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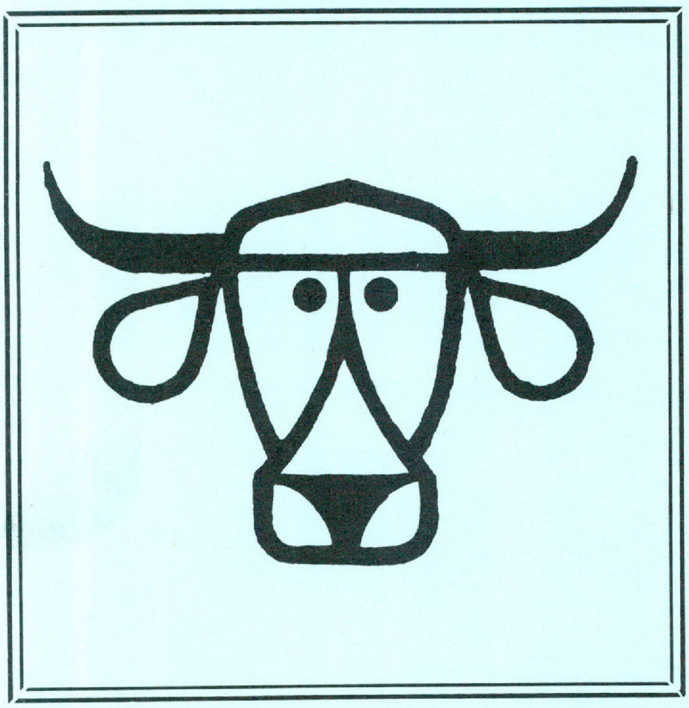

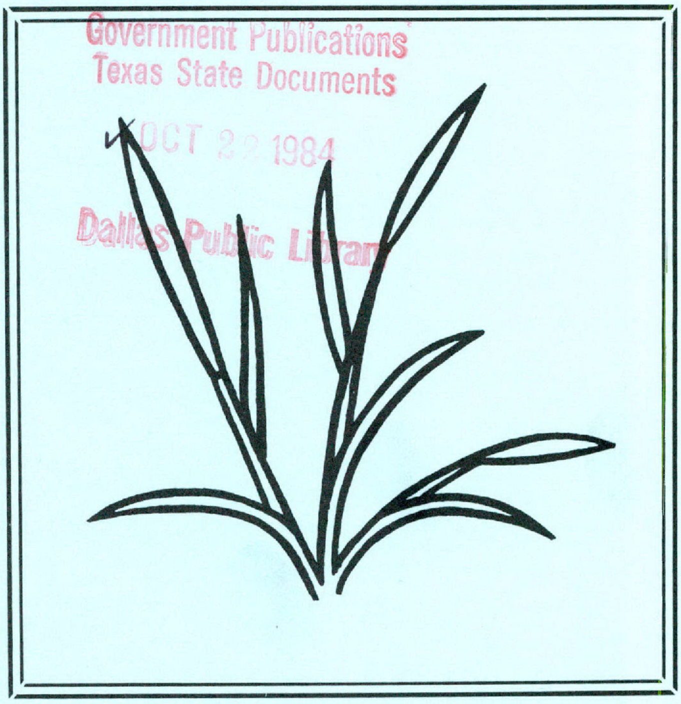

Forage Research in Texas

1984

The Texas Agricultural Experiment Station, Neville P. Clarke, Director, The Texas A&M University System, College Station, Texas

TABLE OF CONTENTS

Animal Performance

Cool Season Grasses

Fertilization

Miscellaneous

Authors

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FOREWORD

FORAGE RESEARCH IN TEXAS

Participants in the Forage Research Work Group have summarized recent accomplishments and results of their investigations. Research ranges from the Lower Rio Grande Valley, with a frost-free growing season, to East Texas, with its ample rainfall, and to the marginal rainfall areas which limit the extent and productivity of improved species for forage and pasture production.

Crop and animal scientists at the Main Station, plus regional centers, 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 other scientists and producers. 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 aspects of legumes, and stand establishment and fertility.

The intended audience includes researchers and extension personnel (many of whom cooperated in these investigations), and others interested in forage and grassland productivity. As additional data are obtained, studies finalized, and conclusive results developed, journal articles will be published.

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

Neville P. Clarke

Neville P. Clarke, Director
Texas Agricultural Experiment Station

ANIMAL PERFORMANCE ON SMALL GRAIN PASTURES IN NORTH TEXAS

D. J. Undersander and D. P. Hutcheson

SUMMARY

Replicated pastures of Grazer Blend triticale, Post barley, Scout wheat and TAM 105 wheat were established with irrigation. Seven hundred weight steers began grazing on the pastures November 8th and were removed when the forage ran out, January 14, 1984. The barley produced the most forage in the fall but suffered approximately 95% winterkill. The other small grains did not vary significantly in forage yield. The barley pasture yielded the highest gain per acre (273 lbs), the triticale had the lowest at 113 lbs./acre and the Scout and TAM 105 wheat were intermediate at 187 and 193 lbs/acre, respectively.

INTRODUCTION

Millions of acres of winter wheat are grazed over winter and then harvested for grain in North Texas. In recent years the newer, higher yielding varieties have been short-statured wheats. No grazing trials have been conducted comparing animal performance on the newer varieties to the older taller varieties. Triticale is another small grain that has been sold for winter pasture for several years in the region. Additionally, interest has been stirred recently in barley because of its potential as an alternate crop to wheat. While clipping trials have compared the forage yield of the four small grain types at several locations, no grazing trial has been conducted comparing animal performance of steers on the four types of winter pasture.

PROCEDURE

Replicated pastures of Grazer Blend triticale, Post barley, Scout wheat, and TAM 105 wheat, were established at the Texas Agricultural Experiment Station North Plains Research Field, Etter, Texas. Pastures were seeded approximately September 1 at the rate of 1.5 bu/acre. Pastures were preirrigated and received one additional fall irrigation prior to grazing cattle. The procedure used to graze the cattle was the put-and take method. Seven hundred and fifty pound steers were used in the study. Each pasture had four testers with additional cattle put on or taken off of the pasture as dictated by forage supply. Additionally, forage yield was determined by clipping 40-inch square areas under cages.

KEYWORDS: wheat, barley, triticale, average daily gain, feed conversion

RESULTS AND DISCUSSION

The winter of 1983-84 was an unseasonably cold period - the temperatures were lower than normal and the cold weather lasted much longer than usual. No winter forage growth occurred for approximately 2-1/2 months - an unseasonably long period. Thus, there was not forage available for spring grazing.

The majority of the forage yield was prior to the initiation of grazing on November 8 (Table 1). Barley pastures had significantly more forage 2682 lbs. than the other pastures. Barley was anticipated to produce more fall growth than the other small grains, however, in most years it is anticipated that the others small grains would produce more spring growth. Thus, the higher seasonal average forage production of barley compared to the other small grains occurred because no spring growth occurred in any of the small grains.

The animal performance characteristics are shown in Table 2. The average daily gain on the pastures ranged from 2.15 to 2.36 lbs. per day and were not significantly different. The average daily gains approached the theoretical maximum and indicated that forage availability was not the limiting factor in average daily gain. The head days range from 519 for the barley to 233 for the triticale. The barley had significantly more head days than the other pastures due to the higher forage productivity. The head days on the wheat pastures were 384 and 385 respectively for the Scout and TAM 105 wheat.

As expected from the similarity in average daily gain and variation in head days, Post barley produced the most gain per acre at 273 lbs. of beef per acre. Scout and TAM 105 were intermediate at 187 and 193 lbs. of beef per acre. The triticale had the lowest gain per acre (113 lbs).

More surprising, was the difference in feed conversion of the various small grains. 15.7 lbs. of triticale were required to produce a pound of gain and 12 lbs. of barley were required to produce a pound of gain while the Scout and TAM 105 wheat produced a pound of gain with 9.4 and 7.9 lbs. of forage respectively. The reasons for these differences are not clear however, differences of this seale would normally indicate energy densities or digestibility differences in forage.

All of the feed conversions appear to be low. Some of this may be due to clipping techniques. Forage yields were taken by clipping 1.75 inches above ground level. The cattle were generally grazed to maintain this forage height in the pasture but near the termination of the study the forage was grazed lower.

In summary, due to an unseasonably cold winter only a fall grazing period occurred for small grains in the 1983-84 winter. As expected, barley produced the most fall growth and therefore the most pounds of beef per acre. The barley also had approximately 95% winterkill. The other small grains produced approximately the same amount of forage however, because of the higher feed conversion of the wheats, Scout and TAM 105 produced more pounds of beef per acre than did the triticale.

In summary, due to an unseasonably cold weather only a fall grazing period occurred for small grains in the 1983-84 winter. As expected, barley produced the most fall growth and therefore the most pounds of beef per acre. The barley also had approximately 95% winterkill. The other small grains produced similar amounts of forage. However, because of the lower feed conversions of the wheats, 'Scout' and 'TAM 105' produced more pounds of beef per acre than did the triticale.

Table 1. Forage yield of small grains by month, Etter, Texas

Date	Grazer blend Triticale	Post Barley	Scout Wheat	TAM 105 Wheat
Nov. 8, 1983	1440	2682	1413	1242
Dec. 7, 1983	178	159	202	147
Jan. 8, 1984	------------------	No Growth	------------------	
Feb. 12, 1984	19	0	24	19
Mar. 13, 1984	125	5	101	82
Total	1762	2846	1740	1490

S_x = 243

Table 2. Forage productivity and animal performance on small grain pasture, Nov. 8, 1983 to Jan. 14, 1984

Pasture	Forage Produced	Average Daily Gain	Head Days	Gain/ Acre	Feed Conversion
Grazer Blend Triticale	1762 b*	2.28 ns	223 c	113 b	15.7 a
Post, Barley	2846 a	2.30	519 a	237 a	12.0 ab
Scout, Wheat	1740 b	2.15	384 b	187 ab	9.4 b
TAM 105, Wheat	1490 b	2.36	385 b	193 ab	7.9 b
S_x	243	.158	1.69	18.2	1.11

* Means followed by the same letter are not significantly different, Duncan's multiple range test, P = 0.05.

Changes in Cattle Body Weight Associated With Onset of Ryegrass Grazing

M. E. Riewe, K. P. Pounders and H. Lippke[1]

Summary

Body weight changes of heifers and young bulls when beginning ryegrass grazing was studied in two trials. Significant body weight losses occurred during the first three days on ryegrass with heifers. Heifers weighed less while young bulls weighed only slightly more after the first 14 days of ryegrass grazing. Weight gains on ryegrass after 14 days, with either heifers or young bulls, was good to excellent.

Feeding hay free-choice to young bulls for the first 28 days on ryegrass did not significantly affect changes in liveweight.

Intermittent overnight fast at 14 and 28 day interval, as sometimes done prior to weighing of cattle grazing experimental pastures, did not adversely affect heifer liveweight gain.

Introduction

It is generally assumed that cattle moving from a low quality roughage diet such as late season summer pasture or dry hay to lush winter annual grass pastures such as wheat or ryegrass, will experience an adjustment period during which little or no gain may be expected. It has been assumed that little or no gain in body weight may occur for the first 30 to 45 days of a 120-150 day grazing season. Dehydration is commonly observed and signs of respiratory stress may occur. A whitish-yellow diarrhea within 2-3 days of entering a cool season annual grass pasture is reported occassionally. If cattle are subjected to stress in addition to the change in diet, potential problems associated with adaptation to diet might be magnified.

If cattle make little or no gain for the first 30 to 45 days on usually expensive winter annual pasture, then economic loss may be incurred; provided, of course, this is not offset by compensatory gain later in the grazing season. For this reason, additional insights into the time and magnitude of body weight changes when cattle first graze winter annual pastures are needed. Additionally, knowledge of how this might be modified by management or feeding would be useful.

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KEY WORDS: ryegrass/early winter grazing/cool-season grass/animal body weight changes.

Procedure

Two trials were conducted to gain insight into the time and magnitude of body weight changes occuring at the initiation of winter annual pasture grazing.

Trial I was conducted to determine the effect of recurring 18-hr withholding of feed and water on weight gains of heifers grazing 'Gulf' ryegrass, Lolium multiflorum, pastures. Following grazing on common bermuda-dallisgrass pasture supplemented with protein and hay, eighteen month old F_1 Hereford X Brahman (1H1B) heifers were introduced to ryegrass pasture on two dates: December 14 and January 19 when ryegrass growth had advanced for more than a month and presumably with a higher indigestible fiber content. Before being introduced to ryegrass pasture, heifers were weighed full on the afternoon preceeding and again following an overnight period (18-hr) without feed or water. Seven heifers were fed hay to fill after the morning weighing and before being introduced to ryegrass pasture on December 14 (Group I) while the remaining 7 heifers (Group II) were introduced to ryegrass pasture immediately after weighing. Both groups were placed on the same pasture and allowed access to hay for the first 7 days. They consumed 7 lbs/hd/day average.

Groups III and IV continued on dormant summer pasture from December 13 to January 18 and were supplemented with an average 4.9 lb grain, 0.7 lb cottonseed cake and 16 lb hay/hd/day.

Groups III and IV (seven heifers each) were introduced to ryegrass pasture on January 19. Ryegrass grazing began after a full body weight on January 18 followed by an overnight period (18-hr) without feed or water and then weighed again. Group IV was introduced to ryegrass pasture immediately after the January 19 AM weighing while Group III was fed hay to fill before being introduced to the same pasture. Both groups were allowed access to hay for the first 7 days on pasture and consumed approximately 6 lbs/hd/day. Afterwards, all groups were maintained on the same pasture until the end of the trial on May 4.

Trial II involved two groups of five F_1 Angus X Brahman (1A1B) young bulls, approximately 10 months of age at the beginning of the trial. Both groups were weighed full on the afternoon of December 27. Prior to this, the bulls had been maintained on a common bermuda-dallisgrass pasture after mid-October weaning and supplemented with ryegrass silage or hay for the preceeding 69 days. Both groups were held without feed or water overnight (18-hr) and weighed again December 28. Group I was moved to 'Gulf' ryegrass pasture immediately after weighing. Group II calves were fed grass hay to fill after weighing and then placed on ryegrass pasture. Group II was fed hay on pasture daily for 28 days. For the first 7 days, the calves consumed 8.6 lbs/hd/day. Thereafter, for days 8 through 28, hay consumption averaged 5.7 lbs/hd/day. Hay was not always consumed on the day fed but all accumulated plus fed was cleared up the next day or two.

The calves were weighed every 14 days for the first six weeks, then at approximately 4-week intervals until ryegrass grazing was terminated on May 2.

Grazing was considered always adequate with forage dry matter available generally exceeding 2000 lbs per acre throughout the grazing season.

Results

Trial I

Groups I and II were weighed directly off pasture on December 17, 3 days after entering ryegrass pasture on December 14. Body weight losses (Table 1) were 26 and 21 lbs/hd. Some loss had been regained on December 28; however, body weight on January 11 were only slightly higher than initial weight on December 14. Thus, net body weight changes for the first 29 days on ryegrass pastures were small. Average daily body weight gain for the next 21 days until February 1 was 1.55 lbs/hd/day. Body weight gains during February and March exceeded 2.3 lbs/hd/day with gains somewhat reduced in April as the ryegrass was maturing.

Body weight changes for Groups III and IV during the first 30 days on ryegrass (January 18 to February 17) were generally similar to the gain of Groups I and II for the first 30 days on ryegrass (Table 1). There was a slight further reduction in body weight, however, between day 3 and 14 for Groups III and IV. This may have been because of difference in rumen fill at time of entry into ryegrass pasture. After February 17, gains were rapid and generally paralleled those for Groups I and II.

Recurring 18-hour periods of fast during the grazing season (seven times for Group II and five for Group IV) did not adversely affect changes in body weight (Table 1).

Trial II

Young bulls, whether or not fed grass hay on ryegrass pasture, had a small increase in body weight for the first 14 days on pasture (Table 2). Group II fed hay may have had a slight advantage for the first 14 days but this was not sustained through the next 14 days. Thereafter, the gains for both groups exceeded 3 lbs/hd/day through February, March and April.

The ryegrass pastures for both trials were similar. The difference in time required for apparent adjustment to the ryegrass as well as season long gains between the heifers in Trial I and young bulls in Trial II was striking.

Table 1. Body weight (lbs) changes of 1H1B heifers grazing Gulf ryegrass.

	Full body weight of group				Fasted weight[1] of group	
Date	I	II	III	IV	II	IV
Dec. 13	557[2]	558[2]	555	559	533[2]	535
Dec. 17	531	537				
Dec. 28	544	547			512	
Jan. 11	570	569			532	
Jan. 18			600[2]	609[2]		580[2]
Jan. 21			570	577		
Feb. 1	597	607	567	565	575	536
Feb. 17	644	650	609	614	619	587
Mar. 7	679	690	652	660	655	628
Apr. 6	748	764	722	744	720	702
May 4	795	805	769	794	768	753

[1]Fasted weights followed full body weight by 18 hours.
[2]Date at entry into ryegrass pasture.

Table 2. Body weight (lbs) changes of 1A1B bull calves grazing Gulf ryegrass with and without free choice grass hay first 28 days.

	Full body weight		Fasted weight[1]	
Date	No hay	Hay	No hay	Hay
Dec. 28	497	496	472	472
Jan. 11	503	511		
Jan. 25	544	536		
Feb. 8	587	583		
Mar. 8	684	678		
Apr. 4	773	769		
May 2	856	857	809	809
Total gain	359	361	337	337

[1]Fasted weight followed full body weight by 18 hours.

STEER PERFORMANCE ON AMMONIA TREATED COASTAL BERMUDAGRASS HAY

W. R. Ocumpaugh, Candy Moore, Cyndi Schultz and Domingo Martinez

Summary

A 111-day feeding study was conducted during the autumn and winter of 1983-84 to determine the effect ammonia treated hay would have on cattle performance. Seven steers (average weight 507 lbs) in each of two groups were fed mature coastal bermudagrass hay free choice and two pounds of whole shell corn per head per day. One group was fed untreated hay, the other group was fed the same hay which had been treated with 4% anhydrous ammonia about three weeks before the feeding study started. The amount of hay consumed and/or wasted per head per day was 14.7 lbs and 12.8 lbs dry matter for the treated and untreated groups, respectively. The steers offered treated hay wasted less than those offered untreated hay. The average daily gains were 1.35 and 0.50 lbs for the treated and untreated groups, respectively. Condition scores were determined on each animal, and the average score was approximately one unit higher for the treated group. Treating the hay increased the *in vitro* dry matter digestibility from about 50% to over 64% and the crude protein from 6.6% to 11%.

Introduction

The perennial forages used for hay in the southern U.S., and particularly in South Texas, are inherently low in quality unless harvested at an immature stage. Thus, a large proportion of the hay produced in South Texas is low in digestibility (TDN) and crude protein. If the protein level of the hay is below 7%, the rate of digestion may be reduced even further, resulting in lower than expected intake rates. Because of this, livestock cannot consume enough of the low quality hay to make reasonable gains without costly supplementation.

Recent research has shown that hay treated with anhydrous ammonia results in higher digestibility, crude protein, improved voluntary intake, and cattle performance as compared to untreated hay. Anhydrous ammonia is absorbed by the forage and is available as a non-protein nitrogen source. This process usually results in an increase of 10 to 12 units in digestibility, and 4 to 6 units in crude protein. The treatment breaks lignin-cellulose bonds, solubilizes hemicellulose, swells plant fibers, increases the rate and extent of digestion, and increases palatability.

Anhydrous ammonia may be applied at a rate of from 2 to 4% (40 to 80 lbs/ton), 3% being the optimum rate, with only 30 to 40% retained. Treatment time varies with air temperature. The higher the temperature the less treatment time is required (85°F, less than one week; 40°F, eight weeks or more). Treatment procedures call for stacking the hay, covering it with 6 mil black plastic, and sealing the edges with soil and/or posts. The ammonia is then injected under the plastic as a gas or liquid. If applied as a liquid, it must be placed in a container (i.e. 55 gal barrels with tops removed).

Anhydrous ammonia is potentially dangerous. It will burn skin, eyes, or throat; is volatile; and is maintained under pressure. This product is commonly used as fertilizer for crops. The same safety precautions should be used when treating hay as when applying fertilizer.

The objectives of this research were to determine the effect of ammonia treatment on (1) the forage quality of mature coastal Bermudagrass hay and (2) the performance of weaned steer calves.

Procedure

A 111-day feeding study was conducted to determine the performance of weaned crossbred steers on Coastal bermudagrass hay treated with anhydrous ammonia. Mature Coastal hay was cut and baled in large round bales in July of 1983. In September, uniform bales were selected, weighed, labeled, and sampled for moisture, laboratory analysis, and randomly allotted into two groups. On September 22, 640 lbs (4%) of anhydrous ammonia was applied to a total of 16,070 lbs of hay that was sealed under 6 mil black plastic. The anhydrous ammonia was applied as a liquid by placing two (2) 55 gallon drums under the plastic and dispensing the liquid into the drums. The drums were placed in two locations such that the ammonia only had to difuse the distance of 3 to 5 bales from the drum. This procedure allows the ammonia to be released for 4 or 5 days. On October 14, the seal was broken and one bale was allowed to "air out". Each time a bale was fed, the next bale was allowed to "air out". On October 17 a group of 14 crossbred (7/treatment) were treated for internal parasites, implanted with Ralgro, and assigned to two groups. On October 18, the feeding study was started. Each bale was weighed and sampled again for moisture and laboratory analysis on the day it was fed. The steers were fed one bale of hay at a time in round bale feeders in an open corral. In addition to the hay, all steers received 2 lbs of whole corn fed daily and free choice minerals and water. A fresh bale was fed as needed when the previous bale was consumed. An attempt was made to quantify the rejected hay, but the degree of trampling and mixing with feces and urine made it an impossible task. The steers were weighed every 28 days. When the experiment was terminated on February 6, 1984, the steers were weighed, given a condition score and taken directly to the local auction sale where each animal was sold individually. Subsequently an average price per pound and an average net revenue per treatment was determined.

Results and Discussion

Forage Data

The bale weights and laboratory quality analysis data are shown in Table 1. The weights shown are adjusted oven dry weights. This was done to reduce difference due to rainfall that may have occurred prior to any sampling date. As can be seen less treated hay was lost between the Sept. weight and the weight taken on the day of feeding. This difference is probably due to the reduced weathering of the treated hay, because it was covered with plastic. Some of the difference could also be due to the added weight of the ammonia. Nearly 40 lbs of anhydrous ammonia was added per bale, but calculations indicate that only 10 to 12 lbs were retained. (Please note that other research has shown that 2 to 3% anhydrous ammonia is considered sufficient. We applied more than we anticipated, our target was 3%).

The in vitro dry matter digestibility (IVDMD) was increased from about 50% to over 64% on the hay treated with ammonia. The quality of the untreated hay showed a drop of about one unit, and although small, was consistant over the entire lot of hay.

The crude protein (CP) was increased from about 6.6% to 11% on the treated hay. There was a small (about ½ unit) but consistent increase in the CP of the untreated hay from the September sampling until the "at feeding" sample. This is often observed, because the protein does not degrade as fast as does the energy component of forage. Thus, the observed response is an increase in protein.

These observed responses are within the limits of those reported by others that have treated hay and measured the responses in the laboratory.

Cattle Data

The average weights for each treatment for each weigh period are shown in Table 2. The total gain was 56 lbs per head for 111 days for the group fed untreated hay, while those fed treated hay gained an average of 150 lbs. The average daily gain was 0.50 lbs for untreated compared to 1.35 lbs for steers fed ammonia treated hay.

Average hay consumed and/or wasted was 12.8 lbs per head per day for untreated hay compared to 14.7 lbs for steers fed ammonia treated hay. Even though it could not be quantified, less treated hay was wasted. The average condition score was nearly one grade higher for those fed treated hay. Due to the higher degree of finish and heavier weights, the average price per pound was less on the group fed treated hay ($0.57 vs $0.61). However, the net per head value after paying all fees etc. was $32.64 greater for steers fed treated hay ($353.63 vs $320.99 per head).

TABLE 1. BALE WEIGHTS AND FORAGE QUALITY DATA BEFORE AND AFTER TREATMENT WITH ANHYDROUS AMMONIA

Sampling time	Bale weight		IVDMD*		Crude protein	
	Treated	Untreated	Treated	Untreated	Treated	Untreated
	lbs		%			
September	1085	1092	50.28	49.92	6.59	6.57
At feeding	1057	1015	64.12	48.91	11.02	7.02

*IVDMD = *in vitro* dry matter digestibility

TABLE 2. STEER WEIGHTS FOR EACH WEIGH PERIOD FOR CATTLE FED TREATED AND UNTREATED HAY

Treatment group	Weigh date: Oct 17	Nov 15	Dec 12	Jan 10	Feb 6
Treated	502	533	572	605	652
Untreated	513	514	536	540	569

MILK PRODUCTION AND COMPOSITION FROM FALL CALVING F-1 (BRAHMAN X HEREFORD) COWS AT THREE LEVELS OF FORAGE AVAILABILITY

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SUMMARY

Eight fall-calving F-1 (Brahman x Hereford) cows were grazed on bermudagrass-clover-ryegrass pastures at each of three levels of available forage during each of two successive years. Animal performance, milk production, percent total solids, protein, and butterfat were measured during the 2-year trial. Low levels of available forage (high stocking rates) caused animal gains to decline. Four-hour milk production decreased with increasing stocking rates. Percent total solids, protein, and butterfat, however, were not adversely affected by increasing stocking rates.

INTRODUCTION

Milk production is affected by both quality and quantity of feed or forage intake. The primary objective of this grazing trial was to evaluate the influence of available forage on four-hour milk production and various milk constituents from fall calving F-1 (Brahman x Hereford) cows.

PROCEDURES

Both common and 'Coastal' bermudagrass were oversown with either 'Mt. Barker' subterranean clover or 'Yuchi' arrowleaf clover and 'Gulf' ryegrass and grazed at three levels of forage availability. The trial was conducted each of two successive years and data will be reported as Trials 1 and 2. The total fertilizer applied during the course of the grazing period was 150-100-100 lbs/ac of $N\text{-}P_2O_5\text{-}K_2O$. Pastures were sampled monthly for available forage and every two weeks for quality.

