
Annual grasses	0.141	0.139
Sideoats grama	0.108	0.102
Forbs	0.181	0.219
Texas wintergrass	0.112	0.115
Warm-season grasses	0.107	0.103
Dead,		
Annual grasses	0.102	0.073
Sideoats grama	0.074	0.079
Forbs	0.194	0.131
Texas wintergrass	0.082	0.082
Warm-season grasses	0.080	0.076

TABLE 4. SODIUM COMPOSITION OF LIVE AND DEAD FORAGE FOR FIVE PLANT SPECIES DURING TWO SAMPLING SEASONS

Sodium, %	March-June	July-November
Live,		
Annual grasses	0.097	0.033
Sideoats grama	0.134	0.113
Forbs	0.118	0.064
Texas wintergrass	0.118	0.112
Warm-season grasses	0.152	0.107
Dead,		
Annual grasses	0.103	0.104
Sideoats grama	0.081	0.134
Forbs	0.163	0.170
Texas wintergrass	0.084	0.110
Warm-season grasses	0.120	0.086

TABLE 5. POTASSIUM COMPOSITION OF LIVE AND DEAD FORAGE FOR FIVE PLANT SPECIES DURING TWO SAMPLING SEASONS

Potassium, %	March-June	July-November
Live,		
Annual grasses	2.360	1.647
Sideoats grama	1.860	1.659
Forbs	3.502	1.670
Texas wintergrass	2.557	2.099
Warm-season grasses	1.998	1.516
Dead,		
Annual grasses	0.670	0.248
Sideoats grama	0.428	0.507
Forbs	2.324	0.809
Texas wintergrass	0.588	0.417
Warm-season grasses	0.484	0.426

Nutritional Value of South Texas Deer Food Plants

L. W. VARNER, L. H. BLANKENSHIP, AND S. C. HEINEMAN

Summary

Thirty-six native forage plants known to be eaten by deer were collected monthly in the Texas Rio Grande Plain. Samples were separated into leaf, stem, and fruit (when available) components and analyzed for crude protein (CP), phosphorus (P), and dry matter digestibility (DMD). Nutritive value of all species followed a bimodal pattern during the year with peaks in quality during April and May with another lesser peak in September and October. Forage quality was lowest during January and February with another low period in late summer. As a class, forbs were generally higher in quality than browse. DMD of forbs was never below 55 percent while some browse species were less than 30 percent during some seasons of the year. CP content of forb leaves varied from 11 percent (*Euphorbia sp.* in August) to 40 percent (*Desmanthus virgatus* in May). Mean CP of leaves of all forb species averaged 16 percent or greater during all months of the year. Mean CP of leaves of browse species was 14 percent or greater during all seasons of the year. Among the browse species, *Celtis pallida* was the highest in overall quality with annual mean values of 73.3, 23.8, and 0.18 percent for DMD, CP, and P, respectively. *Acacia rigidula* was lowest in DMD of all species averaging 31.4 percent for the entire year. Fruits of browse species generally were available only during the summer months and with the exception of *A. berlandieri* and *Eysenhardtia texana* were less than 21 percent CP and 0.30 percent. These data demonstrate that for deer, CP content of South Texas plants appears adequate throughout the year. However, during certain months of the year, energy and P may be limiting nutrients for deer as evidenced by the low DMD and P content of many plants.

KEYWORDS: Texas Rio Grande Plain/forage plants/nutritive value/deer food/dry matter digestibility/crude protein/phosphorus.

Introduction

The white-tailed deer (*Odocoileus virginianus*) is the most widely recognized and economically important large game species in North America (Taylor, 1956). The management of this species has become more intensive in the last 10 years, particularly in Texas. Increased management intensity necessitates a greater knowledge of the habitat, since forage quality and quantity largely determine the optimum carrying capacity of any white-tailed deer range (Moen, 1973; Robbins, 1973). A healthy, productive deer herd depends upon a year-round availability of a sufficient quantity of nutrients. Studies have been conducted for the past 10 years at the Texas Agricultural Experiment Station, Uvalde, Texas (Blankenship et al., 1982; Varner, 1981; Varner and Blankenship, 1976) to determine the nutritional composition of South Texas deer food plants.

Procedure

Important deer food plants were determined from published information (Chamrad and Box, 1968; Drawe, 1968; Everitt, 1972) and from microhistological analysis of deer rumen contents and feces collected during the seasons of the year. Plants were collected monthly when available; however, some data are reported on a seasonal basis.

Care was taken to sample only the current years' growth or, in the case of winter collections, that from the previous growing season. Approximately 1.5 inches of the tips of shrub twigs were clipped. Analyses reported in this paper are DMD-estimated by the in vitro technique (Newman, 1972), CP (Lauber, 1976) and P (Kallner, 1975). Plant species were collected in three areas of South Texas: (1) Rio Grande Plain Experimental Ranch in Kinney and Maverick Counties, (2) Chaparrosa Ranch in Zavala County, and (3) Chaparral Wildlife Management Area in Dimmit and LaSalle Counties. Scientific name, common name, and a code for all species reported are shown in Table 1. In the succeeding discussion, figures and tables, plants will be idenfified by their species code.

Results and Discussion

Dry Matter Digestibility

On a seasonal basis, DMD of all species was greater in spring and fall than either summer or winter (Table 2).