Eight head of F-1 (Brahman x Hereford) fall-calving cows with 4 heifer calves and 4 steer calves were used as "testers". Calves were sired by Simmental bulls. Forage availability was maintained with "regulator" cows and calves via put-and-take method of grazing. All animals were weighed at approximately 28-day intervals. Cows were hand-milked in the following manner for the collection of milk yield,

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KEYWORDS: Forage availability/milk yield/milk composition/Brahman x Hereford/fall calves

total solids, protein, and butterfat: (1) injected with 20 IU of oxytocin intravenously; (2) allowed to stand for approximately 1 minute, removed all milk possible by hand, and discarded milk; (3) allowed cow to stand for 4 hours with only water available; (4) injected 20 IU oxytocin and hand-milked to measure production during the previous 4-hour period.

RESULTS AND DISCUSSION

Table 1 shows the average forage available during the test period for both trials. The desired range in levels of available forage was more nearly attained during the first trial as opposed to the second trial. This is readily apparent by the animal response at the high stocking rate, and the similarity of gains obtained at the low and medium stocking rates during the second year. The two-trial average showed cow average daily gains (ADG) of 1.38, 1.02, and -.96 for the low (L), medium (M), and high (H) stocking rates. Steer ADG were 3.03, 2.68, and 1.09; whereas, heifer ADG were 2.46, 2.27, and 0.86, respectively, for L, M, and H stocking rates. Table 2 shows the condition scores of cows by period for each of the two trials. The overall lighter grazing pressures used during Trial 2 were also reflected by the higher condition scores of cattle at all stocking rates, and especially at the high stocking rate. Because of difficulties encountered in obtaining milk from these crossbred cows, only 7 head each for the L and M stocking rates were used in Trial 2.

Table 3 shows the 4-hour milk production from the fall-calving cows at each of the three stocking rates. The relative level of forage available between the two years was obvious in noting the rate of decline in milk production as well as the total yields. Low forage availability caused a substantial decline in milk production. In addition, the amount of forage available at the low to medium stocking rate was adequate to allow for maximum milk production under the conditions of this trial.

Tables 4, 5, and 6 show the influence of stocking rates, respectively, on percent total solids, protein, and butterfat. Percent total solids averaged approximately 14% and did not appear to be affected by stocking rate. Percent protein averaged slightly more than 3% and no definite trends were apparent with respect to level of forage availability. Percent butterfat averaged about 5.5% from the fall-calving F-1 cows and once again no detectable trends occurred due to treatment. Butterfat did tend to increase, however, with stage of lactation. This increase, however, may not be significant.

TABLE 1. COW AND CALF LIVEWEIGHT GAINS AT THREE STOCKING RATES

		COW		STEERS			HEIFERS		
Stocking Rate	Average Forage Avail.	Initial Weight	ADG	Initial Weight	Weaning Weight	ADG	Initial Weight	Weaning Weight	ADG
TRIAL 1 (4-26 to 7-18									
Low	2485	996	2.09	501	787	3.42	452	691	2.86
Medium	1695	1005	1.28	471	716	2.93	456	672	2.58
High	535	1042	-1.19	467	521	0.64	436	457	0.24
TRIAL 2 (3-1 to 7-8)									
Low	2430	1114	0.66	474	767	2.63	431	659	2.06
Medium	2011	1114	0.76	422	692	2.43	393	609	1.95
High	936	1102	-0.72	451	622	1.54	407	572	1.48
TRIAL AVG.									
Low	2458	1055	1.38	488	777	3.03	442	675	2.46
Medium	1853	1060	1.02	447	704	2.68	428	641	2.27
High	736	1072	-0.96	459	572	1.09	422	515	0.86

TABLE 2. CONDITION SCORES OF FALL CALVING F-1 (BRAHMAN X HEREFORD) COWS AT THREE STOCKING RATES

TRIAL 1

STOCKING RATE	n	Date of Milking 4-26	5-23	6-20	7-18
Low	8		6.2	6.6	6.2
Medium	8		6.6	6.9	6.7
High	8		5.0	4.5	3.9

TRIAL 2

STOCKING RATE	n	3-1	5-1	5-29	6-26	7-8
Low	7	7.1	7.6	8.2	8.3	7.5
Medium	7	7.7	7.8	8.1	8.1	7.8
High	8	7.6	7.4	7.2	7.4	6.9

TRIAL AVG.

STOCKING RATE	n	3-1	4-26 5-1	5-23 5-29	6-20 6-26	7-18 7-8
Low	15	7.1	7.6	7.2	7.5	6.9
Medium	15	7.7	7.8	7.4	7.5	7.3
High	16	7.6	7.4	6.1	6.0	5.4

TABLE 3. FOUR-HOUR MILK PRODUCTION FROM FALL-CALVING F-1 (BRAHMAN X HEREFORD) COWS AT THREE STOCKING RATES

TRIAL 1

STOCKING RATE	n	Date of Milking 4-26	5-23	6-20	7-18
		---lbs---			
Low	8	2.552	2.622	2.376	1.665
Medium	8	2.882	3.150	2.772	1.544
High	8	2.317	1.661	.937	.405

TRIAL 2

STOCKING RATE	n	3-1	5-1	5-29	6-26	7-8
		---lbs---				
Low	7	4.209	3.208	2.752	2.651	1.421
Medium	7	3.241	2.675	2.400	1.949	1.718
High	8	3.353	3.016	2.163	1.091	.339

TRIAL AVG.

STOCKING RATE	n	3-1	4-26 5-1	5-23 5-29	6-20 6-26	7-18 7-8
		---lbs---				
Low	15	4.209	2.880	2.687	2.514	1.543
Medium	15	3.241	2.779	2.775	2.361	1.631
High	16	3.353	2.667	1.912	1.014	.372

TABLE 4. PERCENT TOTAL SOLIDS OF MILK FROM FALL CALVING F-1 (BRAHMAN X HEREFORD) COWS AT THREE STOCKING RATES

TRIAL 1

STOCKING RATE	n	Date of Milking 4-26	5-23	6-20	7-18
		%			
Low	8	14.63	13.78	15.49	14.09
Medium	8	14.26	14.24	15.23	15.16
High	8	13.70	13.95	15.22	14.34

TRIAL 2

STOCKING RATE	n	3-1	5-1	5-29	6-26	7-8
		%				
Low	7	15.15	14.80	13.91	14.29	17.03
Medium	7	13.19	14.42	14.95	13.98	16.90
High	8	13.64	14.10	13.67	15.32	12.27

TRIAL AVG

STOCKING RATE	n	3-1	4-26 5-1	5-23 5-29	6-20 6-26	7-18 7-8
		%				
Low	15	15.15	14.72	13.85	14.89	15.61
Medium	15	13.19	14.35	14.60	14.61	16.03
High	16	13.64	13.90	13.81	15.27	13.31

TABLE 5. PERCENT PROTEIN OF MILK FROM FALL CALVING F-1 (BRAHMAN X HEREFORD) COWS AT THREE STOCKING RATES

TRIAL 1

STOCKING RATE	n	Date of Milking 4-26	5-23	6-20	7-18
		%			
Low	8	2.99	2.59	3.00	2.86
Medium	8	2.86	2.99	2.96	3.15
High	8	2.92	3.05	3.48	3.26

TRIAL 2

STOCKING RATE	n	3-1	5-1	5-29	6-26	7-8
		%				
Low	7	3.42	3.05	3.10	3.33	3.4
Medium	7	3.20	2.97	3.10	3.40	3.25
High	8	3.38	2.93	2.87	3.21	3.21

TRIAL AVG

STOCKING RATE	n	3-1	4-26 5-1	5-23 5-29	6-20 6-26	7-18 7-8
		%				
Low	15	3.42	3.02	2.85	3.17	3.13
Medium	15	3.20	2.92	3.05	3.18	3.20
High	15	3.38	2.93	2.96	3.35	3.24

TABLE 6. PERCENT BUTTERFAT OF MILK FROM FALL CALVING F-1 (BRAHMAN X HEREFORD) COWS AT THREE STOCKING RATES

TRIAL 1

STOCKING RATE	n	Date of Milking 4-26	5-23	6-20	7-18
		%			
Low	8	5.77	5.18	5.58	5.91
Medium	8	5.84	5.49	5.52	6.87
High	8	5.37	5.74	5.11	6.34

TRIAL 2

STOCKING RATE	n	3-1	5-1	5-29	6-26	7-8
		%				
Low	7	5.49	5.77	5.34	4.58	6.65
Medium	7	4.58	5.89	6.14	5.65	7.41
High	8	4.81	5.75	5.20	5.63	4.17

TRIAL AVG

STOCKING RATE	n	3-1	4-26 5-1	5-23 5-29	6-20 6-26	7-18 7-8
		%				
Low	15	5.49	5.77	5.31	5.08	6.28
Medium	15	4.58	5.87	5.82	5.59	7.14
High	15	4.81	5.56	5.47	5.37	5.26

YIELD AND COMPOSITION OF MILK FROM SPRING-CALVING BRAHMAN *VS* F-1 (BRAHMAN X HEREFORD) COWS AT THREE LEVELS OF FORAGE AVAILABILITY

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SUMMARY

Brahman and F-1 (Brahman x Hereford) cows with spring-born calves were grazed at three levels of forage availability during each of two years. Four-hour milk production, percent total solids, protein, and butterfat were compared for both breeds of cattle from mid-July to early October. Milk production decreased with stage of lactation and level of available forage. There were no apparent differences between Brahman and F-1 cows with respect to any of the milk parameters monitored. In addition, stocking rate did not adversely affect percent total solids, protein, or butterfat.

INTRODUCTION

It has been previously suggested that milk production, etc., was partly responsible for gain differences between weaned *vs* suckling calves. This trial was initiated to ascertain the influence of forage availability or stocking rate on production and composition of milk from spring-calving F-1 (Brahman x Hereford) cows *vs* purebred Brahman cows.

PROCEDURE

Common and Coastal bermudagrass pastures were grazed to three different levels of available forage from mid-July to late September-early October during each of two successive years (Trials 1 and 2). Prior to initiation of this grazing trial, pastures had received 150-100-100 lbs/ac of N-P_2O_5-K_2O. After grazing was initiated in mid-July, an additional 50 lbs/ac N was applied to each of the pastures. Pastures were sampled monthly to monitor forage availability and biweekly for quality.

F-1 (Brahman x Hereford) cows had Simmental-sired calves in February-March; whereas, the Brahman cows had Brahman calves in April-May. Both F-1 and Brahman cows occupied the same forage availability pastures in Trial 1, but grazed separate pastures during Trial 2. Four F-1 pair were used per treatment during both trials; whereas only 2 Brahman pair were used on each treatment in Trial 1 and

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KEYWORDS: Forage availability/milk yield/milk composition/Brahman cow/spring calves

4 Brahman pair were used in Trial 2. All cows were weighed at approximate 28-day intervals. All cows were hand-milked in the following manner for the collection of milk yield, total solids, protein, and butterfat: (1) injected with 20 IU of oxytocin intravenously; (2) allowed cow to stand approximately 1 minute, removed all milk possible by hand, and discarded milk; (3) allowed cow to stand for 4 hours with access only to water; (4) injected 20 IU oxytocin and hand-milked to measure production during the previous 4-hour period.

At each milking-weighing period, cows were conditioned scored by at least two individuals. The scoring system was based on a 1 to 10 scale with a 10 being representative of maximum fat and condition obtainable and a 1 representative of a very unthrifty condition and minimum thinness to sustain life functions.

RESULTS AND DISCUSSION

The levels of forage available during each month of Trials 1 and 2 are shown in Table 1. During Trial 2, the Brahman group appeared to have slightly more forage available at the high stocking rate when expressed as lbs forage DM/100 lbs animal body weight. Additionally, the high stocking rate treatment in Trial 1 appeared to have more restricted forage available than in Trial 2. Table 2 shows condition scores for both F-1 and Brahman cows at each milking for both trials. The condition scores might also indicate the more severe grazing pressure at the high stocking rate in Trial 1 as compared to Trial 2. In general, as forage became limiting, animals lost weight and their condition scores declined. At the same general weight and frame size, Brahman cattle did not score as high as did the F-1 cattle. This may be due to differences in priority of fat deposit site, etc. between the two breeds of cattle.

Table 3 shows the monthly 4-hour milk production from both F-1 and Brahman cows during both trials. Milk production declined with stage of lactation and with increased stocking rate for both F-1 and Brahman cows. Although there was some erratic behavior in milk production with advancing season, there appeared to be very little difference between the 4-hour milk production of F-1 (Brahman x Hereford) cows and purebred Brahman cows. The most obvious difference was during the last milk collection period on the high stocking rate in which the Brahman cattle had considerably more milk than the F-1 cows. This may be due to differences in stage of lactation, differences in forage availability in Trial 2, efficiency of the Brahman cow to continue to milk at relatively high stocking rates, or a combination of several factors.

Tables 4, 5, and 6 show the influence of forage availability on percent total solids, protein, and butterfat, respectively. Percent total solids averaged about 14% regardless of the stocking rate or breed of cow. There were no identifiable trends associated with either level of forage available or breed. However, there did appear to be a slight increase in percent total solids with season or stage of lactation, but the degree of significance has not yet been ascertained. Percent protein was also apparently unaffected by stocking rate or breed of cow. However, the two trial average indicated a decline in percent protein from more than 4% in mid-July to less than 3.5 in early October. The relative stability in protein composition may be responsible in part for the level of calf performance at high stocking rates. Also, the efficiency of protein use, rumen bypass, etc. may be largely responsible for the adequate calf gains at restricted levels of available forage. Percent butterfat followed the same trend as total solids and protein with respect to increased stocking rates and breed of cow. Within certain stocking rates and breed of cows, butterfat appeared to increase with stage of lactation. However, this trend was not identifiable with specific treatment combinations.

TABLE 1. FORAGE AVAILABLE FOR CONSUMPTION BY BRAHMAN AND F-1 (BRAHMAN X HEREFORD) COWS AND CALVES AT THREE STOCKING RATES

Date	LOW STOCKED lb DM/ac[1]	LOW STOCKED lb DM[2] / 100 lb BW	MEDIUM STOCKED lb DM/ac	MEDIUM STOCKED lb DM / 100 lb BW	HIGH STOCKED lb DM/ac	HIGH STOCKED lb DM / 100 lb BW
TRIAL 1	F-1 (BxH) and Brahman					
7-24- to 8-22	5,400	310	4,824	180	1,560	21
8-22 to 9-21	11,200	400	6,528	150	672	10
9-21 to 10-10	6,819	240	3,672	85	312	4
TRIAL 2	F-1 (BxH)					
7-15 to 8-13	3,768	355	3,732	200	1,368	48
8-13 to 9-3	3,156	175	1,776	85	685	19
9-3 to 9-26	3,072	295	2,220	130	1,008	44
TRIAL 2	Brahman					
7-15 to 8-13	2,088	200	4,104	230	1,632	84
8-13 to 9-3	4,848	410	3,120	170	1,512	79
9-3 to 9-26	2,784	230	3,216	180	840	45

[1]Pounds dry matter forage per acre

[2]Pounds dry matter forage per pound of body weight of animal

TABLE 2. CONDITION SCORES OF SPRING-CALVING BRAHMAN AND F-1 (BRAHMAN X HEREFORD) COWS AT THREE STOCKING RATES

TRIAL 1

STOCKING RATE	Breed	n	Date of Milking 7-18	8-22	9-21	10-10
Low	F-1	4		7.0	6.4	5.8
	Brah	2	6.3	6.5	5.3	5.5
Medium	F-1	4		6.4	5.0	4.5
	Brah	2	6.0	6.0	5.8	5.3
High	F-1	4		5.1	4.8	4.5
	Brah	2	5.5	3.8	4.8	3.8

TRIAL 2

STOCKING RATE	Breed	n	7-17	8-13	9-3	9-26
Low	F-1	4	6.3	7.3	6.2	7.1
	Brah	4	8.0	7.8	7.6	8.1
Medium	F-1	4	6.5	6.9	5.6	6.1
	Brah	4	7.6	7.5	7.3	8.1
High	F-1	4	6.4	6.6	5.8	6.3
	Brah	4	7.1	6.4	5.1	5.3

TRIAL AVG

STOCKING RATE	Breed	n	7-18 7-17	8-22 8-13	9-21 9-3	10-10 9-26
Low	F-1	8	6.3	7.2	6.3	6.5
	Brah	6	7.2	7.2	6.5	6.8
Medium	F-1	8	6.5	6.7	5.3	5.3
	Brah	6	6.8	6.8	6.6	6.7
High	F-1	8	6.4	5.9	5.3	5.4
	Brah	6	6.3	5.1	5.0	4.6

TABLE 3. FOUR-HOUR MILK PRODUCTION FROM SPRING-CALVING BRAHMAN AND F-1 (BRAHMAN X HEREFORD) COWS AT THREE STOCKING RATES

TRIAL 1

STOCKING RATE	Breed	n	Date of Milking 7-18	8-22	9-21	10-10
			---lbs---			
Low	F-1	4		2.882	1.450	1.124
	Brah	2	2.75	2.891	.997	1.261
Medium	F-1	4		3.078	1.417	1.430
	Brah	2	2.924	3.091	1.659	1.525
High	F-1	4		2.928	1.338	.642
	Brah	2	2.444	1.650	.887	1.100

TRIAL 2

STOCKING RATE	Breed	n	7-17	8-13	9-3	9-26
			---lbs---			
Low	F-1	4	3.320	2.715	2.638	1.756
	Brah	4	2.851	2.440	2.512	2.248
Medium	F-1	4	3.318	3.078	2.193	2.418
	Brah	4	2.776	2.204	2.026	1.951
High	F-1	4	2.596	2.950	1.265	.440
	Brah	4	2.402	1.817	1.712	1.764

TRIAL AVG

STOCKING RATE	Breed	n	7-18 7-17	8-22 8-13	9-21 9-3	10-10 9-26
			---lbs---			
Low	F-1	8	3.320	2.799	2.044	1.440
	Brah	6	2.801	2.666	1.755	1.755
Medium	F-1	8	3.318	3.078	1.805	1.924
	Brah	6	2.850	2.648	1.843	1.738
High	F-1	8	2.596	2.939	1.302	.541
	Brah	6	2.423	1.734	1.300	1.432

TABLE 4. PERCENT TOTAL SOLIDS OF MILK FROM SPRING-CALVING BRAHMAN AND F-1 (BRAHMAN X HEREFORD) COWS AT THREE STOCKING RATES

TRIAL 1

STOCKING RATE	Breed	n	Date of Milking 7-18	8-22	9-21	10-10
Low	F-1	4		12.20	14.7	16.1
	Brah	2	14.3	13.0	14.0	13.1
Medium	F-1	4		13.6	15.1	18.4
	Brah	2	15.3	10.1	13.6	15.5
High	F-1	4		13.4	13.5	14.5
	Brah	2	14.6	13.5	15.3	14.4

TRIAL 2

STOCKING RATE	Breed	n	7-17	8-13	9-3	9-26
Low	F-1	4	12.1	14.3	10.3	12.8
	Brah	4	13.6	14.8	13.9	15.5
Medium	F-1	4	12.9	14.8	11.0	14.2
	Brah	4	13.9	15.2	11.6	15.8
High	F-1	4	11.8	14.4	10.1	14.5
	Brah	4	13.8	15.3	12.5	14.9

TRIAL AVG

STOCKING RATE	Breed	n	7-18 7-17	8-22 8-13	9-21 9-3	10-10 9-26
Low	F-1	8	12.1	13.3	12.5	14.5
	Brah	6	14.0	13.9	14.0	14.3
Medium	F-1	8	12.9	14.2	13.1	16.3
	Brah	6	14.6	12.7	12.6	15.7
High	F-1	8	11.8	13.9	11.8	14.5
	Brah	6	14.2	14.4	13.9	14.7

TABLE 5. PERCENT PROTEIN OF MILK FROM SPRING-CALVING BRAHMAN AND F-1 (BRAHMAN X HEREFORD) COWS AT THREE STOCKING RATES

TRIAL 1

STOCKING RATE	Breed	n	Date of Milking 7-18	8-22	9-21	10-10
Low	F-1	4		2.50	2.77	2.93
	Brah	2	2.73	2.40	2.36	2.92
Medium	F-1	4		2.64	2.43	3.64
	Brah	2	2.83	1.99	2.40	2.95
High	F-1	4		2.86	2.37	3.00
	Brah	2	3.30	3.11	3.07	3.26

TRIAL 2

STOCKING RATE	Breed	n	7-17	8-13	9-3	9-26
Low	F-1	4	4.90	4.08	4.20	3.73
	Brah	4	4.83	4.10	4.03	3.80
Medium	F-1	4	4.60	4.30	3.75	2.88
	Brah	4	5.70	4.00	3.60	3.90
High	F-1	4	4.28	3.83	4.03	4.40
	Brah	4	4.90	4.05	3.43	4.05

TRIAL AVG

STOCKING RATE	Breed	n	7-18 7-17	8-22 8-13	9-21 9-3	10-10 9-26
Low	F-1	8	4.90	3.29	3.49	3.33
	Brah	6	3.78	3.25	3.20	3.36
Medium	F-1	8	4.60	3.47	3.09	3.26
	Brah	6	4.27	3.00	3.00	3.43
High	F-1	8	4.28	3.35	3.20	3.70
	Brah	6	4.10	3.58	3.25	3.67

TABLE 6. PERCENT BUTTERFAT OF MILK FROM SPRING-CALVING BRAHMAN AND F-1 (BRAHMAN X HEREFORD) COWS AT THREE STOCKING RATES

TRIAL 1

STOCKING RATE	Breed	n	Date of Milking 7-18	8-22	9-21	10-10
Low	F-1	4		4.40	4.34	6.62
	Brah	2	5.58	4.55	4.91	5.22
Medium	F-1	4		4.98	6.39	7.59
	Brah	2	6.07	4.03	5.39	6.26
High	F-1	4		5.73	5.18	5.69
	Brah	2	5.78	4.77	5.52	4.77

TRIAL 2

STOCKING RATE	Breed	n	7-17	8-13	9-3	9-26
Low	F-1	4	4.98	4.44	4.64	4.43
	Brah	4	3.95	5.24	5.66	5.70
Medium	F-1	4	4.94	4.86	4.84	5.45
	Brah	4	5.64	5.54	5.94	6.34
High	F-1	4	5.40	4.40	5.54	5.40
	Brah	4	4.36	5.64	4.70	5.65

TRIAL AVG

STOCKING RATE	Breed	n	7-18 7-17	8-22 8-13	9-21 9-3	10-10 9-26
Low	F-1	8	4.98	4.42	4.49	5.53
	Brah	6	4.77	4.90	5.29	5.46
Medium	F-1	8	4.94	4.92	5.62	6.52
	Brah	6	5.86	4.79	5.67	6.30
High	F-1	8	5.40	5.07	5.36	5.55
	Brah	6	5.07	5.21	5.11	5.21

INFLUENCE OF STOCKING RATE ON PUREBRED BRAHMAN COWS AND CALVES *vs* F-1 (BRAHMAN X HEREFORD) COWS AND SIMMENTAL-SIRED CALVES

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SUMMARY

Purebred Brahman cows and calves, along with F-1 (Brahman x Hereford) cows and their Simmental-sired calves, were grazed on bermudagrass pastures at three stocking rates from about mid-July to early October during a 3-year period. The F-1 cows gained more, but also lost more weight than the Brahman cows at the various stocking rates. The Brahman bull calves gained as much or more than the 1/2 Simmental steer and heifer calves at every stocking rate. Both Brahman bull and heifer calves gained considerably more than the Simmental calves at the high stocking rate. It is not clear at this time if the weight-gain advantage is due to bull *vs* steer calves, or breed effects.

INTRODUCTION

The ability of a cow to withstand management abuse, whether planned or unplanned, is a trait that is often overlooked in pasture trials. The grazing behavior, vigor, etc. of lactating cows at a range of forage availabilities may provide valuable economic implications to the producer. This trial was initiated to ascertain the influence of various levels of forage availability or stocking rates on the performance of both purebred Brahman and commercial F-1 (Brahman x Hereford) cows and their suckling calves.

PROCEDURE

The pastures used in this three-year trial were both common and Coastal bermudagrass. These pastures were grazed at three levels of forage availability from mid-July until early October. The low forage available or high stocking rate pastures were grazed with sufficient pressure to restrict the *ad libitum* intake of the grazing cow. Grazing pressures were maintained across forage availability treatments using the put and take method which utilizes both test animals and regulator animals.

During each of the three years, eight F-1 (Brahman x Hereford) cows and their Simmental-sired calves represented average liveweight gains for each of the stocking rate treatments. Heifer and steer calves were equally represented within each pasture. Both sexes of Simmental-sired calves received a single implant of a growth promotant at approximately 3 months of age.

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KEYWORDS: Stocking rate/Brahman cow/Brahman x Hereford/animal performance

With respect to the purebred Brahmans, heifer and bull calves were equally represented on each stocking rate. However, during the first year, only two pair were assigned to each treatment, and during the last two years, four pair were assigned to each treatment. In the first year of the trial, both Brahman and F-1 cows were in the same pastures of a particular stocking rate. In the last two years, all cows and their calves were separated according to breed and there was no mixed grazing of Brahman and F-1 cows. This was primarily a function of pasture and animal availability. Simmental-sired calves were born in February and March and Brahman calves were born in April and May.

All animals were weighed at approximate 28-day intervals. Pastures were sampled for available forage at 28-day intervals and for forage quality samples at 14-day intervals.

RESULTS AND DISCUSSION

Table 1 shows the forage available for each group of cattle during each of the three trials. The original intent was to provide a sufficiently light grazing pressure on the bermudagrass pastures so that spot grazing would essentially be nonexistent. In contrast, the heavy grazing pressures would be sufficiently heavy to prevent an accumulation of forage at dung and urine spots. When that data was expressed as pounds of forage dry matter per 100 pounds of animal body weight, ratios which exceeded 100 were assessed to be "medium" to "light" stocking rates. And, as the ratio approached 0, ad libitum intake was severely restricted. These ratios serve to document the relative relationship between available forage and body weight. In terms of stocking rates, low approximated .75 cow-calf pair per acre; medium, 1.5 pair per acre; and high, 2-3 pair per acre.

Table 2 shows the influence of stocking rate on average daily gains of both purebred Brahman cows and their calves. In general, with increasing stocking rate, the lactating cow lost increasing amounts of weight. During the third year, however, certain cows had unusual gains for their appropriate stocking rate treatment and thus the trend for cows was irregular during this year. Brahman bull calves gained more than the Brahman heifers at essentially all stocking rates. With an increase in stocking rate and a restricted ad libitum intake, the percent difference between bulls and heifers was greater than at the lower stocking rates.

Each of the 3-years' liveweight performance for the F-1 (Brahman x Hereford) cows and their Simmental-sired calves are presented in Table 3. Because of an earlier calving date, the Simmental calves were heavier at initiation of the trial than were the Brahman calves. During the second year of the trial, heifers outgained steers at every stocking rate. In contrast to the Brahman calf performance, the Simmental-sired heifer calves exceeded or were very similar to steer calves at the high stocking rate.

Table 4 shows the 3-year average performance of both breeds of cows and calves at each stocking rate. It was interesting to note that the F-1 cows had larger fluctuations in weight at the different stocking rates. The F-1 cows gained more weight at the low stocking rate (.70 vs .12) and lost more weight than the Brahmans at the high stocking rate (-1.55 vs -.94). Another noteworthy point is that the percent differences between the Brahman bull and heifer calves were greater than the percent differences between the 1/2 Simmental calves. In addition, the Brahman bull calves had equal or slightly higher average daily gain (ADG) than the Simmental-sired steers. Further, the Brahman bull calves had more than double the ADG of the Simmental steers at the high stocking rate; and, likewise the Brahman heifers gained .30 lbs/hd/day more than the Simmental heifers at the high stocking rate. These differences between the Brahman calves and Simmental-sired calves at the high stocking rate may be due in part to age of calf, relative milk production of the dam and the effect of stocking rate on the percent reduction in milk, differences in rumen function and/or efficiency of utilization of forages, or a combination of these along with other as yet undefined relationships.

By knowing the magnitude of animal performance decline with increasing grazing pressures or stocking rates, management decisions may be made which will economically and biologically optimize the year-long forage-animal system.

TABLE 1. FORAGE AVAILABLE FOR CONSUMPTION BY BRAHMAN AND F-1 (BRAHMAN X HEREFORD) COWS AND CALVES AT THREE STOCKING RATES

Date	LOW STOCKED		MEDIUM STOCKED		HIGH STOCKED	
	lb DM/ac[1]	lb DM[2] / 100 lb BW	lb DM/ac	lb DM / 100 lb BW	lb DM/ac	lb DM / 100 lb BW
TRIAL 1 F-1 (BxH) and Brahman						
7-24 to 8-22	5,400	310	4,824	180	1,560	21
8-22 to 9-21	11,200	400	6,528	150	672	10
9-21 to 10-10	6,819	240	3,672	85	312	4
TRIAL 2 F-1 (BxH)						
7-15 to 8-13	3,768	355	3,732	200	1,368	48
8-13 to 9-3	3,156	175	1,776	85	685	19
9-3 to 9-26	3,072	295	2,220	130	1,008	44
TRIAL 3 F-1 (BxH)						
7-15 to 8-13	5,277	250	4,127	120	1,547	25
8-13 to 9-3	4,234	205	3,394	105	695	11
9-3 to 9-26	4,005	180	2,302	71	972	19
TRIAL 2 Brahman						
7-15 to 8-13	2,088	200	4,104	230	1,632	84
8-13 to 9-3	4,848	410	3,120	170	1,512	79
9-3 to 9-26	2,784	230	3,216	180	840	45
TRIAL 3 Brahman						
7-15 to 8-13	4,460	250	6,260	260	2,183	130
8-13 to 9-3	3,886	200	5,804	220	840	24
9-3 to 9-26	3,600	180	3,500	120	888	39

[1]Pounds dry matter forage per acre
[2]Pounds dry matter forage per pound of body weight of animal

TABLE 2. LIVEWEIGHT GAINS OF PUREBRED BRAHMAN COWS AND CALVES GRAZING DIFFERENTLY STOCKED BERMUDAGRASS PASTURES

ITEM	LOW STOCKED	MEDIUM STOCKED	HIGH STOCKED
TRIAL 1			
Starting Date	7-24	7-24	7-24
Ending Date	10-10	10-10	10-10
No. Days on Pasture	78	78	78
Initial Weights (lbs)			
Cows	1022	1029	981
Bull Calves	315	235	217
Heifer Calves	263	247	206
Average Daily Gain (lbs)			
Cows	.29	.36	-.89
Bull Calves	2.44	1.83	1.35
Heifer Calves	1.73	1.85	.63
TRIAL 2			
Starting Date	7-15	7-15	7-15
Ending Date	9-26	9-26	9-26
No. Days on Test	73	73	73
Initial Weights (lbs)			
Cows	1107	1121	1190
Bull Calves	284	297	263
Heifer Calves	228	229	247
Average Daily Gain (lbs			
Cows	.18	-.44	-2.04
Bull Calves	2.30	1.94	1.71
Heifer Calves	2.14	1.62	1.34
TRIAL 3			
Starting Date	7-17	7-17	7-17
Ending Date	10-6	10-6	10-6
No. Days on Test	81	81	81
Initial Weights (lbs)			
Cows	1123	1035	958
Bull Calves	327	313	276
Heifer Calves	313	271	321
Average Daily Gain (lbs)			
Cows	-.13	.08	.12
Bull Calves	1.83	1.91	1.29
Heifer Calves	1.68	1.56	0.86

TABLE 3. LIVEWEIGHT GAINS OF F-1 (BRAHMAN X HEREFORD) COWS AND SIMMENTAL-SIRED CALVES GRAZING DIFFERENTLY STOCKED BERMUDAGRASS PASTURES

ITEM	LOW STOCKED	MEDIUM STOCKED	HIGH STOCKED
TRIAL 1			
Starting Date	7-24	7-24	7-24
Ending Date	10-10	10-10	10-10
No. Days on Test	78	78	78
Initial Weights (lbs)			
Cows	1079	893	1029
Steer Calves	479	473	464
Heifer Calves	430	427	428
Average Daily Gain (lbs)			
Cows	.71	.48	-1.98
Steer Calves	2.02	1.73	.51
Heifer Calves	1.89	1.62	.73
TRIAL 2			
Starting Date	7-15	7-15	7-15
Ending Date	9-26	9-26	9-26
No. Days on Test	73	73	73
Initial Weights (lbs)			
Cows	994	1073	1031
Steer Calves	459	461	449
Heifer Calves	424	436	454
Average Daily Gain (lbs)			
Cows	.77	.13	-1.06
Steer Calves	2.40	2.11	.83
Heifer Calves	2.76	2.15	.94
TRIAL 3			
Starting Date	7-15	7-15	7-15
Ending Date	10-6	10-6	10-6
No. Days on Test	83	83	83
Initial Weights (lbs)			
Cows	1053	1036	1067
Steer Calves	494	498	498
Heifer Calves	474	469	470
Average Daily Gain (lbs)			
Cows	.60	.38	-1.59
Steer Calves	1.88	1.51	.32
Heifer Calves	1.70	1.47	.24

TABLE 4. THREE-YEAR AVERAGE LIVEWEIGHT GAINS OF BRAHMAN AND F-1 (BRAHMAN X HEREFORD) COWS AND THEIR CALVES FROM THREE DIFFERENTLY STOCKED BERMUDAGRASS PASTURES

ITEM	LOW STOCKED		MEDIUM STOCKED		HIGH STOCKED	
	Brah	F-1[1]	Brah	F-1	Brah	F-1
Starting Date	7-19	7-18	7-19	7-18	7-19	7-18
Ending Date	10-4	10-4	10-4	10-4	10-4	10-4
No. Days on Test	77	78	77	78	77	78
Initial Weight (lbs)						
Cows	1084	1042	1062	1001	1043	1042
Male Calves[2]	309	478	282	478	252	471
Heifer Calves	268	443	249	444	258	451
Average Daily Gain (lbs)						
Cows	.12	.70	0	.33	-.94	-1.55
Male Calves	2.19	2.10	1.90	1.78	1.45	.56
Heifer Calves	1.85	2.12	1.68	1.75	.94	.64

[1] Cows are F-1 (Brahman x Hereford) and calves are 1/2 Simmental.

[2] Brahman calves are bulls; Simmental-sired calves are steers.

COMPARISON OF LIVEWEIGHT GAINS OF SUCKLING VS WEANED CALVES GRAZED AT FOUR STOCKING RATES

F. M. Rouquette, Jr., L. D. Roth, M. J. Florence, and W. C. Ellis[1]

SUMMARY

Fall-born and spring-born Simmental-sired, suckling calves were grazed at the same level of forage availability as were Brahman-cross weaned calves. Comparisons of gain per animal and gain per acre were made at each of four stocking rates of Coastal bermudagrass overseeded with 'Marshall' ryegrass and 'Mt. Barker' subterranean clover. Suckling calves gained more than three quarters of a pound a day more than weaned calves at all stocking rates. Because of differences in the calculated stocking rates for weaned calves vs cow-calf units, the weaned calves gained over 500 lbs/acre more than suckling calves at the low, medium low, and medium high stocking rates. At the high stocking rate, gain per acre was nearly equal for both sets of calves with only a slight advantage of 74 lbs/ac in favor of the suckling calf performance.

INTRODUCTION

As stocking rate increases, animal performance ultimately decreases. Because of milk production, primarily, as well as other factors, suckling calves are generally buffered from the dramatic influence of increased rates of stocking. The primary objective of this trial was to measure the influence of stocking rate on suckling and weaned calves.

PROCEDURE

The pastures used in this trial were Coastal bermudagrass oversown with 'Marshall' ryegrass and 'Mt. Barker' subterranean clover. A total of 250-100-100 lbs/ac of $N-P_2O_5-K_2O$ was split-applied from October 1982, until August 1983. Grazing was continuous rather than rotational during the 210-212-day trial. Forage from a test area in each of the pastures was clipped to ground level (0" stubble height) at 28-day intervals to monitor forage availability. The put-and-take method of grazing was utilized to obtain a range in available forage across the four pastures. The high forage availability pasture (low stocking rate) was grazed to a level so that *ad libitum* intake would not be restricted. The low forage availability pasture (high stocking rate) was grazed to a level so

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KEYWORDS: Liveweight gain/stocking rate/suckling calves/weaned calves

that defecation areas were not detectable; and hence, spot grazing was not a significant factor. At the high stocking rate, intake of the grazing animal was restricted due to an insufficient quantity of available forage.

Three steers and two heifers (Brangus and Brahman-Simmental crosses) born in the summer of 1982 were allotted to each of the four pastures. These calves, which served as the "tester" animals for the weaned calves were approximately 8 months of age at the beginning of the trial and had received small grain-ryegrass pastures for approximately 90 days prior to initiation of the trial on March 1, 1983. Two sets of suckling calves were used to compare liveweight gains with the weaned calves. Simmental-sired calves (F-1 Brahman x Hereford dams) born in October-November 1982 (fall-born), and in February-March, 1983 (spring-born), were used as "tester" suckling calves. The fall-born calves grazed the test pastures from March to July and the spring-born calves grazed the test pastures from July to September. Both the weaned calves and suckling calves grazed the same pastures within a forage availability treatment. Animals were weighed at approximate 28-day intervals throughout the duration of the trial.

RESULTS AND DISCUSSION

The levels of available forage at each of the four treatment pastures are shown in Table 1. Expressed as a ratio of lbs DM/a forage:animal weight, there were some fluctuations within a particular pasture, but, in general, there was a fairly uniform separation in level of available forage across the four treatments. The average of the forage:animal ratio was 142, 62, 38, and 12, respectively, for the low (L), medium low (ML), medium high (MH), and high (H) stocking rates.

Liveweight gains of suckling vs weaned calves at L, ML, MH, and H stocking rates are presented in Tables 2, 3, 4, and 5, respectively. At the low stocking rate, suckling heifers had average daily gains (ADG) of .95 lbs more than the weaned heifers (2.59 vs 1.64 lbs); whereas, suckling steers had an ADG of .88 lbs more than weaned steers (2.70 vs 1.82 lbs) (Table 6). Using an average of both steers and heifers, the combined suckling calf ADG exceeded that of the weaned calf by approximately .9 lbs/hd/day. The calculated gains per acre presented are based on 600-pound equivalents for weaned calves and 1500-pound equivalents for an animal-unit (one cow plus one calf). And, the gains per acre shown are based on a pasture comprised of either heifers, steers, or a mixture of heifers and steers. Thus, the gains per acre presented for each sex of calf are not additive. It is of economic importance to note that the total calculated gains per acre of weaned calves was about 1.7 times greater than that for suckling calves. Gains per animal were influenced by milk production and other minor factors; and conversely, gain per animal were affected by the maintenance of a calf vs a cow plus a calf.

Tables 3, 4, and 6 show the performance and gain advantage of suckling calves over weaned calves at both the medium low and medium high stocking rates. With the exception of the gain differences between the steer groups at the ML stocking rate, the gain differences between weaned vs suckling calves were consistent with those differences detected at the low stocking rate. The gain per acre advantage of weaned calves over suckling calves ranged from about 525 to 600 pounds per acre over the L, ML, and MH stocking rates. Of particular interest is the magnitude of gain per acre calculated for the weaned and suckling steers at the MH stocking rate. Admittedly, there may be some error involved with the use of 600 and 1500-lb equivalents for calculating stocking rates; however, the potential magnitude of this error is not thought to be great. Assuming that the entire pasture consisted of weaned steers, the calculated gain was 1800 pounds per acre. On a cow-calf basis, suckling steer performance, using both fall- and spring-born calves, was 1174 pounds of gain per acre. These types of gains per acre resulted primarily from matching up a suitable type (breed, class, age, etc.) of livestock with an optimum (not maximum) level of forage utilization.

Tables 5 and 6 reveal the liveweight gain differences which existed between weaned and suckling calves at a high stocking rate. The gain advantage of steers vs heifers was about .3 lb/hd/day. At the high stocking rate, it was obvious that the cows continued to lactate to allow a considerable improvement in suckling calf liveweight gains. Suckling heifers gained more than twice that of weaned heifers; whereas, suckling steers gained more than 3.25 times more than weaned steers. And, at this level of grazing pressure, suckling steer gains per acre exceeded those of weaned steers by nearly 300 pounds per acre. Again, this is another example of the influence of milk production and the efficiency of utilization of the milk provided to the suckling calf. Any economic implications should be followed only after careful consideration has been given to factors such as margin of resale, pasture expenses, animal expenses, sex of calf for gain and termination point, risk, etc. For example, if one considers the sale of both cow and calf at the low stocking rate, then the calf gain of 870 lbs/acre, plus the cow gain of 195 lbs/acre, yields a total animal-unit gain of 1065 lbs/acre. In this case, the 1065 lbs/ac for the cow and calf is only 300 lbs/acre less than the 1361 lbs/ac for the weaned calf.

TABLE 1. AVAILABLE FORAGE AT FOUR STOCKING RATES

	STOCKING RATES							
	LOW		MEDIUM LOW		MEDIUM HIGH		HIGH	
Date	lb DM/ac[1]	lb DM[2] / 100 lb BW	lb DM/ac	lb DM / 100 lb BW	lb DM/ac	lb DM / 100 lb BW	lb DM/ac	lb DM / 100 lb BW
Feb. 24	3206	-	3331	-	2755	-	2880	-
March 14	2381	147	1603	59	1978	73	1037	28
April 13	2119	116	1185	68	1625	54	780	20
June 1	1046	49	1267	38	547	16	317	7
June 30	2899	114	1526	37	1488	37	922	14
July 27	2698	89	2304	63	1661	32	1046	12
August 31	7085	247	3235	95	1978	38	298	4
Sept. 26	6739	229	2448	76	912	19	86	1.3
AVG	3522	142	2112	62	1618	38	921	12

[1]Pounds of forage dry matter per acre harvested to ground level.

[2]Pounds of forage dry matter per 100 pounds of animal body weight.

TABLE 2. LIVEWEIGHT GAINS OF SUCKLING CALVES AND WEANED CALVES AT A LOW STOCKING RATE

Item	HEIFERS		STEERS		CALVES[1]	
	Weaned	Suckling	Weaned	Suckling	Weaned	Suckling
Initiation	3-1-83	2-28-83	3-1-83	2-28-83	3-1-83	2-28-83
Termination	9-29-83	9-29-83	9-29-83	9-29-83	9-29-83	9-29-83
No. Days	212	210	212	210	212	210
Initial Wt (lbs)	413		460		441	
Fall Born		340		395		368
Spring Born		428		403		416
Termination Wt (lbs)	762		847		813	
Fall Born		705		784		744
Spring Born		607		580		594
Trial Gain (lbs)[2]	349	544	387	566	372	554
Trial ADG (lbs)[2]	1.64	2.59	1.82	2.70	1.75	2.64
Gain/Acre (lbs)[3]	1361	854	1509	889	1451	870

[1]Combined average of steers and heifers.

[2]Includes both fall- and spring-born calf performance.

[3]Gain per acre calculated using Trial gain x Stocking rate. Stocking rate for weaned calves based on 600-pound calf-equivalent and cow-calf pairs based on 1500 lbs equal to one animal-unit.

TABLE 3. LIVEWEIGHT GAINS OF SUCKLING CALVES AND WEANED CALVES AT MEDIUM LOW STOCKING RATE

Item	HEIFERS		STEERS		CALVES[1]	
	Weaned	Suckling	Weaned	Suckling	Weaned	Suckling
Initiation	3-1-83	2-28-83	3-1-83	2-28-83	3-1-83	2-28-83
Termination	9-29-83	9-29-83	9-29-83	9-29-83	9-29-83	9-29-83
No. Days	212	210	212	210	212	210
Initial Wt (lbs)	399		456		433	
Fall Born		338		382		360
Spring Born		424		394		409
Termination Wt (lbs)	667		793		742	
Fall Born		670		710		690
Spring Born		567		527		547
Trial Gain (lbs)[2]	268	475	337	461	309	468
Trial ADG (lbs)[2]	1.26	2.26	1.58	2.20	1.45	2.23
Gain/Acre (lbs)[3]	1340	955	1685	927	1545	941

[1]Combined average of steers and heifers

[2]Includes both fall- and spring-born calf performance.

[3]Gain per acre calculated using Trial gain x Stocking rate. Stocking rate for weaned calves based on 600-pound calf-equivalent and cow-calf pairs based on 1500 lbs equal to one animal-unit.

TABLE 4. LIVEWEIGHT GAINS OF SUCKLING CALVES AND WEANED CALVES AT MEDIUM HIGH STOCKING RATE

	HEIFERS		STEERS		CALVES[1]	
Item	Weaned	Suckling	Weaned	Suckling	Weaned	Suckling
Initiation	3-1-83	2-28-83	3-1-83	2-28-83	3-1-83	2-28-83
Termination	9-29-83	9-29-83	9-29-83	9-29-83	9-29-83	9-29-83
No. Days	212	210	212	210	212	210
Initial Wt (lbs)	397		465		438	
Fall Born		357		387		372
Spring Born		434		412		423
Termination Wt (lbs)	618		742		692	
Fall Born		634		705		669
Spring Born		568		542		555
Trial Gain (lbs)[2]	221	411	277	448	254	430
Trial ADG (lbs)[2]	1.04	1.96	1.30	2.13	1.20	2.04
Gain/Acre (lbs)[3]	1437	1077	1801	1174	1651	1127

[1]Combined average of steers and heifers.

[2]Includes both fall- and spring-born calf performance.

[3]Gain per acre calculated using Trial gain x Stocking rate. Stocking rate for weaned calves based on 600-pound calf-equivalent and cow-calf pairs based on 1500 lbs equal to one animal-unit.

TABLE 5. LIVEWEIGHT GAINS OF SUCKLING CALVES AND WEANED CALVES AT HIGH STOCKING RATE

	HEIFERS		STEERS		CALVES[1]	
Item	Weaned	Suckling	Weaned	Suckling	Weaned	Suckling
Initiation	3-1-83	2-28-83	3-1-83	2-28-83	3-1-83	2-28-83
Termination	9-29-83	9-29-83	9-29-83	9-29-83	9-29-83	9-29-83
No. Days	212	210	212	210	212	210
Initial Wt (lbs)	401		468		441	
Fall Born		355		389		372
Spring Born		423		422		423
Termination Wt (lbs)	534		562		551	
Fall Born		573		644		609
Spring Born		483		471		477
Trial Gain (lbs)[2]	133	278	94	304	110	291
Trial ADG (lbs)[2]	.62	1.32	.44	1.45	.51	1.39
Gain/Acre (lbs)[3]	1290	1090	912	1192	1067	1141

[1]Combined average of steers and heifers.

[2]Includes both fall- and spring-born calf performance.

[3]Gain per acre calculated using Trial gain x Stocking rate. Stocking rate for weaned calves based on 600-pound calf-equivalent and cow-calf pairs based on 1500 lbs equal to one animal-unit.

TABLE 6. ADVANTAGES OF SUCKLING CALVES VS WEANED CALVES AT EACH OF FOUR STOCKING RATE

	HEIFERS		STEERS		CALVES[1]	
Stocking Rate	Weaned[3]	Suckling[2]	Weaned	Suckling	Weaned	Suckling
Low-Stocked						
ADG advantage	-	.95	-	.88	-	.89
Gain/acre advantage	507	-	620	-	581	-
Medium-Low Stocked						
ADG advantage	-	1.0	-	.62	-	.78
Gain/acre advantage	385	-	758	-	604	-
Medium-High Stocked						
ADG advantage	-	.92	-	.83	-	.84
Gain/acre advantage	360	-	627	-	524	-
High-Stocked						
ADG advantage	-	.70	-	1.01	-	.88
Gain/acre advantage	200	-	-	280	-	74

[1]Combined average of steers and heifers.

[2]Includes both fall- and spring-born calf performance.

[3]Gain per acre calculated using Trial gain x Stocking rate. Stocking rate for weaned calves based on 600-pound calf-equivalent and cow calf pairs based on 1500 lbs equal to one animal-unit.

PERFORMANCE OF F-1 (BRAHMAN X HEREFORD) COWS AND SIMMENTAL-SIRED CALVES AT FOUR STOCKING RATES

F. M. Rouquette, Jr., L. D. Roth, M. J. Florence, and W. C. Ellis[1]

SUMMARY

Cows with fall-born calves were grazed at four stocking rates on 'Marshall' ryegrass and 'Mt. Barker' subterranean clover overseeded on Coastal bermudagrass and cows with spring-born calves were grazed at four stocking rates on Coastal bermudagrass. The average stocking rates for the 210-day trial were 1.57, 2.01, 2.62, and 3.92 animal-units per acre. The average daily gain of cows ranged from .59 lbs to -1.57 lbs from low to high stocking rates; whereas, calf gains ranged from 2.64, 2.23, 2.04, and 1.39, respectively, for each of the four stocking rates. Calf gains per acre at the low, medium low, medium high, and high stocking rates, respectively, were 870, 941, 1127, and 1141 pounds.

INTRODUCTION

In order to make sound biological and economical decisions related to stocking rate, one must know the performance boundaries of both the forage and the class of livestock being used. The primary objective of this trial was to determine the influence of level of available forage on the liveweight gains of cows and suckling calves.

PROCEDURE

Coastal bermudagrass was overseeded with 'Marshall' ryegrass and 'Mt. Barker' subterranean clover in mid-October 1982. In November, fertilizer was applied at the rate of 0-100-100 lbs/acre of $N-P_2O_5-K_2O$. A total of 250 lbs/ac nitrogen was split-applied in 50 lb/ac increments beginning in late January and continuing through early August, 1983. Pasture size ranged from 2.3 to 5.5 acres. Forage samples for quality were taken at 14-day intervals and samples for availability were taken at 28-day intervals throughout the duration of the 210-day grazing period (February 28 to September 29).

Two sets of F-1 (Brahman x Hereford) cows and Simmental-sired calves served as "testers" during the 210-day trial. From February 28 to July 12, cows with fall-born calves were used to monitor animal responses to level of available forage. On July 12, the fall-born

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KEYWORDS: Stocking rate/cows/calves/forage availability

(October-November) calves were weaned, and from July 15 to September 29, F-1 cows with spring-born (February-March) calves were used to measure animal performance. Forage availability differences between each pasture were maintained using the put-and-take method of grazing. Regulator animals consisted of other cow-calf pairs and weaned steers and heifers. Animals were weighed at approximate 28-day intervals. Stocking rates were calculated by allowing one cow and one calf equal to 1500 pounds of total animal body weight. Using a common body weight for each pasture allowed for a more uniform estimation of grazing pressure at each of the four forage availability treatments. The 1500-pound animal unit equivalent does not account for differences in intake between cows, suckling calves, and weaned calves. However, for the purpose of estimating stocking rate differences between treatments, the use of 1500-pounds is considered to represent an equal bias across all treatments. Thus, for calculating an absolute stocking rate for one class of livestock when using multiple classes of livestock in the same pasture, other techniques such as the Effective Feed Unit (Petersen and Lucas, 1968), etc., may be more appropriate.

RESULTS AND DISCUSSION

Table 1 shows the monthly and season average forage availabilities for each of the four treatment pastures. The original intent was to maintain a surplus of forage at all times on the low stocking rate treatment and to restrict ad libitum intake on the high stocking rate treatment. The ratio of lbs forage DM/acre to 100 pound units of live weight gives a good illustration of the grazing pressure throughout the season. As this ratio exceeded 100, forage quantity never restricted intake. However, as this ratio moved into the teens, available forage restricted ad libitum intake of the grazing animal.