TABLE 1. NAME AND TYPE OF SOUTH TEXAS DEER FOOD PLANTS

Code	Scientific Name	Common Name	Type
ACBE	*Acacia berlandieri*	Guajillo	Browse
ACGR	*Acacia greggii*	Catclaw	Browse
ACMO	*Acalypha monostachya*	Copperleaf	Forb
ACRI	*Acacia rigidula*	Blackbrush	Browse
ACTO	*Acacia tortuosa*	Twisted acacia	Browse
AMPS	*Ambrosia psilostachya*	Western ragweed	Forb
APRA	*Aphanostephus ramossissimus*	Plains dozedaisy	Forb
BUCE	*Bumelia celastrina*	Coma	Browse
CEPA	*Celtis pallida*	Granjeno	Browse
CEIN	*Cenchrus incertus*	Grassbur	Grass
CHCU	*Chloris cucullata*	Hooded windmillgrass	Grass
COTE	*Colubrina texensis*	Texas colubrina	Browse
COER	*Commelina erecta*	Dayflower	Forb
COOB	*Condalia obovata*	Brazil	Browse
COBT	*Condalia obtusifolia*	Lotebush	Browse
CONU	*Coreposis nuecensis*	Crown coreopsis	Forb
DEVI	*Desmanthus virgatus*	Bundleflower	Forb
DITE	*Diospyros texana*	Texas persimmon	Browse
EPAN	*Ephedra antisyphlitica*	Vine ephedra	Browse
EUSP	*Euphorbia sp.*	Euphorbia	Forb
EYTE	*Eysenhardtia texana*	Kidneywood	Browse
GAPU	*Gaillardia pulchella*	Indian blanket	Forb
HETE	*Hermannia texana*	Texas hermannia	Forb
KRRA	*Krameria ramossissima*	Krameria	Browse
OPLI	*Opuntia lindheimeri*	Texas pricklypear	Browse
PAHA	*Panicum hallii*	Hall's panicum	Grass
PAHY	*Parthenium hysterophorus*	False ragweed	Forb
PHVI	*Physalis viscosa*	Groundcherry	Forb
POAN	*Porlieria angustifolia*	Guayacan	Browse
PRGL	*Prosopis glandulosa*	Honey mesquite	Browse
SCCU	*Schaefferia cuneifolia*	Desert yaupon	Browse
SEMA	*Setaria macrostachya*	Plains bristlegrass	Grass
SIFI	*Sida filicaulis*	Spreading sida	Forb
SICA	*Simsia calva*	Bushsunflower	Forb
THTE	*Thamnosma texana*	Dutchman's britches	Forb
VIST	*Viguiera stenoloba*	Skeletonleaf goldeneye	Browse
ZAFA	*Zanthoxylum fagara*	Lime pricklyash	Browse

OPLI had the highest DMD of all species with a mean of 89.7 percent for the entire year. Forbs were higher in DMD than browse or grasses with an overall average of 70.0 percent compared to 48.9 percent and 51.5 percent for grasses and browse, respectively. COER and PHVI had the highest DMD (> 70 percent) during all seasons of the year. Forbs with the lowest DMD for spring, summer, fall, and winter, respectively, were PAHY (57.2 percent), AMPS (60.6 percent), HETE (66.2 percent), and APRA (52.4 percent). Among the browse species, ACRI and ACTO were the lowest in DMD (= > 37.0 percent) during all seasons of the year. CEPA, the most digestible of all browse species, was never less than 71 percent DMD with an overall mean for the year of 73.3 percent. The mean DMD of all browse species did not vary greatly throughout the year (54.5, 48.5, 51.0, and 49.9 percent for spring, summer, fall, and winter, respectively). The four grass species were highest in DMD in the spring (52.6 percent). CEIN and PAHA were generally higher in DMD than either CHCU or SEMA. Grasses were the lowest in mean DMD (48.9 percent) of all the plant classes although they were higher in DMD than some selected browse species (e.g., ACRI, ACTO, and ACBE).

Crude Protein

Monthly analysis of both forb and browse species show both leaves and stems to be potentially good sources of CP for deer (Figs. 1-3) (Figs. 1-7 on pages 70-75). CP was highest in forb leaves in April with DEVI and PHVI having 29.8 and 40.0 percent CP, respectively. CP was generally lowest in August and September with EUSP the lowest, averaging 11 percent for those 2 months. In addition, EUSP disappeared in November and was not found again until April. Of all the forbs, only AMPS was found throughout the entire year (Fig. 1). Several of the forb species that are highly preferred by deer (DEVI, PHVI, COER, SIFI) were found from December through April. Among browse species, CP leaves varied from a low 11 percent for SCCU in January to 40 percent for COBT in March (Fig. 2). CEPA leaves were among the highest in CP every month, averaging 23.6 percent for the entire year. During average winters many of the browse species (e.g., POAN, EPAN, ACRI, CEPA) will not lose their leaves. In general, even browse species that do defoliate will keep their leaves longer in the fall and leaves will appear earlier in late winter or early spring than forbs (Figs. 1 and 2).