The monthly, seasonal, and total gains for cows, steers, heifers, and averages for steers plus heifers when grazed at low (L), medium low (ML), medium high (MH), and high (H), stocking rates are shown in Tables 2, 3, 4, and 5, respectively. At the low stocking rate (Table 1), fall-born steers gained 2.89 and heifers gained 2.72 lbs/hd/day. The cows gained .87 lbs/hd/day during the 134-day period. Spring-born steers and heifers had average daily gains (ADG) of 2.32 and 2.36 lbs, respectively; whereas, the ADG for these cows was .06 lbs. For the 210-day period, there were 554 lbs of calf gain at the low stocking rate. The average calculated stocking rate for the trial was 1.57 animal-units per acre.

At the medium low stocking rate (Table 2), the ADG of fall-born steers and heifers was essentially the same with an average of 2.46 lbs. These cows gained slightly more than one-half pound per day during this first period of the summer. The ADG for spring-born calves was 1.81 pounds and for the cows was -.13 lbs. During the combined 210-day trial, calves gained 468 pounds at a calculated stocking rate of 2.01 animal units per acre. The medium high stocking rate (Table 4) showed a gradual decline in performance of both cows and calves. At a slightly higher stocking rate, 2.62 vs 2.01, calves gained about a quarter of a pound per day less than their counterparts. The cows lost nearly three quarters of a pound per day more than cows at the next lighter stocking rate. Thus, forage:animal body weight ratios which are representative of these two stocking rates, 62 vs 38 (Table 1), provide for acceptable calf performance, 2.23 and 2.04 ADG, respectively, with a minimum of excess cow gain.

Animal performance from the restricted available forage treatment is shown in Table 5. The dramatic differences in ADG of fall vs spring-born calves may be accounted for during the first 29-day period (February 28 to March 29) when cattle had a higher quality (ryegrass-clover) diet, and also had less grazing pressure per acre. The 210-day trial resulted in cow ADG of -1.57 and calf ADG of 1.39. This was equivalent to 291 pounds of calf gain at a calculated stocking rate of 3.92 1500-pound animal unit equivalents per acre.

Tables 6, 7, 8, and 9 show the gains per animal and gains per acre for both fall and spring-born calves at each of the four stocking rates. Cows which calved during the fall had total period (134 days) gains of 118 pounds to -60 pounds for low to high stocking rates, respectively. Calf gains during this period were 376, 330, 298, and 237 pounds, respectively, for the L, ML, MH, and H stocking rates. Although gain per animal declined with increasing stocking rate, gain per acre increased from 496 to 711 lbs/acre as stocking rate increased from 1.32 to 3.0 animal units per acre. Spring-born calves exhibited a similar trend to the fall-born calves with respect to gain per animal with increasing stocking rate. However, gain per acre was maximized on the MH stocking rate and the performance of the H stocking rate produced the lowest gains per acre. This was due to the higher grazing pressure exerted during the last 76-day period as compared to the first 134-day period and is not exclusively due to the date of calving. Forage quality was primarily responsible for the differences in gain per animal between the fall vs spring-born calves. The data presented attempts to document cow and calf gains which are likely to occur at both optimum and maximum forage utilization. The choice of proper stocking rate is dependent upon additional factors, such as risk, finance, post-weaning ownership, market trends, reproduction, etc.

TABLE 1. FORAGE DRY MATTER AVAILABLE PER ACRE AND PER 100 POUNDS ANIMAL BODY WEIGHT AT FOUR STOCKING RATES

	LOW		MEDIUM LOW		MEDIUM HIGH		HIGH	
Date	lb DM/ac[1]	lb DM[2] / 100 lb BW	lb DM/ac	lb DM / 100 lb BW	lb DM/ac	lb DM / 100 lb BW	lb DM/ac	lb DM / 100 lb BW
Feb. 24	3206	-	3331	-	2755	-	2880	-
March 14	2381	147	1603	59	1978	73	1037	28
April 13	2119	116	1185	68	1625	54	780	20
June 1	1046	49	1267	38	547	16	317	7
June 30	2899	114	1526	37	1488	37	922	14
July 27	2698	82	2304	57	1661	29	1046	11
August 31	7085	247	3235	95	1978	38	298	4
Sept. 26	6739	229	2448	76	912	19	86	1.3
AVG	3522	142	2112	62	1618	38	921	12

[1]Pounds of forage dry matter per acre harvested to ground level.

[2]Pounds of forage dry matter per 100 pounds of animal body weight.

TABLE 2. LIVEWEIGHT GAINS OF COWS WITH FALL- AND SPRING-BORN CALVES AT A HIGH LEVEL OF AVAILABLE FORAGE OR LOW STOCKING RATE

Period	No. Days	Average Daily Gain				Period Gain/Calf	Grazing[1] Pressure Per Acre	Stocking[2] Rate
		Cow	Steer	Heifer	Calf			
		----------------lbs----------------				(lbs)	(lbs/ac)	(AU/ac)
Fall-Born Calves								
2-28 to 3-29	29	0.81	3.25	3.34	3.30	96	1600	1.07
3-29 to 5-23	55	1.18	2.84	2.74	2.79	154	1831	1.22
5-23 to 6-16	24	1.60	3.35	3.02	3.18	76	2123	1.42
6-16 to 7-12	26	-.37	2.19	1.69	1.94	50	2549	1.70
TOTALS/AVG	134	0.87	2.89	2.72	2.80	376	1980	1.32
Spring-Born Calves								
7-15 to 8-10	26	1.74	3.21	3.00	3.11	80	3272	2.18
8-10 to 9-7	28	-2.29	2.25	2.59	2.42	68	2879	1.92
9-7 to 9-29	22	1.09	1.38	1.32	1.35	30	2940	1.96
TOTALS/AVG	76	0.06	2.32	2.36	2.34	178	3030	2.02
SEASON TOTALS	210	0.59	2.70	2.59	2.64	554	2355	1.57

[1]Grazing pressure per acre represents total liveweight of cow-calf pairs and weaned calves which were occupying this particular pasture.

[2]Stocking rate based on 1500 lbs grazing pressure equivalent to one cow and one calf.

TABLE 3. LIVEWEIGHT GAINS OF COWS WITH FALL- AND SPRING-BORN CALVES AT A MEDIUM HIGH LEVEL OF AVAILABLE FORAGE OR MEDIUM LOW STOCKING RATE

Period	No. Days	Average Daily Gain: Cow	Steer	Heifer	Calf	Period Gain/Calf (lbs)	Grazing[1] Pressure Per Acre (lbs/ac)	Stocking[2] Rate (AU/ac)
		------	------	lbs	------			
Fall-Born Calves								
2-28 to 3-29	29	0.27	3.41	3.03	3.22	93	2687	1.79
3-29 to 5-23	55	0.80	2.33	2.45	2.39	132	1753	1.17
5-23 to 6-16	24	1.53	3.02	3.00	3.01	72	3365	2.24
6-16 to 7-12	26	-0.17	1.07	1.44	1.25	33	4096	2.73
TOTALS/AVG	134	.63	2.44	2.48	2.46	330	2700	1.80
Spring-Born Calves								
7-15 to 8-10	26	1.45	2.28	2.46	2.37	61	4008	2.67
8-10 to 9-7	28	-1.05	2.18	2.14	2.16	59	3406	2.27
9-7 to 9-29	22	-0.82	0.91	0.84	.88	18	3215	2.14
TOTALS/AVG	76	-0.13	1.75	1.87	1.81	138	3555	2.37
SEASON TOTALS	210	0.35	2.20	2.26	2.23	468	3015	2.01

[1] Grazing pressure per acre represents total liveweight of cow-calf pairs and weaned calves which were occupying this particular pasture.

[2] Stocking rate based on 1500 lbs grazing pressure equivalent to one cow and one calf.

TABLE 4. LIVEWEIGHT GAINS OF COWS WITH FALL- AND SPRING-BORN CALVES AT A MEDIUM LOW LEVEL OF AVAILABLE FORAGE OR MEDIUM HIGH STOCKING RATE

Period	No. Days	Average Daily Gain: Cow	Steer	Heifer	Calf	Period Gain/Calf (lbs)	Grazing[1] Pressure Per Acre (lbs/ac)	Stocking[2] Rate (AU/ac)
		---lbs---						
Fall-Born Calves								
2-28 to 3-29	29	-.37	3.74	2.93	3.33	97	2705	1.80
3-29 to 5-23	55	.69	2.71	2.05	2.38	131	2982	1.99
5-23 to 6-16	24	-.05	1.52	1.64	1.58	38	3349	2.23
6-16 to 7-12	26	-.13	0.92	1.51	1.22	32	4013	2.68
TOTALS/AVG	134	.16	2.37	2.06	2.22	298	3195	2.13
Spring-Born Calves								
7-15 to 8-10	26	.71	2.17	2.57	2.37	62	5631	3.75
8-10 to 9-7	28	-2.13	1.78	1.78	1.78	50	5142	3.43
9-7 to 9-29	22	-2.46	1.06	.77	0.92	20	4857	3.24
TOTALS/AVG	76	-1.25	1.71	1.76	1.74	132	5220	3.48
SEASON TOTALS	210	-0.34	2.13	1.96	2.04	430	3930	2.62

[1]Grazing pressure per acre represents total liveweight of cow-calf pairs and weaned calves which were occupying this particular pasture.

[2]Stocking rate based on 1500 lbs grazing pressure equivalent to one cow and one calf.

TABLE 5. LIVEWEIGHT GAINS OF COWS WITH FALL- AND SPRING-BORN CALVES AT A LOW LEVEL OF AVAILABLE FORAGE OR HIGH STOCKING RATE

Period	No. Days	Average Daily Gain				Period Gain/Calf (lbs)	Grazing[1] Pressure Per Acre (lbs/ac)	Stocking[2] Rate (AU/ac)
		Cow	Steer	Heifer	Calf			
		----------------lbs--------------						
Fall-Born Calves								
2-28- to 3-29	29	- .09	3.34	3.53	3.43	100	3656	2.44
3-29 to 5-23	55	-1.24	1.86	1.54	1.70	94	3890	2.59
5-23 to 6-16	24	1.31	1.47	1.04	1.26	30	4547	3.03
6-16 to 7-12	26	-0.81	0.76	0.23	0.50	13	6590	4.39
TOTALS/AVG	134	-0.45	1.90	1.63	1.77	237	4500	3.00
Spring-Born Calves								
7-15 to 8-10	26	-3.70	1.42	1.30	1.36	35	9558	6.37
8-10 to 9-7	28	-3.72	0.26	0.92	.59	17	8270	5.51
9-7 to 9-29	22	-3.09	0.22	-.02	.10	2	6875	4.58
TOTALS/AVG	76	-3.53	0.65	0.78	0.72	54	8310	5.54
SEASON TOTALS	210	-1.57	1.45	1.32	1.39	291	5880	3.92

[1]Grazing pressure per acre represents total liveweight of cow-calf pairs and weaned calves which were occupying this particular pasture.

[2]Stocking rate based on 1500 lbs grazing pressure equivalent to one cow and one calf.

TABLE 6. GAINS PER ANIMAL AND GAINS PER ACRE FROM COWS AND CALVES GRAZING CLOVER-RYEGRASS-BERMUDAGRASS AT LOW STOCKING RATE

ITEM	LOW STOCKING Cow	Steer	Heifer	Calf
FALL CALVERS				
Initiation		2-28-83		
Termination		7-12-83		
No. Days		134		
Initial Wt (lbs)	1112	395	340	368
Termination Wt (lbs)	1230	784	705	744
Trial Gain (lbs)	118	389	365	376
Trial ADG (lbs)	0.87	2.89	2.72	2.80
Stocking Rate (AU/ac)	1.32	1.32	1.32	1.32
Gain/Acre (lbs)		513	482	496
SPRING CALVERS				
Initiation		7-15-83		
Termination		9-29-83		
No. Days		76		
Initial Wt (lbs)	1139	403	428	416
Termination Wt (lbs)	1144	580	607	594
Trial Gain (lbs)	5	177	179	178
Trial ADG (lbs)	.06	2.32	2.36	2.34
Stocking Rate (AU/ac)	2.02	2.02	2.02	2.02
Gain/Acre (lbs)		358	362	360
FALL + SPRING CALVERS				
No. Days	210			
Total Gain (lbs)	123	566	544	554
Total ADG (lbs)	.59	2.70	2.59	2.64
Stocking Rate (AU/ac)	1.57	1.57	1.57	1.57
Gain/Acre (lbs)		889	854	870

TABLE 7. GAINS PER ANIMAL AND GAINS PER ACRE FROM COWS AND CALVES GRAZING CLOVER-RYEGRASS-BERMUDAGRASS AT MEDIUM LOW STOCKING RATE

FALL CALVERS

ITEM	MEDIUM LOW STOCKED			
	Cow	Steer	Heifer	Calf
Initiation		2-28-83		
Termination		7-12-83		
No. Days		134		
Initial Wt (lbs)	1086	382	338	360
Termination Wt (lbs)	1170	710	670	690
Trial Gain (lbs)	84	328	332	330
Trial ADG (lbs)	0.63	2.44	2.48	2.46
Stocking Rate (AU/ac)	1.80	1.80	1.80	1.80
Gain/Acre (lbs)		590	598	594

SPRING CALVERS

Initiation		7-15-83		
Termination		9-29-83		
No. Days		76		
Initial Wt (lbs)	1082	394	424	409
Termination Wt (lbs)	1072	527	567	547
Trial Gain (lbs)	-10	133	143	138
Trial ADG (lbs)	-.13	1.75	1.87	1.81
Stocking Rate (AU/ac)	2.37	2.37	2.37	2.37
Gain/Acre (lbs)		315	339	327

FALL + SPRING CALVERS

No. Days	210			
Total Gain	74	461	475	468
Total ADG	.35	2.20	2.26	2.23
Stocking Rate (AU/ac)	2.01	2.01	2.01	2.01
Gain/Acre (lbs)		927	955	941

TABLE 8. GAINS PER ANIMAL AND GAINS PER ACRE FROM COWS AND CALVES GRAZING CLOVER RYEGRASS-BERMUDAGRASS AT MEDIUM HIGH STOCKING RATE

FALL CALVERS

ITEM	MEDIUM HIGH STOCKED Cow	Steer	Heifer	Calf
Initiation		2-28-83		
Termination		7-12-83		
No. Days		134		
Initial Wt (lbs)	1150	387	357	372
Termination Wt (lbs)	1173	705	634	669
Trial Gain (lbs)	23	318	277	298
Trial ADG (lbs)	0.16	2.37	2.06	2.22
Stocking Rate (AU/ac)	2.13	2.13	2.13	2.13
Gain/Acre (lbs)		677	590	635

SPRING CALVERS

ITEM	Cow	Steer	Heifer	Calf
Initiation		7-15-83		
Termination		9-29-83		
No. Days		76		
Initial Wt (lbs)	1102	412	434	423
Termination Wt (lbs)	1007	542	568	555
Trial Gain (lbs)	-95	130	134	132
Trial ADG (lbs)	-1.25	1.71	1.76	1.74
Stocking Rate (AU/ac)	3.48	3.48	3.48	3.48
Gain/Acre (lbs)		452	466	459

FALL + SPRING CALVERS

ITEM	Cow	Steer	Heifer	Calf
No. Days	210			
Total Gain (lbs)	-72	448	411	430
Total ADG (lbs)	-.34	2.13	1.96	2.04
Stocking Rate (AU/ac)	2.62	2.62	2.62	2.62
Gain/Acre (lbs)		1174	1077	1127

TABLE 9. GAINS PER ANIMAL AND GAINS PER ACRE FROM COWS AND CALVES GRAZING CLOVER-RYEGRASS-BERMUDAGRASS AT HIGH STOCKING RATE

ITEM	HIGH STOCKED Cow	Steer	Heifer	Calf
FALL CALVERS				
Initiation		2-28-83		
Termination		7-12-83		
No. Days		134		
Initial Wt (lbs)	1112	389	355	372
Termination Wt (lbs)	1052	644	573	609
Trial Gain (lbs)	-60	255	218	237
Trial ADG (lbs)	-.45	1.90	1.63	1.77
Stocking Rate (AU/ac)	3.00	3.00	3.00	3.00
Gain/Acre (lbs)		765	654	711
SPRING CALVERS				
Initiation		7-15-83		
Termination		9-29-83		
No. Days		76		
Initial Wt (lbs)	1157	422	423	423
Termination Wt (lbs)	888	471	483	477
Trial Gain (lbs)	-269	49	60	54
Trial ADG (lbs)	-3.53	.65	.78	.72
Stocking Rate (AU/ac)	5.54	5.54	5.54	5.54
Gain/Acre (lbs)		271	332	299
FALL + SPRING CALVERS				
No. Days	210			
Total Gain (lbs)	-329	304	278	291
Total ADG (lbs)	-1.57	1.45	1.32	1.39
Stocking Rate (AU/ac)	3.92	3.92	3.92	3.92
Gain/Acre (lbs)		1192	1090	1141

LIVEWEIGHT GAINS OF WEANED CALVES FROM FOUR LEVELS OF AVAILABLE FORAGE

F. M. Rouquette, Jr., L. D. Roth, M. J. Florence and W. C. Ellis[1]

SUMMARY

Coastal bermudagrass was overseeded with 'Marshall' ryegrass and 'Mt. Barker' subterranean clover and continuous grazing initiated with five weaned, crossbred calves at each of four levels of forage availability which, in turn, produced four different stocking rates. Levels of available forage ranged from excessive quantities (>100 pounds forage dry matter per 100 pounds animal body weight) to severely restricted _ad libitum_ intakes (<15 lbs DM/100 lbs BW). Final stocking rates, based on 600-pound calf equivalent, were 3.9, low (L); 5.0 medium low (ML); 6.5, medium high (MH); and 9.7 animals per acre, high (H). Average daily gains for the 212-day trial were 1.75, 1.45, 1.20, and 0.51 pounds per head per day, respectively for L, ML, MH, and H. Gain per acre was 1451, 1545, 1651, and 1067 pounds, respectively for L, ML, MH, and H.

INTRODUCTION

Management decisions which surround a summer grazing period are generally concerned with gains per animal-gain per acre relationships. Selection of the "proper" stocking rate or grazing pressure is critical to the economic stability of the grazing program. This trial was therefore initiated to ascertain the influence of four levels of forage availability on liveweight gains of weaned steers and heifers.

PROCEDURE

Pastures used were Coastal bermudagrass oversown with 'Marshall' ryegrass and subterranean clover. A total of 250-100-100 lbs/ac of N-P_2O_5-K_2O was split-applied from October 1982 (at planting) until August 1983. Grazing was continuous during the 212-day trial from March 1, 1983 until September 29, 1983. Three steers and two heifers (Brangus and Brahman-Simmental crosses) were allotted to each of the four pastures. Heifers weighed approximately 400 lbs and steers weighed approximately 460 lbs at initiation of the trial. The calves were approximately 8 months of age at the beginning of the trial and had received small grain-ryegrass pastures prior to March 1. In

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KEYWORDS: Forage availability/animal performance/stockers/grazing pressure/stocking rate

addition to the weaned calves, F-1 (Brahman x Hereford) cows and their Simmental-sired calves, and two fistulated Brahman steers occupied each pasture. Cattle were weighed at about 28-day intervals and average daily gains for both steers and heifers are reported. The total liveweight which occupied each pasture, including all classes of cattle, was used to estimate the stocking rate on a weaned calf basis. A weaned-calf equivalent was estimated to be 600 lbs. Thus, stocking rates were calculated by dividing the liveweight per acre by 600. It is recognized that stocking rate may be determined in several ways, but this calf-equivalent estimate was considered to be a reasonable method.

Pastures were sampled at monthly intervals to ground level to determine forage available for consumption. Forage quality samples were taken every two weeks by hand-clipping areas which visually represented the animals selectivity.

RESULTS AND DISCUSSION

Table 1 shows the level of available forage at monthly intervals throughout the trial period for each of the four grazing pressure treatments. With the exception of the late May, early June period, the ratio of forage dry matter per 100 lbs animal body weight was approximately 100 or greater at the low stocking rate. The combination of cool night-time temperatures, which slowed bermudagrass growth, and the failure to remove regulator cattle from the pastures caused a temporary decline in forage availability. Otherwise, forage availability never limited ad libitum intake at the low stocking rate. On the other hand, cattle on the high stocking rate were limited in their ability to fill. Note the apparent rapidity of bermudagrass growth at the low stocking rate during the last two months of the trial in contrast to the growth rate from other stocking rate pastures.

The monthly and total trial steer and heifer gains from the low stocked pasture is presented in Table 2. Of primary interest is the decline in average daily gain (ADG) of both steers and heifers with season of the year. Since the quantity of forage was never limiting ad libitum intake, a combination of several factors, notably forage quality decline and increased temperatures, were responsible for the rapid decrease in liveweight gains. Note that as temperatures declined in the fall (9-7 to 9-29) forage quality improved and animal gains increased. Also of particular interest is the absolute rate of gain achieved by these calves. Admittedly, there were some compensatory gains occurring in these predominantly summer-born calves, but the 1.82 ADG for the steers and 1.64 ADG for the heifers was considerably higher than previous grazing trials conducted during similar periods of time. The average for both sexes, 1.75 lbs/hd/day, was represented by 372 lbs of gain per animal during the 212 day trial. By using 600 lbs as one calf equivalent, the average stocking rate was calculated to be nearly 4 calves per acre at the low stocking rate.

At the medium low stocking rate (Table 3), the influence of lack of available forage was evident in the decline in ADG. There was a .35 lb/hd/day decrease from the low stocking rate ADG of 1.75 to 1.45 at the medium low stocking rate. Steers continued to gain more than heifers by about 20%. As the stocking rate increased from 3.9 to 5.0 animals per acre, the average calf gain for the trial declined from 372 lbs to 309 lbs. However, the steer ADG of 1.58 for the duration of the trial are impressive, and especially in the light of 5 calves per acre.

Table 4 illustrates the steady decrease in individual animal performance with an increase in stocking rate or grazing pressure. The calculated stocking rate of 6.5 calf-equivalents per acre or 3900 lbs of liveweight per acre produced the range of ADG which are more commonly found in these types of trials. By further estimating gain per acre of a pasture comprised of only steers, the projections calculate to an enormous 1801 pounds per acre (6.5 animals/acre x 1.3 lbs/hd/day x 212 days). Although the method of estimating stocking rate by using 600 lbs as a calf equivalent may be in error, the fact that Coastal bermudagrass accommodated an average of nearly 4000 lbs of animal body weight per acre and continued to yield respectable steer gains of 1.3 and heifer gains of 1.04 lbs/hd/day is of significant economic importance.

As stocking rates were increased to levels which severely restricted ad libitum intake, calf gains were rapidly and severely depressed during the latter stages of the trial (Table 5). Total animal liveweight per acre of 5760 lbs was approximated to represent nearly 10 calves per acre. At this stocking rate, an average of both steer and heifer gains resulted in only 110 lbs per animal or an ADG of .51 for the trial. Due primarily to the animal performance during the last weigh period, heifers had a higher trial ADG than did steers (.62 vs .44). At this level of stocking, both gain per animal and gain per acre were depressed as compared to the previous stocking rate.

Table 6 presents a summary of gain per animal and gain per acre. The gain per acre for each sex of calf at each stocking rate is not additive, but rather is presented as if the pasture was comprised only of that sex, or in the case of "calf", a mixture of both sexes of calves. Again, the potential of compensatory gain may have been high with this set of calves; however, they were not abnormally thin at initiation of the trial (body condition score estimated at 5). These gains do, however, indicate the potential gains which can be achieved from Coastal bermudagrass based pastures and Brahman crossbred calves which have adequate age and frame size for rapid growth.

The most important factors which must be considered in grazing stocker-type cattle on warm-season perennial grass pastures such as Coastal bermudagrass are: (1) The level or amount of forage available for consumption directly controls rate of gain on a per animal basis (ADG). In other words, one must know "how to graze" Coastal bermudagrass before optimum or maximum animal performance can be obtained; (2) The breed (percent of Brahman influence), age, and frame size are critical to achieving acceptable gains during the hot summer periods. Calves which are 8 to 12 months of age and which weigh 200 to 300 pounds less than their frame size would indicate are excellent prospects because of their ability to make compensatory gains during the bermudagrass stage; (3) Overseeded bermudagrass (ryegrass and clover) contributes significantly to alleviating health problems and reducing death loss and increases the initial rates of gain. From one-third to one-half the gains will occur during that period in which the winter annual forages are completing their growth and bermudagrass is initiating its growth (March, April, and May).

The grazing of stocker-type cattle during the spring-summer-fall months can offer a good economic incentive. By assigning an average gain value of 50 cents per pound, the gross income from 1400 to 1600 pounds of gain per acre rapidly accelerates to some very encouraging numbers ($700 to $800 per acre). However, before this venture is executed, all costs including potential negative margins should be carefully analyzed, and an understanding of some of the relationships between gain per animal and gain per acre as affected by available forage should be appreciated.

TABLE 1. AVAILABLE FORAGE AT FOUR STOCKING RATES

Date	LOW		MEDIUM LOW		MEDIUM HIGH		HIGH	
	lb DM/ac[1]	lb DM[2] / 100 lb BW	lb DM/ac	lb DM / 100 lb BW	lb DM/ac	lb DM / 100 lb BW	lb DM/ac	lb DM / 100 lb BW
Feb. 24	3206	-	3331	-	2755	-	2880	-
March 14	2381	147	1603	59	1978	73	1037	28
April 13	2119	116	1185	68	1625	54	780	20
June 1	1046	49	1267	38	547	16	317	7
June 30	2899	114	1526	37	1488	37	922	14
July 27	2698	89	2304	63	1661	32	1046	12
August 31	7085	247	3235	95	1978	38	298	4
Sept. 26	6739	229	2448	76	912	19	86	1.3
AVG	3522	142	2112	62	1618	38	921	12

[1]Pounds of forage dry matter per acre harvested to ground level.

[2]Pounds of forage dry matter per 100 pounds of animal body weight.