TABLE 2. SEASONAL IN VITRO DRY MATTER DIGESTIBILITY OF SOUTH TEXAS DEER FOOD PLANTS

Species[1] code	Season				
	Spring	Summer	Fall	Winter	Mean
Browse					
ACBE	46.4	38.9	41.1	35.5	40.5
ACGR	62.2	36.7	42.0	47.3	47.0
ACRI	34.1	29.0	37.0	25.6	31.4
ACTO	32.9	36.9	31.9	28.0	32.4
BUCE	47.9	47.0	47.7	40.3	45.7
CEPA	71.7	73.3	75.2	73.0	73.3
COOB	61.4	42.3	47.8	60.4	53.0
COBT	47.7	50.7	38.8	44.4	45.4
EPAN	66.4	54.4	57.5	61.2	60.4
EYTE	62.4	60.2	49.8	54.1	56.6
POAN	58.0	56.6	60.2	54.9	57.4
SCCU	61.4	56.0	58.8	55.5	57.9
ZNFA	56.2	48.1	73.2	69.3	61.7
Mean	54.5	48.5	51.0	49.9	51.5
Forbs					
AMPS	64.9	60.6	69.5	67.7	65.7
APRA	68.0	65.4	85.3	52.4	67.8
COER	82.7	71.5	75.3	—	76.5
CONU	73.0	—	81.8	53.2	69.3
GAPU	68.7	68.0	90.7	60.5	72.0
HETE	74.3	64.5	66.2	—	68.3
PAHY	57.2	60.8	68.4	65.9	63.0
PHVI	74.5	77.9	78.7	78.6	77.4
Mean	70.4	66.9	77.0	63.1	70.0
Grass					
CEIN	58.7	57.1	54.4	48.0	54.5
CHCU	45.3	37.8	49.5	45.8	44.6
PAHA	59.6	37.7	49.2	50.4	49.2
SEMA	47.0	43.5	51.8	46.9	47.3
Mean	52.6	44.0	51.2	47.8	48.9
Cactus					
OPLI	94.8	86.8	90.5	86.8	89.7
Overall Mean	61.2	55.3	61.8	55.0	58.4

[1]See Table 1.

Stems of both forbs and browse species were lower in CP than leaves (Fig. 3) averaging approximately 60 percent the CP level of the leaves. Fruits of browse species were found only during the summer period and varied widely in CP. OPLI and DITE were lowest (6 percent) while ACBE and EYTE were highest (>21 percent). Grasses were generally lower in CP than either forbs or browse (Fig. 5). Mean CP of four grass species was highest at 12.2 and 14.3 percent for spring and fall, respectively. Grasses averaged 11.8 and 8.8 percent for fall and winter.

Phosphorus

Soils in South Texas are generally low in P (Fisher, 1974). This is reflected in the P content of the vegetation (Figs. 4-6). Forb leaves averaged approximately 0.27 percent P while browse leaves averaged 0.22 percent (Fig. 6). Of the forbs, PHVI was the highest in P at 0.51 percent in April and THIE was the lowest at 0.16 percent in September. ACBE and CEPA were the highest in P of the browse species averaging > 0.35 percent in March and April. POAN was the lowest in P of all browse species during most months of the year with a mean of 0.14 percent for the entire year. With the exceptions of EYTE and ACBE (Fig. 4) fruit of browse was > 0.20 percent P. Mean P of four grass species was lowest in winter at 0.16 percent and highest in fall at 0.27 percent.

In addition to quality, both quantity and availability of forage during all seasons is important in the management of wildlife (Walmo et al., 1977). Plants that are very high in protein, such as COBT, with leaves that are 40 percent CP in March may not greatly impact on the total amount of nutrients available to deer. In March the end 3 cm of the twigs of COBT are approximately 30 percent leaves and 70 percent stems (Fig. 7) which are less nutritious than leaves (Sullivan, 1969). Therefore, not only the quality of a particular forage species but the quantity of leaves in relation to stems should be taken into consideration when determining which forage species are important to manage in order to maintain or improve the nutritional plane of deer.

Texas forage plants are generally highest in quality in the spring then gradually decrease in quality through the summer and fall, reaching their lowest value in the winter (Rector and Huston, 1976). Our results show that forage quality in South Texas follows a more bimodal pattern with two peaks of quality during the spring, early summer period and another peak in early fall. Periods of low forage quality were during the hot, dry summer and the winter. These changes in forage quality correspond to the average annual rainfall pattern in South Texas. However, if winter temperatures are mild and adequate moisture is available, forage in South Texas may actually grow throughout the winter. Since green forage is of higher quality than mature forage Sullivan, 1969), low forage quality during the winter may not always be the case. The close relationship between rainfall and forage quality must be considered in making management decisions.

Knowledge of deer food habits, nutritional quality of preferred species, and deer nutritional requirements is necessary to properly coordinate deer management with changes in the nutritional value of the habitat. Deer nutritional requirements are not well defined; however, more information is becoming available on nutrient requirements (Hughes et al., 1981 and 1982) and food habits (Blankenship and Varner, 1980; Varner and Blankenship, 1984) of South Texas deer. This information should allow wildlife managers to make more informed management decisions as more forage quality information becomes available.

Research has shown that CP needed for optimum growth is from 13-16 percent (French et. al., 1956; Ullrey et al., 1967) although actual requirement to maintain rumen function is probably 6-7 percent (Dietz, 1965). This study has shown that most browse and forb species in South Texas contained CP in amounts that would be adequate during all seasons of the year, particularly since deer are selective feeders and select a high percentage of leaves and tendershoots.

Verme and Ullrey (1972) repeated approximately 0.35 percent P was necessary to support maximum gain, bone strength, and antler development of white-tailed bucks. With the exception of a few plants (e.g., PHVI, CEPA, ACBE, SICA, AMPS) in early spring, few species in this study contained this level of P. It is possible that P may be a limiting nutrient in South Texas for maximum antler growth.

Digestible energy (DE) requirements of deer are not well known, particularly how requirements may be affected by physiological status and climatic changes. Since DMD is highly related to DE (Moir, 1961), it accurately reflects the DE content of forages. Based on what is known, DMD requirements for adult deer is probably about 50-55 percent of the diet for maintenance and about 65 percent for lactating does. Only a few browse species (OPLI, CEPA, POAN, EYTE) contained these levels of DMD throughout the year. Almost all the forb species had 50 percent or more DMD during all seasons of the year. Grasses had the lowest DMD levels of all forage types. During the summer, when forage quality may be at its lowest, does in South Texas are under peak lactational stress and bucks are in a period of maximum antler growth. The high DMD content OPLI may explain its high utilization in most reported South Texas deer food habit studies. While OPLI may be a good source of energy, it is deficient in CP and P during all seasons.