TABLE 2. LIVEWEIGHT PERFORMANCE FROM WEANED CALVES GRAZING AT A LOW STOCKING RATE

					CALF AVERAGES		
Period	No. Days	AVERAGE DAILY GAIN Heifer	Steer	Calf	Period Gain/An (lbs)	Grazing[1] Pressure Per Acre (lbs/ac)	Stocking Rate[2] (An/Ac)
3-1 to 3-29	28	3.03	3.09	3.07	86	1618	2.7
3-29 to 5-12	55	1.36	1.95	1.72	95	1831	3.1
5-12 to 6-16	24	2.18	2.26	2.23	54	2123	3.5
6-16 to 7-12	26	1.61	1.51	1.55	40	2549	4.2
7-12 to 8-10	29	1.03	1.06	1.05	30	3016	5.0
8-10 to 9-7	28	.98	.85	.90	25	2870	4.8
9-7 to 9-29	22	1.65	2.15	1.95	43	2940	4.9
TOTALS/AVG	212	1.64	1.82	1.75	372	2340	3.9

TABLE 3. LIVEWEIGHT PERFORMANCE FROM WEANED CALVES GRAZING AT A MEDIUM LOW STOCKING RATE

					CALF AVERAGES		
Period	No. Days	AVERAGE DAILY GAIN Heifer	Steer	Calf	Period Gain/An (lbs)	Grazing[1] Pressure Per acre (lbs/ac)	Stocking Rate[2] (An/ac)
3-1 to 3-29	28	3.21	2.66	2.88	81	2705	4.5
3-29 to 5-23	55	1.30	1.32	1.31	72	1753	2.9
5-23 to 6-16	24	1.41	2.44	2.03	49	3365	5.6
6-16 to 7-12	26	0.90	1.55	1.29	34	4096	6.8
7-12 to 8-10	29	.56	1.33	1.02	30	3666	6.1
8-10 to 9-7	28	1.17	.94	1.03	29	3406	5.7
9-7 to 9-29	22	-.02	1.12	.66	15	3215	5.4
TOTALS/AVG	212	1.26	1.58	1.45	309	3000	5.0

[1]Grazing pressure per acre represents total liveweight of weaned calves and cow-calf pairs which were occupying this particular pasture.
[2]Stocking rate based on 600 lbs grazing pressure equivalent to one calf.

TABLE 4. LIVEWEIGHT PERFORMANCE OF WEANED CALVES GRAZING AT A MEDIUM HIGH STOCKING RATE

					CALF AVERAGES		
Period	No. Days	AVERAGE DAILY GAIN Heifer (lbs)	Steer (lbs)	Calf (lbs)	Period Gain/An (lbs)	Grazing[1] Pressure Per Acre (lbs/ac)	Stocking Rate[2] (An/ac)
3-1 to 3-29	28	3.19	2.86	3.0	84	2705	4.5
3-29 to 5-23	55	0.67	1.53	1.18	65	2982	5.0
5-23 to 6-16	24	1.27	1.34	1.31	31	3349	5.6
6-16 to 7-12	26	1.28	1.91	1.66	43	4013	6.7
7-12 to 8-10	29	0.74	0.01	0.30	9	5172	8.6
8-10 to 9-7	28	0.71	0.47	0.57	16	5142	8.6
9-7 to 9-29	22	-.50	0.75	.25	6	4857	8.1
TOTALS/AVG	212	1.04	1.30	1.20	254	3900	6.5

TABLE 5. LIVEWEIGHT PERFORMANCE OF WEANED CALVES GRAZING AT A HIGH STOCKING RATE

					CALF AVERAGES		
Period	No. Days	AVERAGE DAILY GAIN Heifer (lbs)	Steer (lbs)	Calf (lbs)	Period Gain/An (lbs)	Grazing[1] Pressure Per Acre (lbs/ac)	Stocking Rate[2] (An/ac)
3-1 to 3-29	28	2.16	2.57	2.40	67	3698	6.2
3-29 to 5-23	55	0.25	.19	.21	12	3890	6.5
5-23 to 6-16	24	1.08	1.33	1.23	30	4547	7.6
6-16 to 7-12	26	1.05	0.62	0.80	21	6590	11.0
7-12 to 8-10	29	-.58	-.64	-.62	-18	8608	14.0
8-10 to 9-7	28	-.23	.13	-.01	-.30	8270	13.8
9-7 to 9-29	22	1.31	-1.00	-.07	-2	6875	11.5
TOTALS/AVG	212	.62	.44	.51	110	5760	9.7

[1]Grazing pressure per acre represents total liveweight of weaned calves and cow-calf pairs which were occupying this particular pasture.

[2]Stocking rate based on 600 lbs grazing pressure equivalent to one calf.

TABLE 6. GAIN PER ANIMAL AND GAIN PER ACRE OF STEERS AND HEIFERS GRAZED AT FOUR STOCKING RATES

ITEM	LOW STOCKED			MEDIUM LOW STOCKED			MEDIUM HIGH STOCKED			HIGH STOCKED		
	Heifer	Steer	Calf	Heifer	Steer	Calf	Heifer	Steer	Calf	Heifer	Steer	Calf
Initiation		3-1-83			3-1-83			3-1-83			3-1-83	
Termination		9-29-83			9-29-83			9-29-83			9-29-83	
No. Days		212			212			212			212	
Initial wt. (lbs)	413	460	441	399	456	433	397	465	438	401	468	441
Termination wt (lbs)	762	847	813	667	793	742	618	742	692	534	562	551
Trial Gain (lbs)	349	387	372	268	337	309	221	277	254	133	94	110
Trial ADG (lbs)	1.64	1.82	1.75	1.26	1.58	1.45	1.04	1.30	1.2	0.62	0.44	.51
Stocking Rate[1] (An/ac)	-------3.9-------			---------5.0-------			---------6.5-------			---------9.7-------		
Gain/acre (lbs)	1361	1509	1451	1340	1685	1545	1437	1801	1651	1290	912	1067

[1]Stocking rate calculated using total pounds liveweight per acre divided by 600 lbs per animal.

SMALL GRAIN AND RYEGRASS FORAGE VARIETY TESTS 1982-83

L. R. Nelson, S. L. Ward and Cathy Bateman[1]

SUMMARY

It is important for producers to know which small grain varieties have the potential to produce high forage yields. This information is very valuable for cattlemen who will either graze out the small grain or pull cattle off and harvest grain. Therefore, in an attempt 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 and oats were planted into separate tests on September 9. The wheat and ryegrass variety tests were planted on September 10. Seed was planted into six-row plots spaced 8 inches apart, 10 ft 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 60-60-60 (N-P_2O_5-K_2O) lbs/a and a split N application of 80 lbs on October 25, 1982 and 70 lbs on February 18, 1983 for a total N application of 210 lbs/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.

Moisture was limiting during most of the fall and winter. This required one irrigation on September 27 of 2 inches to avoid losing stands of all small grain forage tests. Good stands resulted on the rye and oat tests; however, erratic stands in ryegrass and wheat plots resulted and reduced yields of some varieties (as noted on tables).

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

Precipitation amounts in inches by months were: September - 0.7; October - 6.6; November - 6.2; December - 6.3; January - 0.9; February - 8.3; March - 5.0; April - 2.4; May - 7.2. Winter freeze damage was of little or no importance with the coldest temperature of 19°F being recorded on December 13 and December 19, 1982.

RESULTS AND DISCUSSION

Forage yield data are presented in Tables 1 through 4. Highest overall forage yields in 1982-83 were produced by rye and oats, followed by wheat and ryegrass. Overall, the warmer than average temperatures did not result in higher forage yields. None of the winter annuals got off to a good start and fall forage yields were quite low.

Rye forage yields (Table 1) were spread throughout the season with the highest yields being harvested in March. Unusually late production of rye forage resulted in a May harvest. Differences between varieties were significant in the yield data for the last four harvests, however, total yields were not significantly different at the $P<.05$ level. This indicates that for the entire season, total yields were similar, however, forage production by some varieties differed between periods.

In addition to the wheat varieties (Table 2) Grazer II triticale was included in this test and produced the highest forage yield (compared to the wheat varieties). The first harvest was late (December 7) indicating little forage production during the fall even though it was planted early (September 10). Stands were not consistant and poor stands were probably the major cause of reduced yields throughout the growing season.

Oat yields were higher than wheat yields (Table 3). Big Mac produced the highest forage yield. Total forage yields ranged from 3,900 to 4,600 lbs/a. There were no significant differences between yields until the third harvest.

Ryegrass yields were reduced because of poor stands and varieties were probably affected differently by stands (Table 4). Some other experimental forages were included in this study as indicated in Table 4.

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 one 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 data.

TABLE 1. RYE FORAGE VARIETY TEST AT OVERTON, TX, 1982-83

Variety	Harvest Date					Total
	Nov. 12	Jan. 28	Mar. 7	Apr. 5	May 3	Yield
	----------------Pounds of dry matter per acre----------------					
Vitagrazer	1047	1532	1685	639	792	5695
Maton	970	1124	1532	1149	715	5490
Bonel	817	1047	1864	1072	664	5464
Elbon (Check)	1021	1200	1583	843	690	5337
Noble Foundation - 91	817	996	1405	1175	792	5185
Noble Foundation - 214	868	996	1685	1072	562	5183
Noble Foundation - 142	894	1021	1532	1123	562	5132
Curley Grazer	868	1276	1685	715	588	5132
Wintergrazer - 70[1]	868	485	1022	1098	1251	4724
Mean	908	1075	1555	987	735	5260
LSD (10% level)[2]	NS	256	354	226	209	NS
CV	18	19	19	19	23	9

Planted on September 9, 1982. Seeding rate = 120 lbs/acre.

Fertilizer application: preplant 500 lbs of 12-12-12 per acre, topdress N 80 lbs/ac on October 25 and 70 lbs N on February 18, 1983.

[1]Wintergrazer 70 had low germination in this study and yields were reduced.

[2]Yield differences compared to the check greater than the LSD indicate that in 9 out of 10 times this difference is real and not experimental error.

TABLE 2. WHEAT VARIETY FORAGE TEST AT OVERTON, TX, 1982-83

Variety	Harvest Date				Total Yield	% Stand[2]
	Dec. 7	Mar. 8	Apr. 8	May 4		
	----------- Pounds of dry matter per acre ----------					
Grazer II (Triticale)	792	1251	817	996	3856	25
Coke-762	409	1660	537	715	3321	80
Tx-75-213[1]	587	1149	588	715	3039	90
Southern Belle	638	971	868	511	2988	80
Delta Queen	281	1175	511	919	2886	45
Mit	587	1124	511	613	2835	45
Coker 68-15 (Check)	588	741	996	485	2810	60
Bradford	409	741	1047	460	2657	80
Northrup King pro 812	536	741	715	639	2631	35
TAM-106	460	485	1123	435	2503	70
Coker-916	408	460	919	715	2502	30
Tx-71C-8130-R[1]	536	792	639	486	2453	45
Tx-71A-1039-X6[1]	357	639	894	562	2452	35
Tx-71D-4876-X5[1]	332	817	537	664	2350	40
McNair 10-03	358	766	460	715	2299	45
Tx-73-009[1]	383	409	945	537	2274	60
Mean	479	870	756	635	2741	
LSD (10% level)[3]	NS	397	155	150	539	
CV	45	38	17	20	16	

Planted September 10, 1982. Seeding rate = 120 lbs/acre.

Fertilizer application: preplant 500 lbs of 12-12-12 per acre, topdress N was 80 lbs/ac on October 25 and 70 lbs/ac on February 18, 1983.

[1]Experimental lines, seed is not available.

[2]Stands were reduced by dry soil conditions during germination and probably reduced yield of some varieties. Percent stand is the mean of four replications.

[3]Yield differences compared to the check greater than the LSD indicate that in 9 out of 10 times this difference is real and not experimental error.

TABLE 3. OAT VARIETY FORAGE TEST AT OVERTON, TX, 1982-83

Variety	Harvest Dates Dec. 12	Mar. 7	Apr. 8	May 3	Total Yield
	-----------Pounds dry matter per acre-------------				
Big Mac	715	1251	1813	868	4647
Coker 422	715	1940	1200	792	4647
Mesquite	715	1558	1481	792	4546
Walken	613	1430	1456	1021	4520
Coker 227	766	1175	1634	843	4418
Coker 80-20	664	1583	1277	894	4418
Coker 234 (Check)	690	1379	1430	817	4316
TAM-0-312	766	1379	1303	741	4189
Bob	664	1430	1277	792	4163
New Nortex	588	1200	1507	639	3934
Mean	690	1432	1438	820	4380
LSD (10% level)[1]	NS	NS	196	107	423
CV	19	26	11	11	8

Planted on September 9, 1982. Seeding rate = 120 lbs/acre.
Fertilizer application: preplant 500 lbs of 12-12-12 per acre , topdress N was 80 lbs/ac on October 25 and 70 lbs/ac on February 18, 1983.

[1]Yield differences compared to the check greater than the LSD indicate that in 9 out of 10 times this difference is real and not experimental error.

TABLE 4. RYEGRASS VARIETY AND RESQUEGRASS SELECTION FORAGE TEST AT OVERTON, TX, 1982-83

Varieties	Harvest Dates Dec. 21	Mar. 8	Apr. 11	May 4	Total Yield	% Stand[2]
	---------Pounds of dry matter per acre--------					
Achicoria-Cichorium (Hoja ancha)[3]	638	766	792	1123	3319	30[2]
Achicoria-Cichorium (Hoja fina)[3]	766	715	587	1149	3217	10
Tx-R-80-T[1]	587	996	588	741	2912	65
Gulf (Check)	562	1047	664	588	2861	75
Georgia Reseeding[1]	383	1124	639	562	2708	50
ISI-80- 1 resquegrass	511	715	639	817	2682	20
Tx-R-80-4[1]	511	894	613	588	2606	50
Urbana	690	766	511	613	2580	50
Tx-R-81-T[1]	460	792	690	587	2529	50
Florida 80	485	868	562	588	2503	60
Tx-R-81-1[1]	383	868	664	537	2452	50
Common	357	690	639	715	2401	15
ISI-79-1 resquegrass	358	562	664	766	2350	10
Marshall	383	588	511	868	2350	55
ISI-80-4 resquegrass	409	536	588	741	2274	10
Shannon	536	613	537	460	2146	75
ISI-78-1 resquegrass	306	537	511	792	2146	5
Ninak	460	562	511	588	2121	55
Wilo-Tetraploid - Italian	204	383	588	664	1839	20
Dalita-Tetraploid - Italian	153	409	537	664	1763	20
Mean	462	728	596	700	2487	
LSD (10% level)[4]	195	188	144	164	413	
CV	36	21	20	19	14	

Planted September 10, 1982. Seeding rate = 35 lbs/acre for ryegrass and resquegrass.

Fertilizer application: preplant, 500 lbs of 12-12-12 per acre, topdress N was 80 lbs/ac on October 25 and 70 lbs/ac on February 18, 1983.

[1]Experimental varieties, seed is not available.

[2]Stands were not acceptable and yields were reduced due to dry weather during germination.

[3]Experimental broadleaf forage from Argentina.

[4]Yield differences compared to the check greater than the LSD indicate that in 9 out of 10 times this difference is real and not experimental error.

Cool Season Perennial Grass Test - Dallas

J. C. Read*

SUMMARY

Ten tall fescue and three hardinggrass cultivars were tested for dry matter production and protein content. The experimental line Temple-1 and the cultivars Ky-31 and Kenhy had the highest dry matter production with a three year average of 8662 lb. dry matter per acre. There were no significant differences in yield of the three hardinggrass lines tested. Fawn tall fescue had the lowest production with a three year average of only 5664 lb. per acre. S. D. hardinggrass had the highest protein content of all the grasses tested with an average of 20 percent. There were no significant differences in the protein content of the tall fescues with averages of 17 to 18 percent.

Introduction

Tall fescue is probably the most widely adapted temperate perennial grass and is tolerant of hot, dry summers that exist in Northeast Texas. Tall fescue has not gained popularity in Texas because of toxicity problems frequently encountered. With the discovery that these toxicity problems are greatly reduced in tall fascue free of the endophyte Epichloe typhina syn. Acremonium coenophialum there has been an increased interest in its utilization for forage in Texas. The other temperate perennial grass that have been utilized in Texas is hardinggrass. Although hardinggrass has good tolerance to the hot, dry summers, poor seedling vigor thus difficulty in establishing and maintaining stands significantly reduces its use. This study was undertaken to determine if the experimential lines of tall fescue and hardinggrass developed at Dallas were superior to standard cultivars in production and persistence.

Procedure

Ten tall fescues and three hardinggrasses (Table 1) were planted 14 Oct 80 in a randomized block and good stands were obtained in all plots. Plots were 4 feet wide (4 rows spaced 1 foot apart) by 15 feet long. Eight feet of the two center rows were harvested using a flail harvester for yield determinations. Samples were collected and oven dried at 149F. This material was

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KEYWORDS: tall fescue, hardinggrass, yield, protein.

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used to determine protein content by micro-Kjeldahl. Fertility consisted of 200 lb. per acre of 33-0-0 and 100 lb. per acre of 18-46-0 in February, 1981 and then 200 lb. per acre of 33-0-0 and 100 lb. per acre of 18-46-0 each fall.

Results and Discussion

Temple-1, Ky-31 and Kenhy had the highest mean yield of all entries with Fawn being the lowest (Table 2). There were no differences in the average protein content of the tall fescues with mean of all harvest being 17 or 18 percent protein. Yield of the three hardinggrasses was similar (Table 2). S. D. hardinggrass had the highest percent protein of all entries (Table 3).

If the average yields of the 80-81 growing season, the year of establishment, are excluded then the mean yield of PI-26 and PI-144 with 9291 and 8669 would have the highest yields. This indicates that Temple-1, Ky-31 and Kenhy probably has greater seedling vigor than the other entries and to adequately test for yield and presistance a test should be conducted longer than 3 years. The lack of variation among the tall fescues indicate little progress could be made through breeding for protein content using this material.

Table 1. Source of seed for tall fescue and hardinggrass material tested.

Cultivar	Species	Source of seed
Ky-31	Tall fescue	University of Kentucky
Kenhy	"	"
Temple-1	"	TAES Dallas
PI-144	"	"
PI-26	"	"
S-Sel	"	"
PI-25	"	"
Kaspa	"	Ring Around Products
Jepel	"	"
Fawn	"	Oregan State University
TAM Wintergreen	Hardinggrass	TAES Foundation seed
S. D.	"	TAES Dallas
S. G.	"	"

Table 2. Dry matter production of tall fescue and hardinggrass at Dallas.

Cultivar	80-81 Growing Season			81-82 Growing Season				82-83 Growing Season			Mean per growing season
	7May81	29Jun81	Total	7Dec81	13Apr82	1Jun82	Total	20Dec82	9Jun83	Total	
	lb/ac										
Temple-1	4351	6201	10552	793	3188	4280	8261	286	7691	7977	8930a [1]
Ky-31	4206	6336	10542	455	3216	4014	7685	180	8143	8323	8850a
Kenhy	4065	6155	10220	456	2260	4240	6956	234	7207	7441	8206ab
S. G.[2]	3071	3888	6959	2016	842	4697	7555	441	8133	8574	7696 b
TAM Wintergreen[2]	3785	3751	7536	1319	599	4533	6451	368	8409	8777	7588 b
PI-144	1288	3880	5168	1515	2906	4016	8437	360	8542	8902	7502 b
PI-26	933	2847	3780	3076	1351	3982	8409	633	9540	10173	7454 b
Kaspa	1500	3649	5149	1681	2530	4009	8220	468	8353	8821	7397 b
S. D.[2]	2938	3468	6406	1915	625	4167	6707	591	7694	8285	7133 bc
S-Sel	503	1750	2253	1065	2070	4007	7142	447	9047	9494	6296 cd
Jepel	1329	3830	5159	1012	900	3569	5481	328	7379	7707	6116 cd
PI-25	458	2020	2478	1435	1859	3626	6920	642	8176	8818	6072 cd
Fawn	1859	3742	5601	341	2254	2395	4990	218	6184	6402	5664 cd

[1]Means with a common letter are not significantly different at the .05 level.
[2]Hardinggrass lines. All others are tall fescue.

Table 3. The mean protein content of tall fescue and hardinggrass.

Cultivar	Mean Protein Content -------%-------
S. D.	20a [1/]
Jepel	18 b
TAM Wintergreen	18 b
S. G.	18 b
Kaspa	18 b
PI-144	17 b
PI-26	17 b
Kenhy	17 b
Fawn	17 b
Temple-1	17 b
PI-25	17 b
S-Sel	17 b
Ky-31	17 b

[1/] Means with a common letter are not significantly different at the .05 level.

The Effects of Planting Methods and Rates of Sod Seeded Crops on Forage Production, 1981-1983

E. C. Holt and B. E. Conrad [1]

ABSTRACT

Yuchi arrowleaf clover and Gulf ryegrass were overseeded separately at varying rates on Coastal bermudagrass sod by drilling or broadcasting following either shredding or shredding and paraquat treatment. This is part of a larger study to partition energy requirements for forage production and energy contributions of components of pasture systems to livestock production. Winter crop production did not differ between shredding and paraquat, between drilling or broadcasting, or among seeding rates of the two species. Total yields of ryegrass plus Coastal and Clover plus Coastal were the same. Production through April was increased by overseeding plots.

However, summer Coastal production following the winter crop seemed to be reduced approximately equivalent to the winter crop production when compared with non-overseeded Coastal. Thus, total yields were about the same with or without overseeding.

INTRODUCTION

Previous sod-seeded winter pasture research has largely ignored the potential effects of the winter pasture on the subsequent summer pasture component of the system. In areas west of the 40-inch rainfall line, the total pasture system must be considered. Plant growth made either in the fall or late winter may have a profound effect on growth of the permanent grass the following summer through soil moisture effects. Also, if the cool-season crop is a grass, total nitrogen requirements may be greater. Similarly, pasture component contributions to livestock production, including energy efficiency and economic returns, require evaluation in the context of the whole pasture system. The agronomic research reported in this paper was designed to evaluate establishment production strategies for the winter pasture component and the carry-over effects on the summer pasture.

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KEY WORDS: sodseeding/ Coastal/ Yuchi clover/ Gulf ryegrass/ seeding rate/ seedbed preparation.

MATERIALS AND METHODS

The second year of the study was seeded on the same plots as in the preceding year. Seeding was about October 1, 1983 on Coastal bermudagrass sod sprigged in 1974 and grazed with stocker steers each summer from 1975 through 1981. The soil is a fine silty loam fertilized each year from 1975 through 1981 with 200-0-0 per acre. A split-split-split plot field design was employed with 3 replications. Main plots were seedbed preparation consisting of either (1) shredding at less than 2-inch height or (2) shredding plus paraquat to desiccate the stubble. Subplots consisted of (1) broadcasting seed on the surface or (2) drilling the seed in 10-inch drill rows using a special plot drill. Sub-sub plots consisted of either (1) Yuchi arrowleaf clover, or (2) Gulf ryegrass within each broadcast or drilled plot. The clover and ryegrass were not seeded in a mixture in this study. The sub-sub-subplots were three seeding rates (high, medium, low) which were as follows: Yuchi clover - 10, 20, and 30 pounds of seed per are; Gulf ryegrass - 20, 30 and 40 pounds per acre. The ryegrass plots received 50 pounds of nitrogen per acre at planting. Three Coastal check treatments (no overseeding) were included in an adjacent experiment. These were fertilized at the rate of 0, 50 and 100 pounds of N per acre in mid-March. The plot area was fertilized with 70-0-0 on June 29. The study was reestablished on plots receiving the same treatment in 1981-82. Harvests made on April 19, May 25 and June 28 were separated into clover, wintergrass, and bermudagrass components. Harvests were made on August 5 and September 13 consisting of only Coastal bermudagrass to evaluate the effects of overseeding treatments on the permanent grass.

RESULTS

The overseeding methodology study indicates no real effects of shredding versus shredding followed by paraquat desiccation of the sod on subsequent dry matter production (Table 1) Similarly broadcasting the seed, either ryegrass or Yuchi clover, resulted in the same dry matter production as placing the seed in the soil with a drill. The third variable in the study was seeding rate. Yield was the same, including first-cutting yield, for seeding rates of 20 to 40 pounds per acre of ryegrass or 10 to 30 pounds of Yuchi. The two-year averages follow the same patterns as the 1983 data (Table 2).

The above data suggest that energy and seed costs for establishment can be reduced by reducing sod cover by shredding (or close grazing) followed by broadcasting 10 pounds of Yuchi or 30 pounds of ryegrass or a mixture of the two species. It should be pointed out that there was some volunteer wintergrass (rescue and/or ryegrass) present in both years of the study which, if not present, could alter early production. Further, the exposure of inoculated clover seed to direct sunlight where the seed are placed on the surface (by broadcasting) may be detrimental to the inoculum. This may be an important factor with initial planting before any buildup of Rhizobia occurs in the soil and if moisture for germination is not available at planting time.

There was no negative effect of paraquat on Coastal recovery and production in 1983 as was evident in 1982. Yield of the check plot (Coastal only) in April was less than that of overseeded plots. Conversely, yield of Coastal only (checkplot) in early August was much higher than overseeded plot yields resulting in yield of Coastal alone being as high or higher than Coastal plus overseeded crop yield. Apparently overseeding in this environment results in shifting some of the yield to the cool season but not in increasing total yield in a system where some of the nitrogen was applied to the winter crop. In other words, at a fixed nitrogen level, Coastal is more efficient in nitrogen use than the winter crops, thus total yield is not increased by winter overseeding If additional nitrogen were applied to Coastal following the winter crop and assuming that moisture was not a limiting factor, greater total production might be realized by sod seeding than by Coastal alone.

The two-year yield data (Table 2) show the same pattern as the 1982-83 data. Also, yields for the two years were very similar, averaging about 6 tons per acre.

The data in Table 3 indicate essentially no effects of establishment practices on botanical composition. In legume overseeded plots there is a trend toward higher percentage of legume and less weeds in April with heavier seeding rates. Ryegrass did not show a similar pattern, and the cost of the extra legume seed to achieve the result would be prohibitive especially since yield was not affected (Table 1). Weed invasion in April and May was greater in legume plots than in ryegrass plots. Apparently Yuchi clover is less competitive than Gulf ryegrass in the early stages of plant development thereby allowing more weeds to develop. The competitive effects of clover vs ryegrass on Coastal were variable in May. On the average there was more Coastal in the ryegrass plots indicating that ryegrass has passed its peak but individual treatment combinations varied. Ryegrass had completely disappeared prior to the June 28 harvest whereas clover still constituted 15 to 20% of the population in clover overseeded areas.