These data demonstrate that a diversity of plant species is necessary in a well managed deer habitat. No one plant appeared adequate in all nutrients evaluated during all months. It appears that both P and energy (DMD) could be deficient nutrients for deer in South Texas at certain times of the year. These deficiencies would be aggravated by an overpopulation of deer, which occurs in many parts of Texas, or by competition with sheep, goats, or cattle for preferred, high quality forage species. Livestock and range management practices must be integrated into the wildlife management plan to maintain deer on a high nutritional plane.

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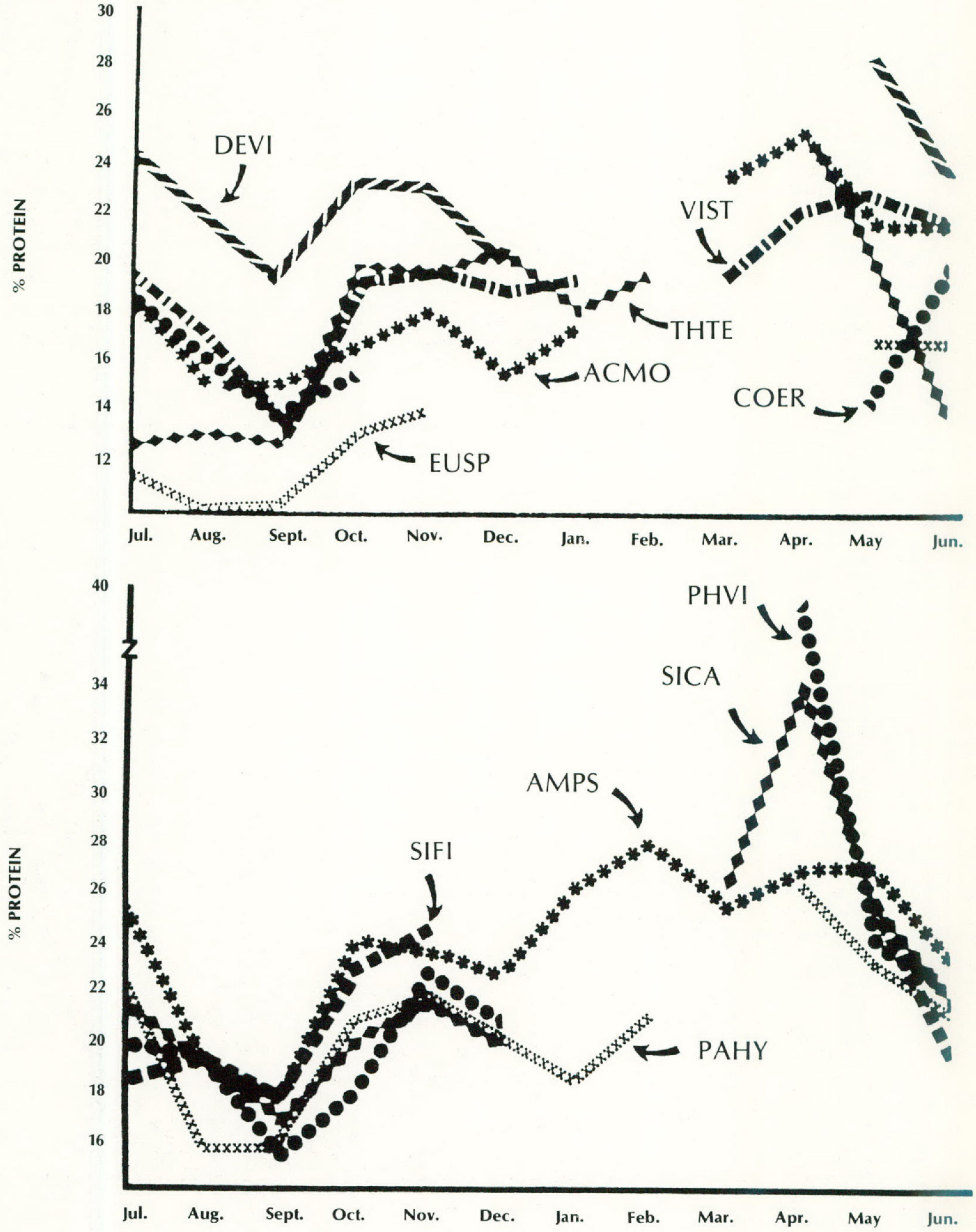


Figure 1. Monthly protein content of leaves of South Texas forb species (Species code listed in Table 1).

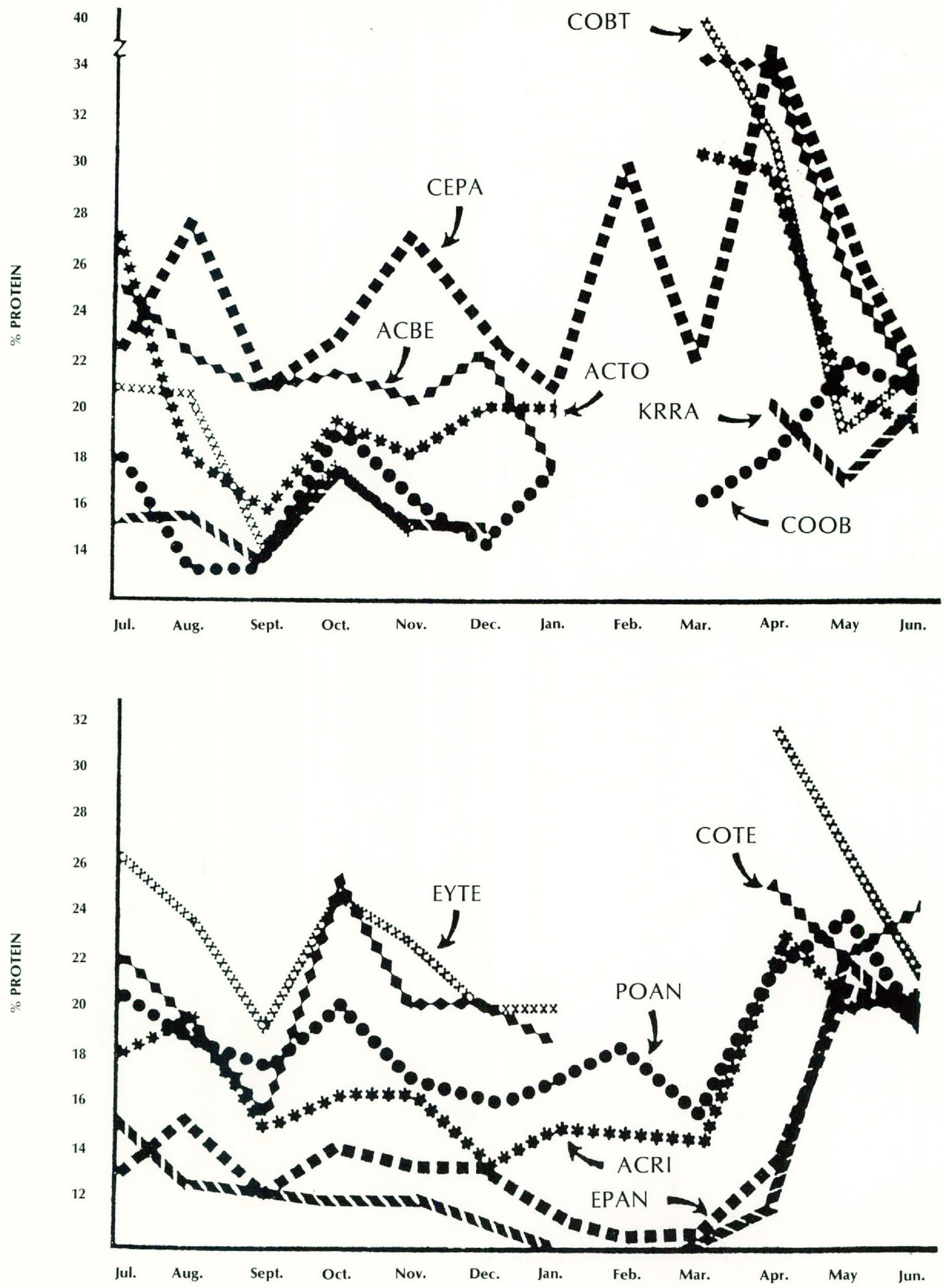
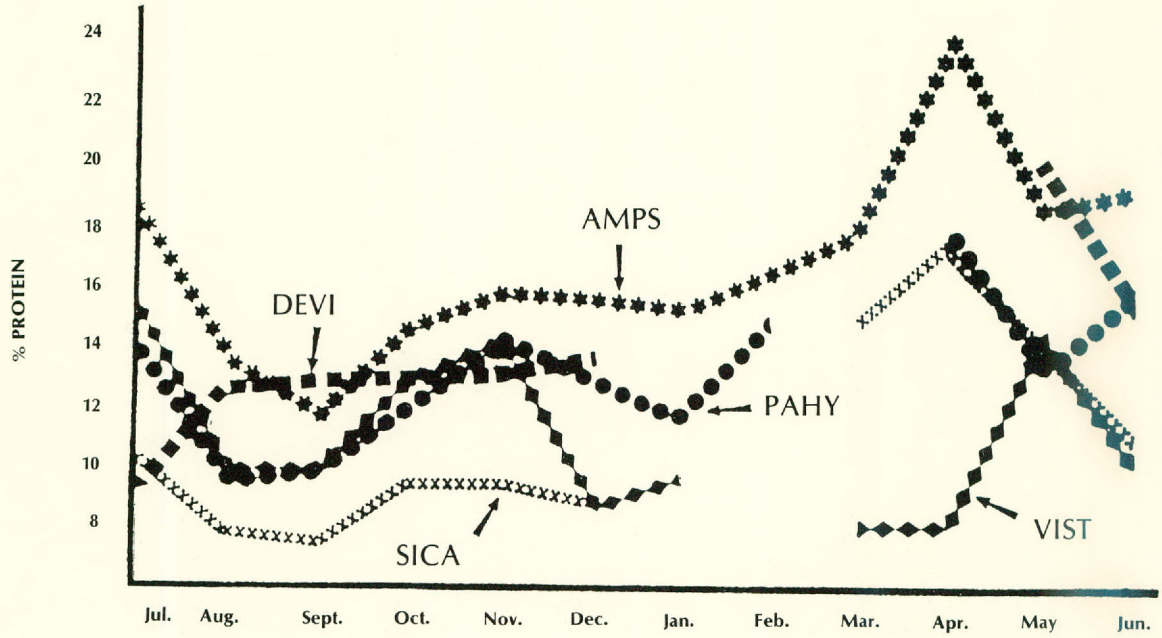


Figure 2. Monthly protein content of leaves of South Texas browse species (Species code listed in Table 1).