CONCLUSIONS

The results of this initial study have implications concerning winter pasture establishment practices and costs.

Ryegrass and clover emerged in the fall of 1981 and again in 1982 with broadcast seed following shredding only. These results indicate that reduction of competition of Coastal bermudagrass by close grazing or shredding is adequate for late September and October plantings without chemically induced dormancy or mechanical disturbance of the sod. However, earlier planting or seedling emergence would likely necessitate reduction in bermudagrass competition by one of the means indicated above. Also, it should be noted that legume inoculant is susceptible to direct sunlight. Thus, broadcasting the seed on the surface may result in less early nodulation and nitrogen fixation than when the seed are placed in the soil by drilling unless planting is followed by rainfall and early emergence.

Winter pasture lengthened the potential grazing season by 45 to 60 days but increased total production of the system little over Coastal bermudagrass alone. Winter crop production up to mid-April exceeded 2,500 pounds per acre while later Coastal production was reduced about the same amount as compared with non-overseeded Coastal. Additional energy is involved in the sod-seeding operation without an appreciable increase in total dry matter production, but temperate crops and early spring forage are higher in available energy content than mid-summer Coastal forage. Also, forage availability in mid to late winter may reduce winter supplementary feed requirements because forage availability is more critical than in mid-summer. Thus, the practice may make a positive contribution even though dry matter production is not increased. Confirmation of these responses and further evaluation of energy requirements and contributions will constitute follow-up studies.

Table 1. Main effects of seedbed preparation and seeding rate on forage production, 1983

		Date of forage harvest						
Treatment lb.	Seed/ac	Mar. 3	Apr. 19	May 25	June 28	Aug. 15	Sep. 13	Total
		pound of dry forage per acre						
Shred	-	526a	1854a	1530a	884a	3817a	2568a	11179a
Paraquat	-	504a	2128a	1372b	877a	3733a	2710a	11284a
Broadcast	-	527a	1994a	1456a	940a	3773a	2693a	11383a
Drill	-	503a	1992a	1443a	822b	3777a	2584a	11121a
Ryegrass	20	536	2370	1217	877	3566	2646	11213
	30	637	2407	1079	832	3737	2706	11398
	40	562	2252	1133	829	3474	2561	10821
Average		547a	2341a	11743b	849a	3593a	2640a	11113a
Yuchi	10	486	1433	1952	973	4114	2617	11575
	20	534	1953	1633	894	3795	2673	11482
	30	426	1579	1697	869	3964	2628	11163
Average		482a	1655b	1765a	912a	3958a	2638a	11410a
Coastal alone		774	451	1875	1264	6051	2269	12684

Values within a column for paired treatments or ryegrass vs. Yuchi means with a common letter do not differ significantly ($p<0.05$)

Table 2. Two-year average of main effects of seedbed preparation and seeded rate on forage production, 1982-83

Treatment	seed/ac. lb	1982	1983	Average
		---Pounds dry forage per acre---		
Shred	-	13,782[a]	11,179[a]	12,480[a]
Paraquat	-	12,966[a]	11,284[a]	12,125[a]
Broadcast	-	13.682[a]	11,383[a]	12,532[a]
Drill	-	13,088[a]	11,121[a]	12,104[a]
Ryegrass	20	12,311	11,213	11,762
	30	11,803	11,398	11,600
	40	13,292	10,921	12,056
Average		12,474[a]	11,113[a]	11,793[a]
Yuchi	10	14,427	11,575	13,001
	20	13,012	11,482	12,247
	30	15,377	11,163	13,270
Average		14,285[a]	11,410[a]	12,847[a]
Coastal alone		12,461	12,684	12,572

Values within a column for paired treatments or ryegrass vs. yuchi means within a common letter do not differ significantly ($p<0.05$).

Table 3. Botanical composition of forage mixtures in overseeding study, 1983

Treatment	Seed Rate[1]	Legume overseeded plots: Legume	Winter grass	Coastal	Weeds	Ryegrass overseeded plots: Legume	Winter grass	Coastal	Weeds
		Ratio (percent) of components of plant population							
April 19, 1983									
Shred		84	0	3	13	0	93	5	2
Paraquat		87	0	1	12	0	94	3	2
Broadcast		88	0	2	15	0	93	5	2
Drill		83	0	3	10	0	95	2	3
Legume or grass	1	80	0	4	16	0	92	5	3
	2	84	0	1	15	0	96	4	0
	3	92	0	2	6	0	93	5	2
May 25, 1983									
Shred		67	0	27	6	0	48	49	3
Paraquat		60	0	27	13	0	73	22	5
Broadcast		70	0	18	12	0	60	37	3
Drill		58	0	36	6	0	60	37	3
Legume or grass	1	63	0	29	8	0	58	36	6
	2	60	0	25	15	0	60	40	0
	3	68	0	25	7	0	64	35	1

Table 3. Botanical composition of forage mixtures in overseeding study, 1983 (Continued)

		Ratio (percent) of components of plant population							
		Legume overseeded plots				Ryegrass overseeded plots			
Treatment		Legume	Winter grass	Coastal	Weeds	Legume	Winter grass	Coastal	Weeds
		June 28, 1983							
Shred		14	0	86	0	0	0	100	0
Paraquat		19	0	81	0	0	0	100	0
Broadcast		15	0	85	0	0	0	100	0
Drill		17	0	83	0	0	0	100	0
	Seed Rate[1]								
Legume or grass	1	13	0	87	0	0	0	100	0
	2	18	2	82	0	0	0	100	0
	3	19	0	81	0	0	0	100	0

[1] Seedling rates were 10, 20 and 30 and 20, 30 and 40 pounds per acre for Yuchi clover and ryegrass, respectively.

The Performance of Cool-season Forage Mixtures with Coastal Bermudagrass

E. C. Holt and B. E. Conrad[1]

SUMMARY

Warm-season grass pastures, especially bermudagrass, are frequently overseeded with cool-season annual crops for winter pasture. In a study in the Brazos River bottom on Miller clay soil, Gulf ryegrass, Yuchi arrowleaf clover or a mixture of the two overseeded on Coastal bermudagrass increased production through April about 1,500 pounds per acre. Mid-summer Coastal production appeared to be less where winter crops had been grown resulting in about the same total production per year with or without overseeding. While the cool-season crops (ryegrass and Yuchi clover) responded to both fall and spring applied nitrogen, the yield response was only in the range of 8 to 11 pounds of production per pound of nitrogen applied. The level of production in the presence of no fall or spring nitrogen and 70 pound per acre of nitrogen in June suggests that considerable soil nitrogen is available on the test site and that responses might be different when soil nitrogen is depleted or on a less fertile site.

INTRODUCTION

Sod-seeding cool-season annual crops on perennial grass stands may extend the pasture production season several weeks or even months. The cool-season grasses and legumes generally have better forage quality than perennial warm-season grasses, thus forage quality may be improved. If a legume is used in overseeding operations, it may fix appreciable amounts of nitrogen, thereby reducing the amount of applied nitrogen necessary for summer production of the permanent sod. Sod-seeding requires no seedbed preparation and therefore the energy expenditure for sod-seeding is less than that required for seeding on prepared seedbed. But forage production from sod-seeding is generally less than that resulting from prepared seedbed plantings. Also, spring growth of the annual crop may

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KEY WORDS: Sod-seeding/ Gulf ryegrass/ Yuchi arrowleaf clover/ Competition/ Component yield.

remove soil moisture that would otherwise be available to the permanent sod thus reducing summer production. This may be increasingly important where total rainfall is below 40 inches annually. Quantification of summer growth responses and energy inputs is needed as a more complete basis for evaluating sod seeding.

MATERIALS AND METHODS

Gulf ryegrass and Yuchi arrowleaf clover were overseeded separately and in a mixture together on Coastal bermudagrass in late September 1982. Individual plots were 6 x 20 feet, three replications in a split-split plot design. Three mixtures constituted the main plots: (1) Gulf ryegrass, (2) Yuchi clover, (3) Gulf + Yuchi. Superimposed on each main plot were nine nitrogen treatments consisting of 3 fall rates and 3 spring rates in all combinations, as follows: 0, 50 and 100 pounds N per acre at planting, and 0, 50 and 100 in March, except that Yuchi alone received 0, 25 and 50 at planting . In addition a blanket application of 70 pounds of N was applied in June.

Gulf ryegrass was seeded at 30 pounds per acre and Yuchi clover at 20 pounds per acre on plots that had been seeded at these same rates in 1981. Rescue and some ryegrass volunteered throughout the plot area resulting in wintergrass mixture in the Yuchi plots. Replicated check plots with three spring (March) nitrogen rates (0, 50, 100 pounds per acre) were provided by desiccating all winter crop growth in early spring.

RESULTS

Good stands were obtained from fall overseedings on Coastal bermudagrass. However, minimal growth was made during the winter even though temperatures were very mild. March 3 yields averaged only about 700 pounds per acre.

The average yields of the three overseeding treatments and Coastal alone by harvest dates are shown in Table 1. The data represent averages of three fall nitrogen rates in all combinations with three spring nitrogen rates. Ryegrass overseeded on Coastal and Coastal alone produced more forage than ryegrass plus Yuchi overseeded on Coastal.

Nitrogen effects on yields of the individual mixtures are shown in Table 2. The lowest average yield across all mixtures was with no nitrogen and the highest average yield was with 100 pounds each fall and spring. There was a linear response in average yield to fall nitrogen rate if no spring nitrogen was applied. However in the presence of either 50 or 100 pounds of spring nitrogen, the average response to fall nitrogen was quadratic with no difference between 0 and 50 pounds. This would suggest that the response to fall nitrogen occurred primarily after early March when the spring nitrogen was applied. On the otherhand the response in average yield to spring applied nitrogen was linear regardless of the rate of fall nitrogen. These responses suggest that at least 100 pounds of nitrogen be applied in the fall in order to be effective, followed by 50 or 100 pounds in the spring dependent on growth conditions and forage needs.

If only the growing season involving the overseeded crops is considered (data not shown), 50 pounds of N in the fall and 50 pounds in March maximized production in ryegrass overseeded plots or 100 pounds in the fall maximized ryegrass + Yuchi and Yuchi plots. Averaged across all mixtures, either 50 or 100 pounds N in the fall followed by 50 or 100 pounds in the spring resulted in about 2 tons of production by late May with a maximum of 300 pounds of difference among the nitrogen treatements.

The linear response to spring applied nitrogen can be seen in the average yields in Table 3. The quadratic response to fall applied nitrogen is evident in average yield and in the presence of 50 or 100 pounds of spring N. Spring applied N resulted in 11 pounds of forage for each pound of N applied while fall applied N provided 8 pounds of forage for each pound of N applied at the 100 pound rate. These are minimal reponses probably because of climatic factors limiting plant growth, biological nitrogen fixation, and a high level of soil N.

Plant separations were made at each harvest to determine the contribution of components of the mixture. The data were variable and showed no major patterns related to nitrogen application except that the population of Yuchi clover in May and June tended to decrease with increased amounts of spring applied nitrogen.

The botanical data are summarized by overseeding mixtures in Table 4. The large amounts of Coastal bermudagrass in March do not represent new growth but are dead material that accumulated after the study was seeded in the fall. There was some volunteer rescue and ryegrass as evidenced by the presence of up to 37% wintergrass in Yuchi overseeded plots. Wintergrass consituted a high percentage of the forage through April where ryegrass alone was overseeded. However, ryegrass disappeared earlier than clover resulting in a higher percentage of Coastal in the mixture after April where ryegrass alone was overseeded. Yuchi constituted over 15% of the mixture through June.

Total yield of the sod-seeded mixtures followed the same pattern in each of the two years (Table 5). However, Coastal alone produced as much as any mixture with Coastal in 1983 but not in 1982. The mixture yields were about 2.5 tons less in 1983 than 1982. This may be due to less favorable environmental conditions but more likely represents a less favorable nutrient level. Production in 1982 was very high relative to the fertility treatments. The plots were located in a pasture that had been fertilized for several years with 200 pounds of nitrogen per acre. Some nitrogen buildup may have ocurred in this alluvial clay soil. The reduced yields in 1983 may represent some depletion of nutrients in the plot area. The objective of the study is to determine production with minimal cost inputs and not to maximize production. It would likely be possible to increase summer production with additional fertilizer applications.

Table 1. Average forage yield of various winter overseeding mixtures with Coastal bermudagrass, 1983

Mixture with Coastal	Date of harvest						
	Mar. 3	Apr. 21	May 26	June 28	Aug. 12	Sep 15	Total
	pounds of dry forage per acre						
Ryegrass	803a	1427b	1262b	1216a	3194b	2212a	10114a
Yuchi clover	772a	1728ab	1675a	836b	2478c	2186a	9675ab
Ryegrass + Yuchi	626a	1852a	1188b	885b	2172d	2046a	8769b
Coastal alone	638a	380c	1439ab	1186a	4816a	2171a	10630a

Values within a column followed by the same letter are not significantly different at the 0.05 probability level.

Table 2. The influence of rate and time of application of nitrogen and total forage yield of Coastal- overseeding mixtures 1983

Nitrogen lb/acre Fall	spring	Ryegrass	Yuchi + Yuchi	Ryegrass alone	Coastal	Average
		pounds of dry forage per acre				
0	0	-	9270	7569	7967	8269 c
	50	-	9999	8239	9662	9300 abc
	100	-	8117	9216	11040	9828 ab
Average		_	9499	8341	9556	9132
50	0	9440	8018	8840	-	8766 cb
	50	10109	8576	8940	-	9208 abc
	100	9258	10549	8823		9143 abc
Average		9602	9048	8868	-	9173
100	0	9388	10105	8872	-	9455 abc
	50	10529	9064	9858	-	9817 ab
	100	11077	10811	9575	-	10488 a
Average		10331	9993	9435	-	9920

Average yields followed by the same letter are not significantly different at the 0.05 probability level.

Table 3. Average response to fall and spring fertilizer applications, 1983

Fall N, lb/ac	Spring N, lb/ac			
	0	50	100	Average
	-----pounds forage per acre-----			
0	8269	9300	9828	9132
50	8766	9208	9543	9171
100	9455	9817	10488	9920
Average	8830	9442	9953	

Table 4. Botanical composition of overseeding mixtures on Coastal bermudagrass, 1983

Mixture with Coastal	March 3 Cl:WG:C:W[1]	April 21 Cl:WG:C:W	May 25 Cl:WG:C:W	June 26 Cl:WG:C:W
Ryegrass	2:83:12:3	3:93:3:1	0:30:65:5	0:0:100:0
Yuchi	24:19:56:1	57:37:2:4	52:0:33:15	16:0:84:0
Ryegrass + Yuchi	15:35:48:2	41:57:2:0	35:21:44:0	21:0:79:0

[1]Ratio (Percentage) of Cl(clover), WG(winter grass), C(Coastal), and W(weeds).

Table 5. Forage yield of sodseeded mixtures with Coastal, 1982-83

Mixture with Coastal	---------pounds of dry forage per acre --------		
	1982	1983	Average
Ryegrass	15,400 a	10114 a	12757 a
Yuchi clover	14,678 a	9675 ab	12176 ab
Ryegrass + Yuchi	13,386 b	8769 b	11078 b
Coastal alone	12,561 c	10630 a	11596 b

Performance of Warm-season Grass Varieties and Species

D. H. Bade, E. C. Holt, and B. E. Conrad[1]

ABSTRACT

Twenty-seven warm-season grass varieties and species were evaluated for yield, in vitro dry matter digestibility, and winter hardiness during the 1983 growing season and 1983-84 winter. Dry matter yields varied from 2188 to 13680 pounds per acre. Several varieties and species produced in excess of 5 tons dry forage per acre. In vitro dry matter digestibilities (IVDMD) of vegetative tillers sampled in August varied from 32.9 to 69.3% with 10 varieties and species above 60% IVDMD. Winterhardiness ratings are also reported.

INTRODUCTION

Twenty-seven warm-season varieties and species representing many commonly available native and introduced species were established in a twice replicated nursery in 1981 primarily for observational purposes. Comparative yield and quality information of warm-season grass varieties and species are needed to assist producers in species evaluations. Plots were harvested in 1982 and in 1983 for yield and quality comparisons.

MATERIALS AND METHODS

Seedlings of the grass varieties and species were started in peat pots in the greenhouse, and transplanted on 12 inch centers in 20 foot rows, 3 rows per plot, 2 replications in early April 1981. The plots were shredded in July 1981 and during the 1981-182 dormant season. Plots were harvested for yield in May and August of 1982.

Plots were fertilized with 400 pounds of 13-13-13 on April 13, 1983. Varieties and species were visually rated for stand density in May 1983. The rating was based on a 1 to 5 scale with 1 assigned to excellent stands with no skips and 5 assigned to a stand with no live plants present.

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KEYWORDS: Warm-season grasses, yield, digestibility, winterhardiness for in vitro dry matter digestibility.

Yields were determined from harvest on May 30, June 27, July 22, August 25, and September 26, 1983. The center row of each plot was harvested to a 4 inch harvest height for the yield determinations. Vegetative tillers at the 3 to 5 leaf growth stage were hand harvested prior to the August 25 harvest and analyzed .

Winterhardiness ratings were determined by visual observation in May 1984 following the cold winter of 1983-84. The rating was based on a 1 to 5 scale with 1 assigned to an excellent stand with no skips or dead plants; 5 assigned to plots with no live plants present.

RESULTS

Forage yields and in vitro dry matter digestibilities (IVDMD) are reported in Table 1. Large variation existed between replications resulting in large LSD values.

The average yield for the twenty-seven varieties and species of warm-season grasses was 7515 pounds of dry forage per acre. Production from Pretoria 90 bluestem, Lometa Indiangrass, Eastern Gamagrass (PMT 831), Kleberg bluestem, Big Sacaton (PMT 820) and Alamo Switchgrass was in excess of 5 tons dry forage per acre.

Yield rankings generally correspond to those in other studies where some of these varieties and species were included, and are very similar to those reported for the 1982 growing season. Three notable differences in the yield rankings between 1982 and 1983 are Birdwood-buffel, Common buffel, and Lometa Indiangrass. Birdwood-buffelgrass which was the fourth highest yielding variety in 1982 (10,067 pounds/acre) only produced 4340 pounds of dry forage per acre in 1983 (ranking 23). Common buffelgrass which produced 7293 pounds of dry forage per acre in 1982 only produced 2655 pounds of forage in 1983. Both grasses had poor stands at the start of the 1983 growing season (stand density rating of 3.5 - Table 2). Lometa Indiangrass which only produced 6949 pounds of dry forage per acre in 1982 (ranking 15) produced 12,592 pounds of dry forage in 1982 (ranking 2). Lometa Indiangrass has an excellent stand in 1983 (stand density rating of 1.0).

In vitro dry matter digestibilities rankings corresponded to those reported in other studies which included various of these grass varieties and species. Average IVDMD of vegetative tillers harvested in August was 54.62%.

Winter hardiness ratings taken in May 1984 are reported in Table 2. Winterhardiness patterns are as expected for the grass varieties and species. Since the last harvest was September 26, very little fall growth occurred prior to the first freeze of 1983.

Table 1. Average dry matter yield and August vegetative dry matter digestibility (IVDMD) of warm-seson grasses

Variety (PMT Number)	IVDMD	5/30	6/27	7/22	8/25	9/26	Total
	--%--	pounds dry forage/acre					
1. Pretoria 90 bluestem	65.8	5,405	2,814	2,070	2,031	1.360	13.680
2. Lometa Indiangrass	59.1	6.588	2.359	1.434	1.344	867	12.592
3. Eastern gammagrass (831)	48.0	5.440	2.078	1.476	1.323	1.073	11.393
4. Kleberg bluestem	68.2	5.141	1.385	1.058	2.164	1.499	11.247
5. Big sacaton (820)	46.8	4.951	1.950	1.280	1.796	1.189	11.166
6. Alamo switch	51.9	6.930	971	1.079	874	501	10.355
7. Kleingrass 75	59.5	5.092	1.314	1.020	1.718	842	9.986
8. Renner weeping lovegrass	32.9	3.722	1.755	1.018	1.076	1.249	8.820
9. Alkali sacaton	48.6	3.592	1.922	1.055	1.033	884	8.486
10. Llano buffelgrass	62.3	2.452	2.379	1.175	1.643	780	8.429
11. Nueces buffelgrass	62.9	2.461	2.684	990	1.211	796	8.142
12. Polar lovegrass	64.0	2.231	2.102	874	1.683	1.074	7.964
13. Plains bluestem	59.2	2.689	1.161	960	1.493	1.297	7.600
14. Old world bluestem (487)	62.5	2.046	1.450	1.001	1.656	1.323	7.476
15. Big bluestem (1947)	53.2	2.753	1.690	982	1.005	939	7.369
16. Red alta limpograss	60.2	2.945	1.402	1.115	991	531	6.984
17. Dallisgrass	51.2	3.421	1.327	587	757	642	6.766
18. Sideoats grama (470)	54.4	3.195	1.441	832	701	399	6.566
19. Little bluestem (2738)	45.2	2.282	1.109	881	1.398	597	6.267
20. Caucasian bluestem (588)	60.6	2.680	1.138	588	779	743	5.928
21. Lehamann lovegrass	34.7	1.841	1.227	547	631	761	5.007

Table 1. Average dry matter yield and August vegetative dry matter digestibility (IVDMD) of warm-seson grasses

Variety (PMT Number)	IVDMD	5/30	6/27	7/22	8/25	9/26	Total
	--%--	---pounds dry forage/acre---					
22. Little bluestem (1652)	48.9	1.448	1.008	695	705	491	4.347
23. Birdwood-buffel	69.3	855	1.386	542	827	530	4.240
24. Green spangletop (746)	56.7	988	985	408	796	859	4.046
25. Plains bristlegrass (4022)	40.3	785	570	369	393	600	2.717
26. Common buffelgrass	67.5	623	999	243	373	417	2.655
27. Pensacola bahiagrass	41.3	378	589	578	345	298	2.188
Average	54.6	3.276	1.525	921	1.143	828	7.515
LSD .10	9.1	2.455	640	452	750	565	3.039

Table 2. Stand density ratings of warm-season grass varieties and species

Variety (PMT Number)	Rating May 1983*	Rating May 1984*
Pretoria 90 bluestem	1.0	4.75
Lometa Indiangrass	1.0	1.00
Eastern gammagrass (831)	1.0	1.25
Kleberg bluestem	1.0	1.00
Big sacaton (820)	1.0	1.50
Alamo switch	1.0	1.25
Kleingrass 75	1.0	1.00
Renner weeping lovegrass	1.0	3.00
Alkali sacaton	1.0	1.00
Llano buffelgrass	1.5	5.00
Nueces buffelgrass	2.0	5.00
Polar lovegrass	3.0	3.00
Plains bluestem	2.0	1.25
Old world bluestem (487)	1.0	3.50
Big bluestem (1947)	2.0	1.50
Red alta limpograss	1.0	1.75
Dallisgrass	1.5	3.00
Sideoats grama (470)	1.5	1.00
Little bluestem (2738)	2.0	1.00
Caucasian bluestem (588)	1.0	3.25
Lehamann lovegrass	3.5	2.00
Little bluestem (1652)	2.5	1.50
Birdwood-buffel	3.5	5.00
Green spangletop (746)	2.5	2.00
Plains bristlegrass (4022)	3.0	1.25
Common buffelgrass	3.5	5.00
Pensacola bahiagrass	1.0	1.00

Performance of Sorghum-Sudan Hybrids Grown Dryland

R. M. Jones and J. C. Read*

Summary

Eighteen hybrids of sorghum X sudangrass [Sorghum bicolor (L.) Moench] were grown dryland on Windthorst fine sandy loam. The first seeding April 13, 1983 resulted in a very poor stand due to cool soil temperature. Yields of the May 9 seeding ranged from 2.14 to 4.11 tons per acre when cut once at the boot stage. Yield of SX-17+ at 4.11 tons was significantly greater than all other cultivars, but SX-17+ required thirteen days longer to reach boot stage than eight other hybrids. Daily growth rate among the hybrids was not significantly different.

Crude protein content ranged from 7.27 to 10.54 percent. Six hybrids contained significantly more crude protein than four others. Highest yielding hybrids did not contain the higher percentages of crude protein.

Plants surviving at harvest as a percentage of seed planted ranged from 40 to 82 despite germination percentages exceeding 82%. No difference in survival of hybrids could be determined statistically.

Introduction

Hybrids of sorghums X sudangrass have been shown to provide acceptable yields and crude protein content when properly managed. They are extensively used for grazing and hay for both dairy and beef animals. Hybrids resulting from crossing sorghum and sudangrass are very common offering the producer an array of choice with considerable variation in seed price. The purpose of this study was to assess the yield and protein content of forage of several of the hybrids available in the Stephenville, Texas area.

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Key words: Sorghum-sudan hybrids/Sorghum bicolor/sorghum X sudangrass/crude protein/forage yield/soil temperature

Procedure

Eighteen hybrids (Table 1) of [Sorghum bicolor (L.) Moench] were seeded April 13 and reseeded May 9, 1983 on Windthorst fine sandy loam near Stephenville at a rate of one seed per row inch. All hybrids were types generally used for hay or grazing. Fertilizer was broadcast April 7 at the rate of 148-48-48 and incorporated by disking. Plots were replicated four times in a randomized, complete-block design. Plots sixteen feet long had four rows spaced at fifteen inches. Soil temperature was monitored six inches below ground level from April 15 to May 27.

Individual hybrids were cut once when 25-50% of the plants had reached the boot stage of maturity. Four feet of the two center rows of each plot were cut at a height of three inches with a machete for yield determination. Subsamples were dried at 158F for dry matter determination and retained for crude protein analysis.

Seed germination was determined for fourteen of the eighteen hybrids. Fifty seed of each hybrid were placed on a paper towel, moistened, and stored in the dark inside a sealed plastic bag at 72F for seven days. Each seed was counted as germinated if it produced a radical.