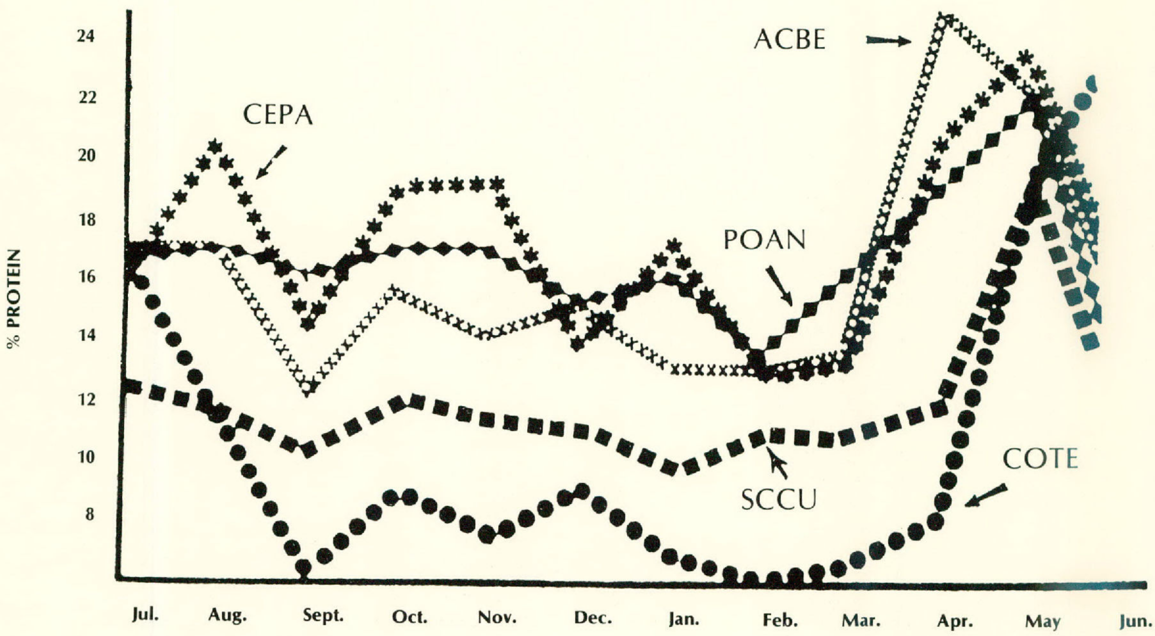


Figure 3. Monthly protein content of stems of South Texas forb (top) and browse (bottom) species (Species code listed in Table 1).

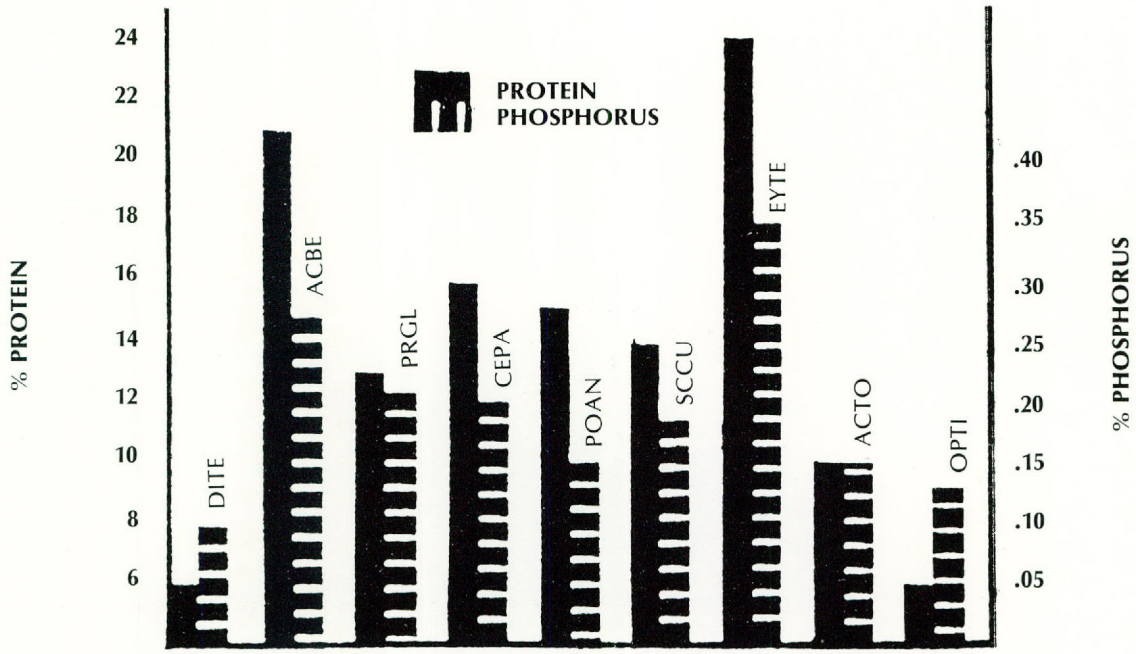


Figure 4. Protein and phosphorus content of fruit of South Texas browse species (Species code listed in Table 1).

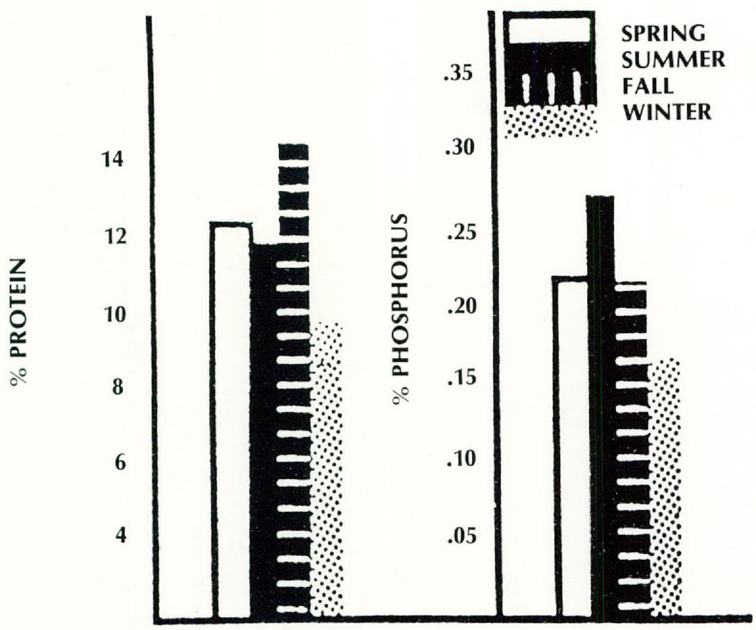
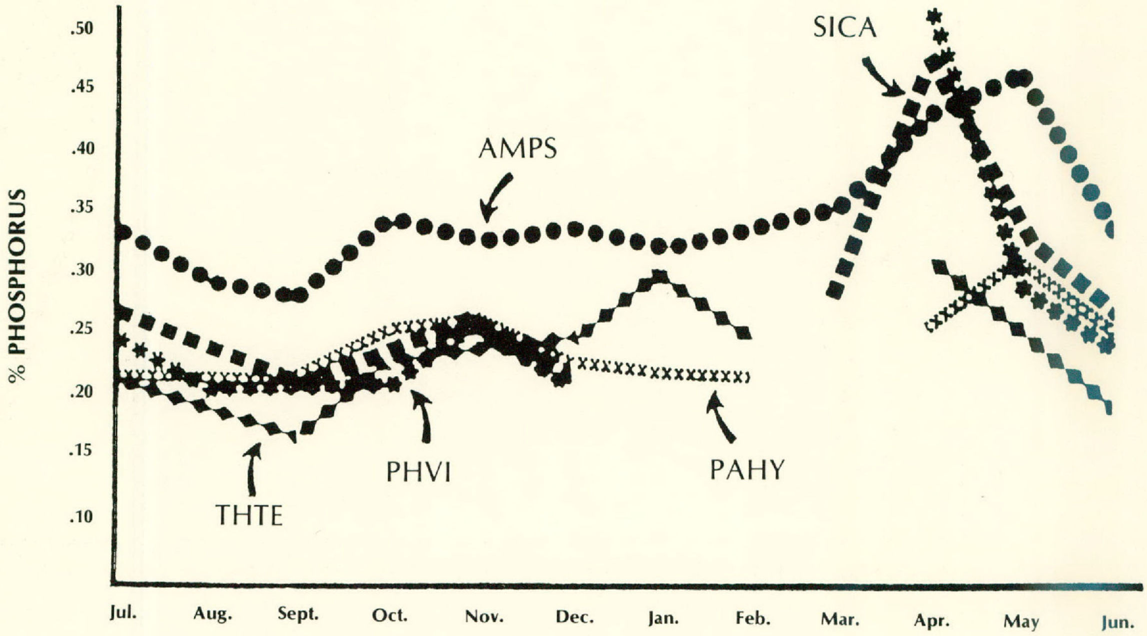


Figure 5. Average seasonal protein and phosphorus of four South Texas grass species (Species same as Table 2).