Number of plants per eight feet of row was determined at harvest. Percentage of plants surviving at harvest was determined by dividing plants per eight row-feet by number of seed planted per eight row-feet.

Results and Discussion

The first planting on April 13 resulted in a very poor stand even though soil moisture was adequate. Daily minimum soil temperature was below 60F until April 27 (Figure 1). Daily maximum soil temperature increased from 59F to 69.5F April 15-19, but dropped and remained below 67F until April 27. A second seeding May 9 resulted in a good stand. Minimum soil temperature at six inches depth exceeded 60F until May 15 when most plants had emerged. Maximum daily soil temperatures following seeding were 70F or more except for one day. Cool soil temperature was apparently responsible for poor germination of the first seeding.

Yields ranged from 2.14 to 4.11 tons dry matter per acre (Table 1). However, under the conditions of this test all yields were statistically the same except for 'SX-17+', which produced yields statistically greater than all other hybrids. SX-17+ required 69 days to reach boot stage while eight cultivars required only 56 days from seeding until harvest. Mean yield of hybrids requiring 63 days to reach boot stage was only 0.19 tons/acre greater than the mean yield of hybrids requiring 56 days. Rainfall was the same as the average for the period 1938-1979 and totaled 5.85 inches from planting to harvest. SX-17+ received 0.97 inches more rainfall due to its longer maturity.

Daily growth rate ranged from 77.0 to 128.5 pounds dry matter per day, but differences could not be detected statistically at the 0.05 level (Table 1). Mean daily growth rate for all hybrids was 96.44 pounds dry matter per acre.

Percent crude protein content ranged from 7.27 to 10.54 (Table 2). 'TE Haygrazer II', 'Trudan 8', 'Sugraze', 'TE Chieftian-A', 'Morgain III', and 'Cattle Grazer' contained significantly higher amounts of crude protein than 'Grow-N-Graze', 'SX-17+', 'Ribbon-Grazer', and 'Kow Kist'. The fact that the latter four cultivars produced higher (though not significantly higher) yields than the former six hybrids points to the compromise that must often be made between producing high yields and high crude protein content.

Plant survival at harvest appeared to be low compared with the percentage of germinating seed determined before seeding (Table 2). Many plants apparently were lost for reasons other than germination. Although the percentage of plants surviving ranged from 40 to 82, differences among cultivars were not found to be statistically significant.

Acknowledgement

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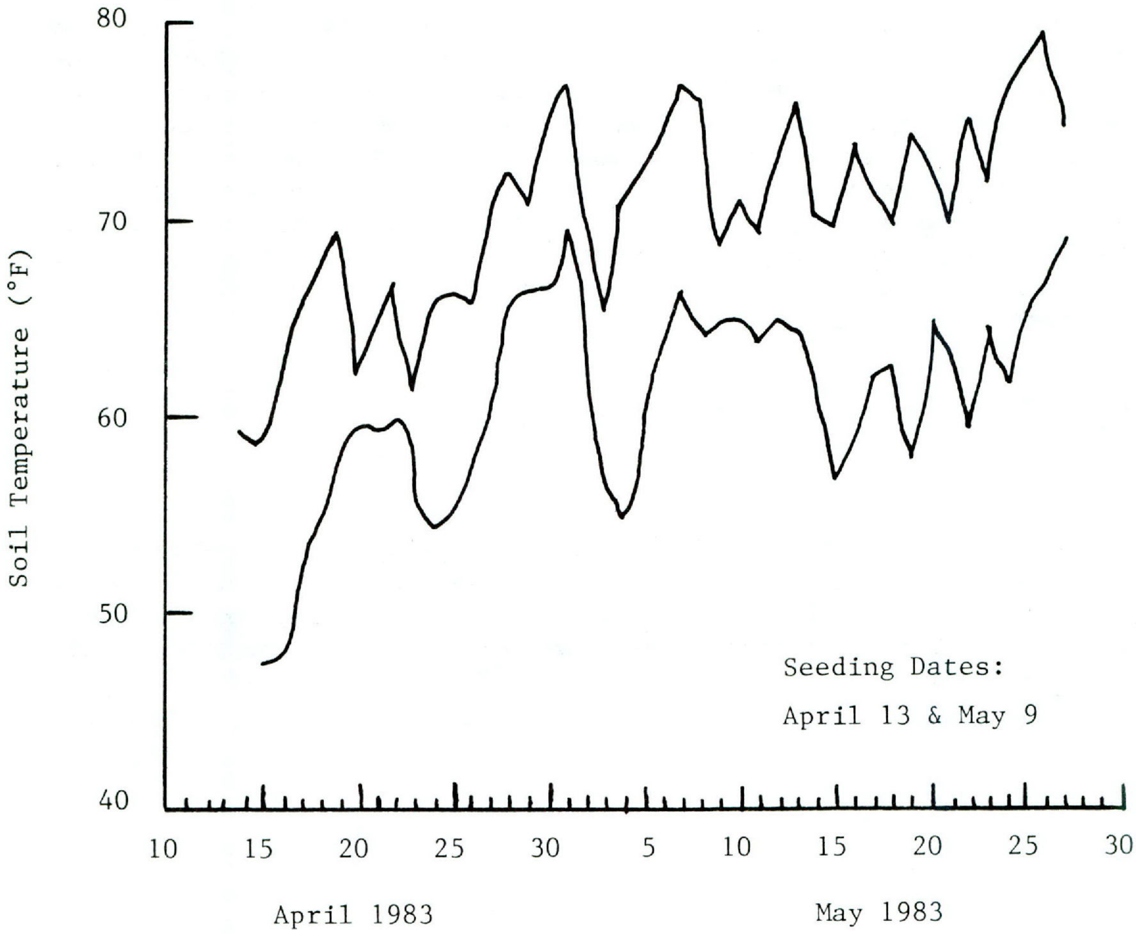

Figure 1. Daily maximum and minimum soil temperatures at six inches depth

TABLE 1. DRY MATTER YIELD, GROWTH RATE, CRUDE PROTEIN CONTENT, HARVEST DATE, AND AGE AT HARVEST OF SORGHUM X SUDANGRASS HYBRIDS GROWN DRYLAND ON WINDTHORST FINE SANDY LOAM

	Dry Matter*				
Cultivar	Total Tons/Ac	Growth Rate** lbs/day	Crude Protein* %	Harvest Date	Age at Harvest 1/
TE Haygrazer II	2.27 b	90.7	10.54 a	July 5	56
Trudan 8	2.15 b	95.6	10.41 ab	July 1	52
Sugraze	2.14 b	85.5	9.86 abc	July 5	56
TE Chieftian-A	2.53 b	101.3	9.65 abc	July 5	56
Morgain III	2.37 b	94.5	9.62 abc	July 5	56
Cattle Grazer	2.49 b	99.6	9.61 abc	July 5	56
Stockman's Pride	2.50 b	100.0	9.24 abcd	July 5	56
Cattle King	2.50 b	100.0	9.16 abcd	July 5	56
HS-101	2.27 b	85.7	8.84 bcde	July 8	59
HS-301 A	2.20 b	77.0	8.81 bcde	July 12	63
Gotcha	2.57 b	96.8	8.71 cde	July 8	59
Kow Kandy	2.71 b	95.2	8.63 cde	July 12	63
XSG-13	2.64 b	105.4	8.63 cde	July 5	56
Thrifty Grazer	2.85 b	99.8	8.18 cde	July 12	63
Grow-N-Graze	2.44 b	85.6	7.96 de	July 12	63
SX-17+	4.11a	128.5	7.89 de	July 19	69
Ribbon Grazer	2.63 b	92.2	7.87 de	July 12	63
Kow Kist	2.92 b	102.5	7.27 e	July 12	63

* Means followed by the same letter are not significantly different at the 0.05 level, Duncan's Multiple Range Test.

** Growth rate was not significantly different at the 0.05 probability level.

1/ Days since seeding.

TABLE 2. SEED GERMINATION AND PERCENT OF SEEDING RATE SURVIVING AS PLANTS AT HARVEST

Cultivar	Company	Germination %	% Plants Surviving at Harvest*
Kow Kandy	R. C. Young	94	82
TE Haygrazer II	Taylor-Evans	94	59
TE Chieftian-A	Taylor-Evans	92	73
SX-17+	DeKalb-Pfizer Genetics	90	72
Ribbon Grazer	Crop Seed	90	70
Kow Kist	Harper	88	66
Thrifty Grazer	Crop Seed	88	64
Morgain III	Conlee	87	63
Stockman's Pride	R. C. Young	86	64
Cattle Grazer	Kan Tex	86	60
Grow-N-Graze	George Warner	86	56
XSG-13	Pioneer	85	79
Cattle King	Lewis Barker	85	71
Sugraze	R. J. Riley	82	46
HS-101	Harpool	--	46
Gotcha	Harpool	--	81
HS-301 A	Harpool	--	40
Trudan 8	Northrup King	--	60

* Based on seeding rate of one seed per row inch. Differences are not significantly different at the 0.05 probability level.

EFFECTS OF FALL CLIPPING ON BERMUDAGRASS YIELDS THE FOLLOWING YEAR

T. S. Harris, V. L. Jones and L. Gordon[1]

SUMMARY

Callie and coastal bermudagrasses were subjected to 6 different fall clipping treatments consisting of ending monthly harvesting in the months of August through November 1982 (4 treatments) and 2 other treatments consisting of delaying harvesting after August until October and November. The purpose of the experiment was to measure the effects of fall clipping on winter tolerance as manifested by yields the following year. Four nitrogen levels were also included in the test. Yields during 1983 through August decreased from 11,675 to 9,835 pounds of dry matter per acre as a result of continued monthly fall harvesting through November 1982. Yields during 1983 due to the 2 delayed 1982 fall clipping treatments were identical at 10,671 pounds of dry matter per acre and generally ranked second to the treatment not harvested after August. When the amounts of forage harvested during application of the 1982 fall treatments were added to 1983 yields, the 2 delayed fall harvest treatments resulted in much greater yields, a mean of 13,821 compared to a mean of 11,911 pounds of dry matter per acre for the 4 other treatments. The total of fall and following year yields were not different for these 4 treatments because the decrease in 1983 yields due to late fall harvesting was compensated by the amounts harvested during the fall. Nitrogen fertilizer, up to 360 pounds per acre did not influence clipping treatment results, but increased yields from 3,694 to 16,742 pounds per acre for Callie and from 7,238 to 21,876 pounds per acre for coastal.

INTRODUCTION

Since bermudagrasses are of tropical origin, one of the problems associated with their production in the U. S. is that some varieties are damaged by the relatively cold temperatures which occur some winters in the southern region where they are grown. This problem has been approached through plant selection and breeding, but often at the sacrifice of other desirable attributes such as high dry matter yield and forage quality. Many observations suggest that winter tolerance can be improved by reducing nitrogen application or not harvesting late or frequently during the fall. A certain amount of regrowth after fall utilization is believed to increase protection against winter kill through natural development of winter hardiness or through the insulation effect provided by standing fall regrowth. Less drastic

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KEYWORDS: Bermudagrass/cultivars/winter hardiness/fall clipping/yield fertilization.

clipping heights have tended to support this latter claim. Quantitative data required to ascertain these observations are not available, especially on the numerous bermudagrass varieties recently being evaluated or released in Texas. This study was designed to evaluate any effect of selected fall clipping lateness and frequency treatments on the winter tolerance of Callie and coastal bermudagrasses as manifested by spring dry matter yields. Different levels of soil nitrogen are also included in the study to determine whether nitrogen influences the effect of fall clipping treatments on bermudagrass yields.

PROCEDURE

This study was established on field plots arranged in a randomized complete block design with split blocks and split plots. Each of 4 blocks (containing a replication of the experiment) was split to accommodate the 2 bermudagrass varieties, Callie and coastal. Four nitrogen levels were used for each block and variety to result in 32 main plots, 8 by 24 feet with 5-foot alleyways between each. These main plots were split to accommodate 7 fall clipping treatments, resulting in 224 experimental units. The grasses were established during April 1982 by sprigging plant materials in a row located in the center of each 3.4 by 8 foot subplot, placed 1 foot apart in the row.

Nitrogen treatments consisted of a check (0 nitrogen) and 3 levels of nitrogen, 22.5, 45 and 90 pounds per acre applied each year in April, and these same amounts applied immediately after each harvest through August. Phosphorus and potassium fertilizers were applied each spring on all plots to provide 53 pounds per acre of actual ingredients.

Fall clipping treatments commenced each year after monthly harvests were taken through July. Four of these consisted of taking the last monthly harvest for the year in August, September, October and November. These are designated as Treatments 1 through 4 in Tables 1 and 2. Two other treatments consisted of not harvesting after August until October and November, designated as Treatments 5 and 6, respectively. A seventh plot was used as a spare in 1982, but was used as an additional treatment beginning in August 1983.

Harvests were taken by clipping a 26-inch strip through the center of each designated subplot with a sickle bar mower, each strip being 6 feet in length and clipped 1 inch above ground level. Clippings were raked onto a canvas and weighed in the field. A sample of approximately one-half pound from each harvested subplot was bagged, sealed, and used to determine percent dry matter. These samples are also to be used in forage quality analyses.

RESULTS AND DISCUSSION

Dry matter yields harvested through August 1983 as a response to 1982 fall clipping treatments are given by variety and harvest date in Table 1. These data show that 1983 yields are significantly higher as a result of Treatment 1 where the grasses were not harvested after August 1982. As monthly fall clipping treatments were continued from

September through November 1982 (Treatments 2-4) yields during 1983 showed a steady decline as a result of lateness of clipping during the previous year. Mean yields for both varieties due to Treatments 1 through 4 were 11,675, 10,658, 10,469 and 9,835 pounds of dry matter per acre, respectively. For Treatments 5 and 6 (not harvested in 1982 after August until October and November, respectively) yields for the 1983 season through August were identical for both treatments (10,671 lbs/ac). Yields resulting from these 2 treatments were significantly less than those from Treatment 1 and higher than Treatment 4 which provided the lowest 1983 yields. The above clipping treatment results on 1983 yields were similar for separate variety analyses as no significant interaction was found between clipping treatment and variety. The coastal variety was found to yield about 30 percent more forage than Callie under all treatment factors. This was partially attributed to a rust-like infestation in the Callie stand. A significant interaction was also found between fall clipping treatment and harvest date for each variety. Yield data for June and July 1983 show greater numbers and amounts of significant differences among the 6 treatments than data for the month of August. This indicates that previous fall clipping effects were essentially overcome by the time of the July 20-21, 1983, harvest.

The results presented above and in Table 1 do not reflect various amounts of forage harvested during the application of fall clipping treatments, which were produced after a cutting on August 23-24, 1982, to initiate the clipping treatments. In the case of Treatment 1, which was not harvested after August 1982, a large amount of fall produced forage was sacrificed for winter protection, and was considered unsuitable for feed in the spring and not harvested. This amounted to from 1209 to 3975 pounds per acre based on the amounts harvested after August 1982 in the application of the other clipping treatments. Amounts of fall forage sacrificed for winter protection in the case of Treatment 1, however, resulted in from 1004 to 1840 pounds per acre more forage the following year compared to the other treatments.

The results in Table 2 consider total forage harvested after August 24, 1982, during the application of fall clipping treatments and the amounts harvested in 1983 through August 25. These data show that all forage actually harvested during the experimental year were significantly higher under treatments 5 and 6 than under other treatments. Since these treatments allowed long growth periods during the fall, ending in October and November 1982, respectively for Treatments 5 and 6, but caused only slight yield reductions the following year (Table 1), most of the higher total yields were attributed to fall harvesting. Treatments 1, 2, 3 and 4 however, were not significantly different from each other in the amount of forage harvested during the experimental year (Table 2). The mean dry matter yield for Treatments 1 through 4 over the period was 11,911 compared to 13,821 pounds per acre for the mean of Treatments 5 and 6. For Treatments 1 through 4, the spring yields decreased as monthly fall harvesting continued, but the increasing amounts of fall forage harvested as a result of the application of Treatments 2, 3 and 4 completely compensated for gains in yields due to early cessation of fall harvesting. This resulted in yields harvested over the experimental year to be statistically the same for these 4 treatments.

The different levels of nitrogen application had significant effects on yields of each variety at each harvest, but did not interact significantly with fall clipping effects on yields the following year. Table 3 shows the effect of increasing nitrogen fertilization rate from 0 to 90 pounds per acre applied initially each season, and in the same amounts after each harvest through August. Dry matter yields were significantly correlated with increasing levels of nitrogen fertilization, and ranged from 3,694 to 16,742 pounds per acre for Callie and 7,238 to 21,876 pounds per acre for coastal over the experimental year.

Table 1. Yields of Callie and coastal bermudagrasses during 1983 as influenced by 1982 fall clipping treatments

Treatment reference number	[1]1982 Fall clipping treatment			[2]Mean dry matter yields, 1983								
				Callie				Coastal				Means
	Sep	Oct	Nov	Jun	Jul	Aug	Totals	Jun	Jul	Aug	Totals	
				------ lbs/ac ------								
1	-	-	-	4444 a	1745 a	2939 a	9128 a	7305 a	3050 a	3867 ab	14,222 a	11,675 a
2	x	-	-	3747 bc	1450 b	3113 a	8310 bc	6240 b	3022 a	3744 b	13,006 b	10,658 b
3	x	x	-	3602 bc	1600 ab	3012 a	8314 bc	5894 a	2978 a	3852 ab	12,724 b	10,469 b
4	x	x	x	3413 c	1467 b	2848 a	7728 c	5364 c	2710 b	3867 ab	11,941 c	9,835 c
5	-	x	-	4143 ab	1556 b	2967 a	8716 ab	5861 b	2972 a	3792 ab	12,625 bc	10,671 b
6	-	-	x	3697 bc	1533 b	2961 a	8191 bc	5961 b	3073 a	4117 a	13,151 b	10,671 b

[1]The symbol "x" indicates that a harvest was taken after August 24, 1982, during the month where the symbol appears. The symbol "-" indicates that harvest was not taken during the month in 1982.

[2]Yields within a column followed by the same letter are not different at the 0.05 level according to the Duncan Multiple Range test.

Table 2. Total forage harvested during application of fall clipping treatments after August 24, 1982, and during the 1983 season through August 25

Treatment reference number	[1]1982 Fall clipping treatment			[2]Total forage harvested during application of 1982 fall clipping treatments and during 1983 through August		
	Sep	Oct	Nov	Callie	Coastal	Means
				-----------------	lbs/ac	-----------------
1	-	-	-	9,129 a	14,222 a	11,676 a
2	x	-	-	9,519 a	14,520 a	12,019 a
3	x	x	-	9,877 a	14,450 a	12,164 a
4	x	x	x	9,491 a	14,078 a	11,785 a
5	-	x	-	11,369 b	15,695 b	13,532 b
6	-	-	x	11,096 b	17,125 c	14,110 b

[1]The symbol "x" indicates that a harvest was taken after August 24, 1982, during the month where the symbol appears. The symbol "-" indicates that harvest was not taken during the month in 1982.

[2]Yields within a column followed by the same letter are not different at the 0.05 level according to the Duncan Multiple Range test.

Table 3. Yields of Callie and coastal bermudagrasses as influenced by level of soil applied nitrogen

[1]Nitrogen level (lbs/ac)	[2]Dry matter yields									
	Callie					Coastal				
	Fall	1983				Fall	1983			
	1982	Jun	Jul	Aug	Totals	1982	Jun	Jul	Aug	Totals
	lbs/ac									
0	707 a	1171 a	610 a	1206 a	3,694 a	997 a	2394 a	1212 a	2635 a	7,238 a
23	1436 b	2866 ab	1212 b	2383 ab	7,897 b	1829 ab	5015 b	2316 b	3191 ab	12,351 b
45	1832 b	5290 bc	1758 b	3106 b	11,986 c	2479 bc	7948 c	3431 c	4736 b	18,594 c
90	2819 c	6071 c	2654 c	5198 c	16,742 d	2976 c	9059 c	4911 d	4930 b	21,876 c

[1]Level of actual nitrogen applied during each application through August 1982; and April, June and July 1983.

[2]Yields within a column followed by the same letter are not different at the 0.05 level according to the Duncan Multiple Range test.

Performance of Bermudagrass Hybrids and Cultivars in the Brazos River Bottom, 1981-1983

Ethan C. Holt[1]

SUMMARY

Twenty-two new bermudagrasses and three standard cultivars were established in a replicated test in 1980. Due to weed competition and a very dry summer in 1980, some of the sources did not become well established until mid-spring 1981. Yields in 1981 reflect the slower establishment of sources such as Brazos, Tifton 44, B-11 and B-10. Several rapid starting hybrids produced more than 6 tons of forage in 1981. Yields in 1982 reflect to some extent stand damage from 5° F temperature in January. The highest yielding sources in 1982 were Coastal Pybas-1, Brazos and B-13 with more than 9.5 tons per acre. B-11 and B-13 exceeded 9 tons per acre in 1983. Most of the highest quality sources were damaged by the low temperature in the 1981-82 winter and did not recover sufficiently to be among the highest yielding sources. Brazos and Pybas-8 were among the sources showing the best combinations of quality, winter survival and yield.

INTRODUCTION

Bermudagrass is the most important tame pasture grass in Texas, and Coastal is by far the most important improved cultivar in terms of total acreage. Coastal has the potential for producing high yields and is responsive to fertilization, but forage quality does not meet the requirements of some classes of cattle, especially in mid-summer.

Research in recent years has shown that forage quality in bermudagrass can be improved through breeding. Improved quality is reflected, in turn, in increased animal performance. The important characteristics of an improved bermudagrass cultivar are higher dry matter digestibility, winter hardiness, ground cover density and stand maintenance under grazing, and yield. Coastal bermudagrass is a highly productive cultivar with adequate winterhardiness for most of the state and adequate ground cover to resist common bermudagrass invasion even under intensive

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KEY WORDS: Bermudagrass hybrids/ forage yield/ forage quality/ IVDMD/ winter damage.

grazing. Thus, Coastal serves as a standard for these characteristics. The major improvement needed over Coastal is forage quality and winter hardiness for North Texas.

A study was initiated in 1980 to evaluate 22 new genotypes of bermudagrass for some of the characteristics described above.

EXPERIMENTAL PROCEDURE

Twenty-two genotypes of bermudagrass not previously evaluated in Texas were made available for study in the spring of 1980. Fourteen of these are hybrids from the USDA bermudagrass breeding program at Tifton, Georgia (Dr. G. W. Burton) and eight originated from a field where an observation nursery had been grown previously on the J. Pybas ranch near Gainesville, Texas, as types surviving two preceding severe winters.

Four rooted sprigs were planted four feet apart in the center of 6 x 20 foot plots, 4 replications, on June 4, 1980. The plot area was treated with a preemergence herbicide following sprigging, but prostrate milkweed developed and competition retarded spread and ground cover development, especially in the slow spreading genotypes.

The test was harvested five times in 1981: May 13, June 30, July 30, September 11, and November 19; five times in 1982: May 11, June 11, July 29, September 13, and December 8; and five times in 1983: May 8, June 16, July 26, August 23 and October 7. Nitrogen was applied at the rate of 60 pounds per acre in late March and following the June 30 and September 11 harvests in 1981; 100 pounds N per acre in early May and 66 pounds per acre each in June and August 1982; and 100 pounds N per acre each on April 29, 1981 and 1982 and June 27, 1983. Forage samples were saved from each harvest except December 8, 1982, for analysis by the in vitro technique for dry matter digestibility.

RESULTS AND DISCUSSION

The production yields in 1983 (Table 1) of two sources, B-13 and B-11, exceeded 9 tons of forage per acre and five additional sources exceeded 8 tons per acre.

Total yields for each of the three years are shown in Table 2 along with the winter damage ratings. The average yields are not very meaningful for the reasons that some of the sources were slow starting and had low yields in 1981 but high yields in 1982 (e.g. Brazos, Tifton, and B-11), while some of the sources started rapidly, producing high yields in 1981, but were winter damaged and produced low yields in 1982 (e.g. B-3, B-4 and B-9).

While rapid production of a ground cover is an important characteristic, it is less important than low temperature tolerance and the ability to persist under close grazing. Many of the open-sod types such as Callie (not included in this test) will produce a very rapid ground cover but do not persist under close grazing. Also many of the open-sod types have good forage quality but are not winter hardy enough to persist in Central and North Texas.

Forage quality evaluations (in vitro dry matter digestibility) are given in Table 3. Two Burton hybrids had average digestibilities for 9 harvests of above 60 percent, each exceeding Brazos in average digestibility. However, winter damage was more than 70 percent on these hybrids in the 1981-82 winter. Brazos had the highest digestibility among sources sustaining relatively little winter damage in 1981-82.

The results of this experiment typify the problems inherent in improving bermudagrass. The more robust (large stems and wide leaves) stoloniferous types produce a more rapid ground cover but with less density, and generally have higher quality forage than the finer-stemmed types. Also, the robust, more rapid spreading and less winter hardy types generally have higher forage quality than the finer denser types. Brazos bermudagrass, released in 1982, represents a compromise in most of these characteristics. It has higher quality and slightly better low temperature survival than Coastal but produces a ground cover no more rapidly than Coastal. There are a number of hybrids that spread much more rapidly and have much higher quality but lack low temperature survival and ground cover density. Even though they are severely damaged in some winters they may produce as much forage as Coastal because of rapid stand recovery in the absence of competition. However, they are subject to invasion by Common bermudagrass when stands are thinned by winter damage or by close grazing. There are other types that produce a rapid cover and are winter hardy but do not possess the desired forage quality.

Additional hybrids are being developed with the objective of combining the desired characteristics of coed hardiness, rate of spread, quality, ground cover density and yield.