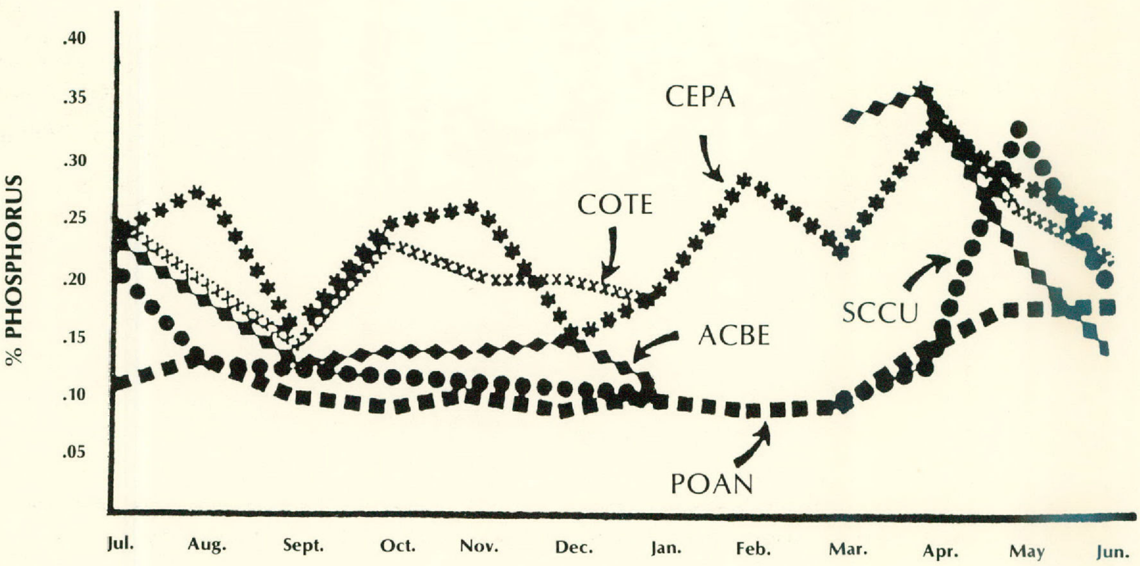
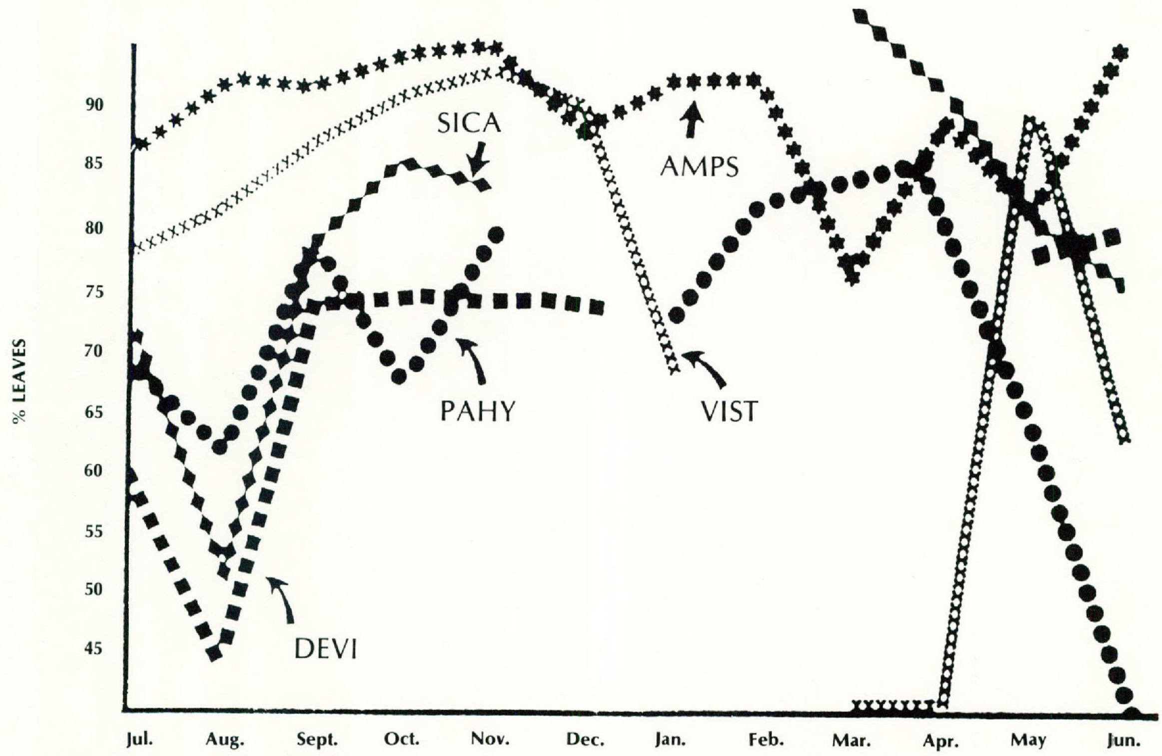


Figure 6. Monthly phosphorus content of leaves of South Texas forb (top) and browse (bottom) species (Species code listed in Table 1).



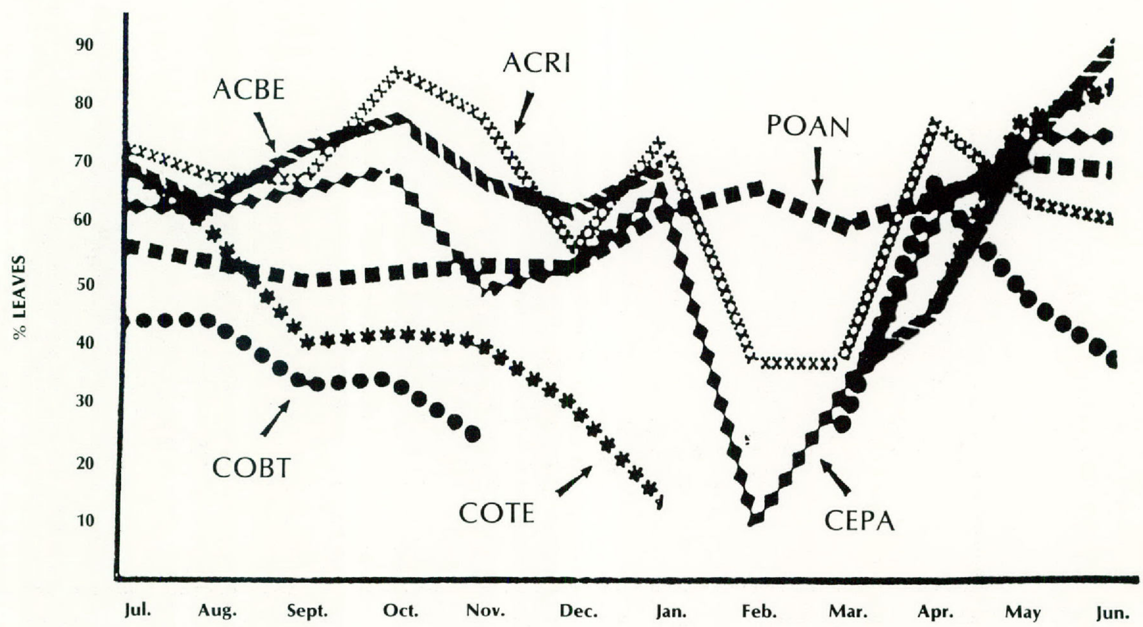


Figure 7. Leaves as a percent of dry matter of South Texas forb (top) and browse (bottom) species (Species code listed in Table 1).

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