Table 1. Performance of bermudagrass cultivars (1980) at College Station, 1983

	Cultivar	May 9	June 16	July 26	Aug 23	Oct 7	Total
		Date of Harvest					
		pounds of dry forage per acre					
13	Burton 13	2461	3552 a-b	6123 a	3378 b-c	2866 a-d	18380 a
11	Burton 11	3252	3235 a-c	5992 a-b	2817 b-c	3022 a-c	18318 a
22	Pybas 8	2630	29586 e	3937 c-f	4508 a	2761 a-e	16794 a-b
7	Burton 7	2262	3073 a-d	4702 a-e	3788 a-b	2919 a-d	16744 a-c
24	Tifton 44	3264	3067 a-d	4409 b-f	3596 a-c	2306 b-f	16642 a-c
25	Brazos	2828	2713 b-e	5350 a-d	3238 b-e	2262 c-g	16391 a-d
15	Pybas 1	2364	3152 a-d	5244 a-e	3111 b-e	2433 a-e	16304 a-d
21	Pybas 7	2168	4273 a	3985 c-f	5292 b-c	2147 c-g	15865 a-d
9	Burton 9	1686	2353 b-f	5370 a-d	3322 b-c	3010 a-c	15741 a-d
8	Burton 8	2979	2779 b-e	5187 a-e	3220 b-c	1418 g-h	15583 a-d
16	Pybas 2	2066	3457 a-c	4484 a-e	3138 b-c	2164 c-g	15309 b-e
18	Pybas 4	2284	3090 a-d	4415 a-e	3315 b-c	2164 c-g	15268 b-e
23	Coastal	2598	2815 b-e	3846 d-f	2899 b-c	3010 a-c	15168 b-e
10	Burton 10	2340	2736 b-e	5674 a-c	2862 b-c	1322 h	14934 b-e
20	Pybas 6	2026	2863 b-e	4221 b-e	2465 a-e	2465 a-e	14499 b-e
17	Pybas 3	2236	3147 a-d	4024 c-f	2953 b-c	2015 d-h	14375 b-f
19	Pybas 5	2004	2763 b-e	4138 c-f	3040 b-c	2380 b-f	14325 b-f
1	Burton 1	1418	1718 e-f	3940 c-f	3478 a-c	3400 a	13954 c-g
14	Burton 14	2270	2209 d-f	4283 b-f	3221 b-c	1874 e-h	13857 c-g
4	Burton 4	2145	2344 c-f	3830 d-f	2934 b-c	2500 a-e	13753 d-g
12	Burton 12	1690	1911 d-f	5353 a-d	2914 b-c	1733 f-h	13601 d-g
6	Burton 6	1502	2537 b-f	5266 a-e	2600 b-c	1585 f-h	13490 e-g
5	Burton 5	2596	1354 f	2665 f	3048 b-c	3250 a-b	12715 f-g
2	Burton 2	2074	1748 e-f	3470 e-f	2564 c	2732 a-e	12588 f-g
3	Burton 3	2156	2231 c-f	3774 e-f	2481 c	1548 f-h	12198 g

Values in the same column with a common letter are not significantly different at the 0.05 level.

Table 2. Forage yield and winter survival of bermudagrass cultivars (1980), College Station,1981-83

	Cultivar	1981	1982	1983	Average	1981-82 Winter Damage
		------------Year--------------				
		-----------tons of dry forage per acre--------				1=least
13	Burton 13	8.3	9.6	9.2	9.4 a	4.3
15	Pybas 1	8.2	9.7	8.2	8.7 a-b	1.3
21	Pybas 7	8.7	9.2	7.9	8.6 a-b	1.8
16	Pybas 2	8.0	9.0	7.2	8.2 a-c	1.3
23	Coastal	6.5	10.6	7.6	8.2 a-c	4.0
6	Burton 6	8.6	9.0	6.7	8.1 b-c	6.0
7	Burton 7	7.8	8.0	8.4	8.1 b-d	5.3
18	Pybas 4	7.2	9.0	7.6	7.9 b-e	1.3
17	Pybas 3	8.0	8.8	7.2	7.9 c-e	1.3
22	Pybas 8	6.5	8.7	8.4	7.8 c-f	2.8
12	Burton 12	7.8	8.6	6.8	7.7 c-f	5.3
14	Burton 14	8.0	8.0	6.9	7.6 c-f	4.0
19	Pybas 5	7.7	7.6	7.2	7.5 d-g	1.3
1	Burton 1	8.2	7.4	7.0	7.5 d-g	8.5
9	Burton 9	7.7	6.7	7.9	7.4 d-g	7.8
25	Brazos	4.3	9.6	8.2	7.4 d-h	4.3
20	Pybas 6	6.9	8.0	7.2	7.4 d-h	2.3
11	Burton 11	4.0	9.0	9.2	7.4 d-h	5.0
10	Burton 10	5.3	8.9	7.5	7.2 e-h	2.5
8	Burton 8	6.2	7.4	7.8	7.1 f-h	7.5
4	Burton 4	7.2	6.6	6.9	6.9 f-h	5.8
3	Burton 3	7.0	6.5	6.1	6.5 g-h	7.0
24	Tifton 44	1.9	8.5	8.3	6.1 h	2.0
2	Burton 2	5.7	6.9	6.3	6.3 g-h	7.8

Average values with a common letter are not significantly different at the 0.05 level.

Table 3. Dry matter digestibility of bermudagrasses at College Station 1981-82

	Hybrid or Cultivar	Date of Harvest 1981 5/13	6/30	7/30	9/11	11/19	1982 5/11	6/11	7/29	9/13	Average
		% IVDDM									
3	B-3	63.2	65.1	58.7	66.9	55.6	59.0	63.8	60.1	58.8	61.2 a
2	B-2	65.2	64.6	59.1	65.9	55.4	54.6	62.5	61.8	58.4	60.8 a
9	B-9	62.0	60.8	53.5	65.8	52.9	57.4	69.4	60.5	54.8	59.7 a-b
1	B-1	64.1	64.5	53.7	62.4	54.3	55.8	67.4	57.8	55.5	59.4 a-b
4	B-4	64.4	62.7	57.0	62.0	52.2	50.8	62.0	58.5	56.5	58.4 a-c
6	B-6	62.5	59.6	52.8	63.7	50.0	56.2	62.7	56.4	53.4	57.5 b-c
8	B-8	63.5	62.5	50.9	58.8	53.2	52.6	65.1	54.2	55.1	57.3 b-d
25	Brazos	65.0	67.7	50.4	62.0	52.0	50.2	61.6	53.3	49.1	56.8 b-c
10	B-10	64.1	59.6	51.3	60.2	51.2	49.2	62.6	55.2	50.1	55.9 c-e
22	P-8	62.3	59.8	52.7	60.0	45.9	50.7	64.5	56.0	52.7	55.8 c-e
13	B-13	57.4	58.4	50.9	63.8	49.2	52.0	59.1	53.7	54.7	55.5 c-e
12	B-12	58.6	58.1	52.0	60.2	50.3	51.4	61.1	56.4	51.2	55.4 c-e
7	B-7	60.4	59.7	52.9	61.3	47.6	49.3	58.7	55.2	53.7	55.4 c-e
14	B-14	61.5	58.2	51.2	64.3	48.8	52.2	60.7	51.7	50.4	55.2 c-e
24	Tifton 44	65.7	60.2	50.3	58.8	51.4	51.0	60.0	52.3	50.1	55.1 c-e
16	P-2	62.2	56.9	53.0	61.0	47.8	49.9	58.7	51.2	54.2	55.0 c-e
20	P-6	62.0	58.5	54.5	61.9	42.4	48.7	60.9	53.9	51.9	55.0 c-e
19	P-5	61.0	57.5	50.2	61.7	46.8	49.3	59.7	55.2	52.0	54.8 c-e
18	P-4	60.1	56.5	53.2	62.0	47.3	49.2	62.2	54.2	48.2	54.8 c-e
15	P-1	59.8	56.0	53.8	61.1	48.6	47.0	61.4	52.9	51.9	54.7 d-e
11	B-11	62.4	56.0	50.2	56.0	51.1	49.8	64.1	51.8	49.2	54.6 d-e
17	P-3	58.6	56.2	53.3	58.0	49.5	51.4	58.4	52.5	51.9	54.4 d-e
23	Coastal	60.2	54.6	48.2	57.1	49.3	51.7	58.1	53.4	48.0	53.5 e
21	P-7	60.5	54.6	51.1	58.7	46.6	47.3	56.8	53.1	52.4	53.5 e

Average values followed by a common letter are not significantly different at the 0.05 level.

Response of Experimental Bermudagrass Hybrids and Cultivars to Defoliation Frequency

E. C. Holt and B. E. Conrad[1]

ABSTRACT

Eight Oklahoma bermudagrass hybrids not previously tested in replicated plots were evaluated beginning in 1981. Harvests were made at 3, 6 and 9 weeks frequency or ages at harvest. At least two hybrids were equal to Coastal in dry matter production and followed approximately the same response pattern as Coastal to frequency of harvest.

INTRODUCTION

More than 80 bermudagrass hybrids developed by the Oklahoma Agricultural Experiment Station have been screened for growth characteristics and forage quality. In the continuing search for hybrids with an acceptable combination of forage quality, winter hardiness, sod density and productivity, the hybrids with the best apparent combinations of these characteristics were tested further in a quantified yield test.

MATERIALS AND METHODS

A test was sprigged in July 1979 involving eight previously untested Oklahoma hybrids, two limpograsses, four standard cultivars (Coastal, Tifton 44, Callie, and Brazos), and 72-77 (a Burton hybrid with superior forage quality). The limpograsses and one Oklahoma hybrid (71-x-11-15) did not become established. Because of weed competition in 1979 and an extended drought period in 1980, the experiment was not harvested until 1981. Main plots were 18 feet wide and 20 feet long surrounded by an 8-foot alley maintained free of vegetation chemically. Each main plot was divided into 3 subplots, each 6 x 20 feet, for harvesting at 3, 6 and 9-week intervals. The main plots were randomized within each of 4 replications. There were 7, 4 and 3 harvests, and 9, 5 and 4 harvests at 3, 6 and 9 weeks of age in 1981 and 1982, respec-

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KEY WORDS: Bermudagrass hybrids/yield/forage quality/harvest frequency.

tively. The plots were fertilized at the rate of 80-00 in early April and 60-0-0 about June 1 and August 1 each in 1981 and 1982, and 100-0-0 each on April 26 and June 23, 1983. No irrigation water was applied during the study.

RESULTS

Forage yield data for 1981 are shown in Table 1. Average yields ranged from less than 5 tons per acre to more than 7 tons per acre. There were at least four individual cultivar-age combinations that exceeded 8 tons per acre. Coastal had the highest yield though not significantly different to Brazos and three Oklahoma hybrids. In general less frequent harvesting results in increased production.

However, in 1981 maximum yield was at the 6-week harvest frequency. Only one cultivar (LCB-11-13) had a higher yield at 9 weeks than at 6 weeks. Brazos showed less of a pattern with age than did most of the cultivars. Rainfall was very high in the spring and early summer of 1981 and harvests could not always be made on schedule. Thus, both the amount of rainfall and some failure in following the specified harvest schedule may have influenced the response to harvest frequency.

Forage yield data for 1982 are shown in Table 2. Average yields ranged from 3.4 tons to over 8 tons per acre. Brazos and Tifton 44 produced significantly less forage than Coastal, and Callie was the lowest yielding entry in the test. There was no difference in yield among the top 5 cultivars. LCB-11-6, the highest yielding cultivar in 1982, was the lowest yielding in 1981. LCB-6-18 was near the top both years and did not differ from Coastal in either year. Entry 72-77 performed very well in 1981 but was near the bottom in 1982. The yield of 72-77 in an earlier test was not outstanding but its quality was exceptional.

Yield increased with each increase in age at harvest in 1982. It is assumed that quality will decrease with advancing age. However, this study is being conducted, in part, to determine if all cultivars respond the same to advancing age.

Yields increased as time between cuttings increased in 1983 (Table 3), each three-week delay in cutting resulting in a 2000-pound increase in total yield for the season. The range in cultivar yields was approximately 5,000 pounds, LCB-11-6 which was the lowest yielding variety in 1981 producing the most dry matter in 1983.

Mean yields for the three years are shown in Table 4. Coastal had the highest average yield and Callie the lowest average yield. Brazos and Tifton 44 averaged about one ton less than

Coastal but did not differ significantly from Coastal. Two Oklahoma hybrids (LCB-6-18 and 71-x-3-6) produced essentially the same as Coastal and several did not differ significantly from Coastal. Further evaluations based on forage quality, quality patterns, sod density and persistence will determine whether they have any value. The three-year average yield response to age at harvest is shown more clearly in Figure 1a than in Table 4. The cultivar x age interaction approached significance ($p = 0.061$). All of the sources increased in yield between 3 and 6 weeks age at harvest but Brazos was the only source that increased between 6 and 9 weeks of age, and Coastal actually decreased to some extent. All of the sources except Brazos and LCB-11-13 increased in yield between 3 and 6 weeks of age in 1981 (Figure 2) and then decreased sharply between 6 and 9 weeks of age. Brazos produced the same at 3 and 6 weeks of age but decreased at 9 weeks of age. In 1983 all sources increased in yield from 3 to 9 weeks of age. Thus, the 3-year average yields for 9 weeks of age generally include a year in which 9-week yields were lower than 6-week yields and a year in which 9 week yields were higher than 6 week yields.

Forage quality (*in vitro* digestible dry matter) is shown for each harvest in 1981 in Table 5. Three-week old forage was generally quite high in digestibility and there was no major decline in the summer. Actually, two summer harvests were missed because of excessive rainfall between mid-May and mid-July. If those harvests had been made, more of a seasonal pattern may have been evident. Cultivars averaged across harvest dates and harvest ages showed a range of eight digestibility units with LCB-6-10 having the highest value (60.4%) and Coastal the lowest (52.5%).

The interaction of cultivars with age at harvest for IVDMD is shown in Figure 1b and was significant at the .05 level. Three cultivars (hybrids) showed a near linear decrease in digestibility from 3 weeks of age to 9 weeks of age (Coastal, LCB-11-6, 71-x-3-6). LCB-11-13 decreased slowly from 3 to 6 weeks of age and then decreased rapidly to 9 weeks of age. Four of the cultivars showed a quadratic response to age, decreasing rapidly from 3 to 6 weeks of age with little further decline to 9 weeks of age. These included Brazos and Tifton 44. These response patterns do not appear to be related to yield response to age at harvest in 1981 (Table 1). LCB-11-6 remained fairly stable over the range of 3 to 6 weeks of age which would appear to be a desirable trait if this pattern persists. On the other hand LCB-6-10 had as good quality forage as LCB-11-6 at six weeks of age though it had decreased between 3 and 6 weeks of age. LCB-6-10 would appear to be superior over a wide range of ages because of its high quality in the young stage and its relatively acceptable stabilized quality at advanced ages. However, LCB-6-10 was at the low end of yields of the hybrids in this study.

Table 1. Forage yield of bermudagrass hybrids and cultivars cut of different ages, 1981

Cultivar	Age (weeks) 3	6	9	Average
	pounds dry forage per acre			
LCB-6-10	10,660	13,990	7,170	10,607 g[1]
LCB-6-18	13,000	16,165	12,940	14,035 abc
LCB-6-35	9,860	12,640	10,130	10,880 efg
LCB-11-6	7,940	11,290	9,660	9,630 g
LCB-11-13	9,000	10,630	12,280	10,640 fg
71-x-3-6	12,860	16,500	12,315	13,890 abc
72-77	12,030	14,075	12,750	12,950 bcd
Coastal	16,250	16,215	12,485	14,980 a
Callie	10,750	13,910	11,700	12,120 def
Tifton 44	12,430	14,070	10,960	12,490 cde
Brazos	14,690	14,560	13,620	14,290 ab
71-x-9-6	12,550	18,290	12,795	14,545 ab
Average	11,860 b	14,360 a	11,570 b	

[1] Average values in the same line or column followed by a common letter are not significantly different ($P < 0.05$).

Table 2. Forage yield of bermudagrass hybrids and cultivars cut of different ages, 1982

Cultivar	Age (weeks) 3	6	9	Average
	pounds dry forage per acre			
LCB-6-10	7,930	11,510	14,320	11,250 bc[1]
LCB-6-18	11,010	15,660	18,360	15,010 a
LCB-6-35	9,205	13,050	13,760	12,005 b
LCB-11-6	12,430	17,420	18,580	16,140 a
LCB-11-13	11,120	17,320	16,130	14,860 a
71-x-3-6	11,670	14,020	18,770	14,820 a
72-77	6,340	9,640	13,070	9,680 c
Coastal	13,770	16,700	16,560	15,680 a
Callie	5,775	6,930	7,490	6,730 d
Tifton 44	9,475	13,710	14,320	12,500 b
Brazos	8,590	12,120	15,650	12,120 b
71-x-9-6	8,840	13,630	14,870	12,450 b
Average	9,800 c	13,480 b	15,175 a	

[1] Average values in the same line or column followed by a common letter are not significantly different ($P < 0.05$).

Table 3. Forage yield of bermudagrass hybrids and cultivars cut at different ages, 1983

Cultivar	--------Age (weeks)-------- 3	6	9	Average
	pounds dry forage per acre			
LCB-11-6	11046	17164	18380	15530 a[1]
LCB-11-13	13596	14428	15422	14482 a-b
LCB-6-18	12781	15238	15173	14397 a-b
71-x-3-6	10325	15803	16257	14128 a-b
LCB-6-10	8165	14516	18894	13858 a-c
Coastal	12574	12831	14232	13212 a-d
71-x-9-6	12400	10585	15741	12909 b-d
72-77	11476	12412	14301	12730 b-d
LCB-G-35	11658	11058	13767	12161 b-d
Tifton 44	9918	11717	13162	11599 c-d
Brazos	8668	10536	13821	11008 d
Callie	9567	9950	12324	10709 d
Average	11045 a	13020 b	15123 c	

[1] Average values in the same line or column followed by a common letter are not significantly different ($P < 0.05$).

Table 4. Forage yields of bermudagrass hybrids and cultivars cut at different ages, 1981-83

Hybrid or Cultivar	Age (weeks) 3	6	9	Average
	pounds dry forage per acre			
Coastal	14198	15250	14424	14624 a
LCB-6-18	12264	15686	15491	14480 a-b
71-x-3-6	11612	15450	15779	14280 a-b
LCB-11-6	10472	15291	15540	13768 a-b
LCB-11-13	11239	14126	14577	13314 a-b
71-x-9-6	11263	14168	14467	13309 a-b
Brazos	10649	12425	14364	12479 a-b
Tifton 44	10606	13166	12814	12195 a-b
LCB-6-10	8918	13339	13461	11906 b-c
72-77	9949	12044	13374	11789 b-c
LCB-6-35	10239	12249	12552	11680 b-c
Callie	8696	10263	10505	9821 c
Average	10842 b	13788 a	13946 a	

Average yields in a column or line followed by a common letter are not significantly different ($P < 0.05$).

Table 5. The effect of cultivar and age on bermudagrass forage digestibility (IVDDM) College Station, 1981

	Cultivar or Hybrid	% IVDDM									
		4/29	5/19	7/21	8/11	9/7	9/22	10/20	11/5	Average	Cultivar Average
						3 week frequency					
1	LCB6-10	62.0	68.7		63.0	68.1	66.6	66.1		65.7 a	60.4
2	LCB-6-8	61.4	67.7		64.0	67.5	66.3	62.6		64.8 a	58.6
3	LCB-G-35	65.7	64.7		61.3	61.4	62.8	65.2		63.5 a-b	59.0
4	LCB-11-6	64.0	68.3		64.5	63.6	63.5	64.1		64.7 a	59.1
5	LCB-11-13	64.4	64.4		59.5	64.0	61.9	60.5		62.8 a-b	59.1
6	71-x-3-6	55.7	63.3		65.1	64.8	59.2	56.3		59.6 c-d	52.7
8	72-77	67.0	66.5		63.1	66.5	65.7	62.7		65.2 a	59.2
9	Coastal	57.9	63.9		56.4	57.6	53.8	56.4		57.9 c-d	52.5
10	Collie	60.4	68.1		63.0	67.6	61.4	59.9		63.2 a-b	57.0
11	Tifton 44	61.4	61.4		58.8	60.8	48.8	53.8		57.5 d	53.7
12	Brazos	59.3	64.5		60.1	65.6	57.7	56.2		60.6 b-c	54.8
15	71-x-9-6	62.2	68.4		61.9	64.4	57.6	61.3		62.6 a-b	56.9
						6 week frequency					
1	LCB6-10		63.0			60.1		57.2	54.3	58.6 a	
2	LCB-6-10		55.8			61.6		53.9	52.9	56.0 b	
3	LCB-G-35		61.6			59.1		57.6	56.9	58.8 a	
4	LCB-11-6		58.3			62.9		57.1	60.6	59.7 a	
5	LCB-11-13		65.4			62.4		54.2	57.7	59.9 a	
6	71-x-3-6		54.3			57.3		51.0	52.4	53.8 b-d	
8	72-77		55.0			63.1		50.5	54.9	55.9 b	
9	Coastal		52.1			52.2		51.7	56.8	53.2 b-d	
10	Collie		62.0			57.9		52.6	50.1	55.2 b-c	
11	Tifton 44		54.4			49.8		55.4	52.1	52.9 c-d	
12	Brazos		51.0			59.5		50.1	47.1	51.9 d	
15	71-x-9-6		58.5			56.1		55.6	52.9	55.8 b	

Table 5 (Cont'd). The effect of cultivar and age on bermudagrass forage digestibility (IVDDM) College Station, 1981

	Cultivar or Hybrid	4/29	5/19	7/21	8/11	9/7	9/22	10/20	11/5	Average	Cultivar Average
		% IVDDM									
						9 week frequency					
1	LCB6-10			53.1			54.1		63.1	56.8 a	
2	LCB-6-8			47.6			56.1		60.9	54.9 a-b	
3	LCB-G-35			41.1			56.3		60.8	52.7 a-c	
4	LCB-11-6			46.8			51.4		60.7	53.0 a-c	
5	LCB-11-13			47.8			57.9		58.3	54.7 a-b	
6	71-x-3-6			41.2			49.3		51.4	47.3 d	
8	72-77			51.7			57.0		61.1	56.6 a	
9	Coastal			40.7			43.9		54.7	46.4 a	
10	Collie			48.9			55.7		52.8	52.5 b-c	
11	Tifton 44			45.1			50.2		57.1	50.8 c-d	
12	Brazos			44.9			54.9		56.0	51.9 c-d	
15	71-x-9-6			43.7			54.5		57.7	52.3 b-c	

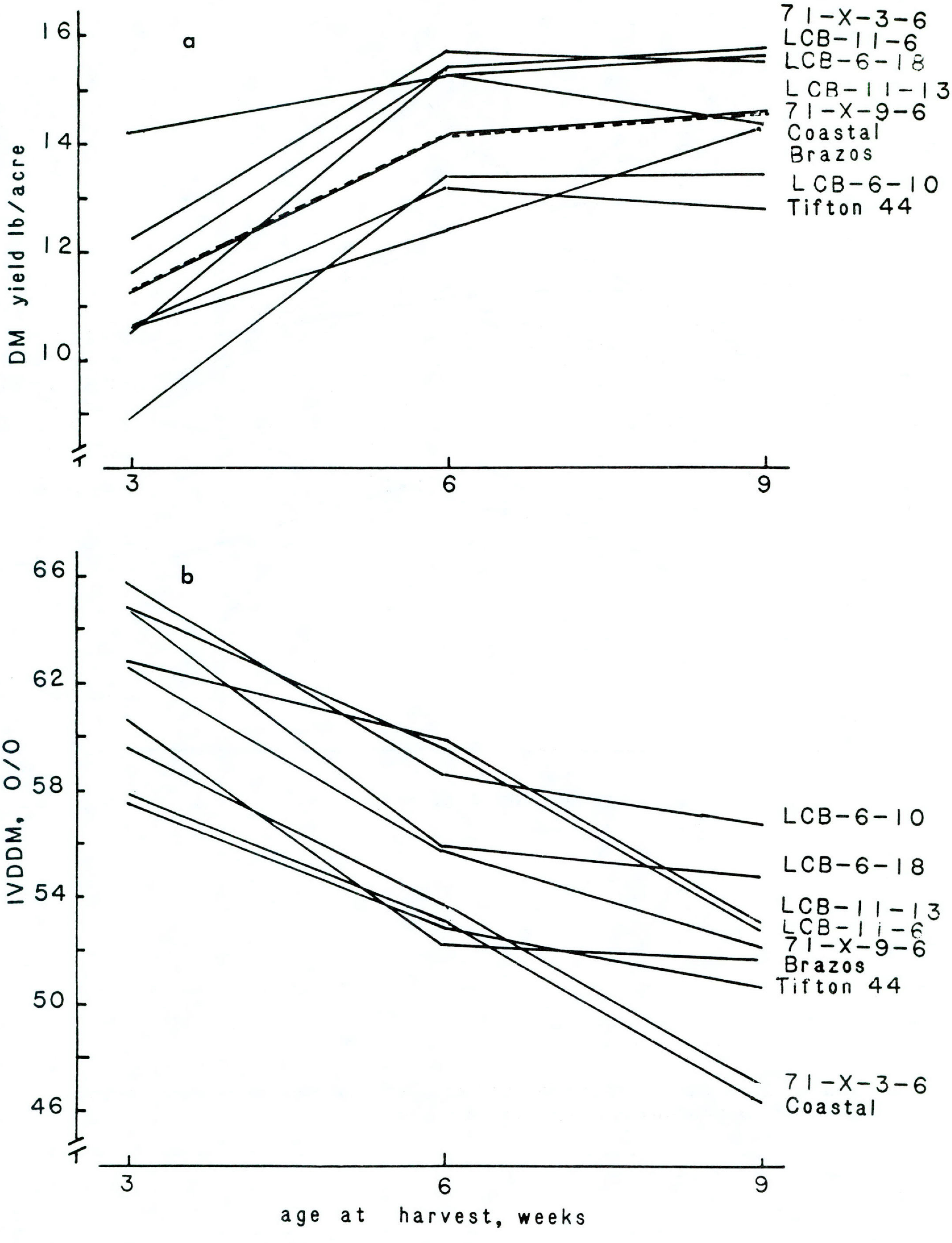

Figure 1. The influence of age at Harvest on three-year average dry matter yield (a) and 1981 forage quality (b) of selected bermudagrass.

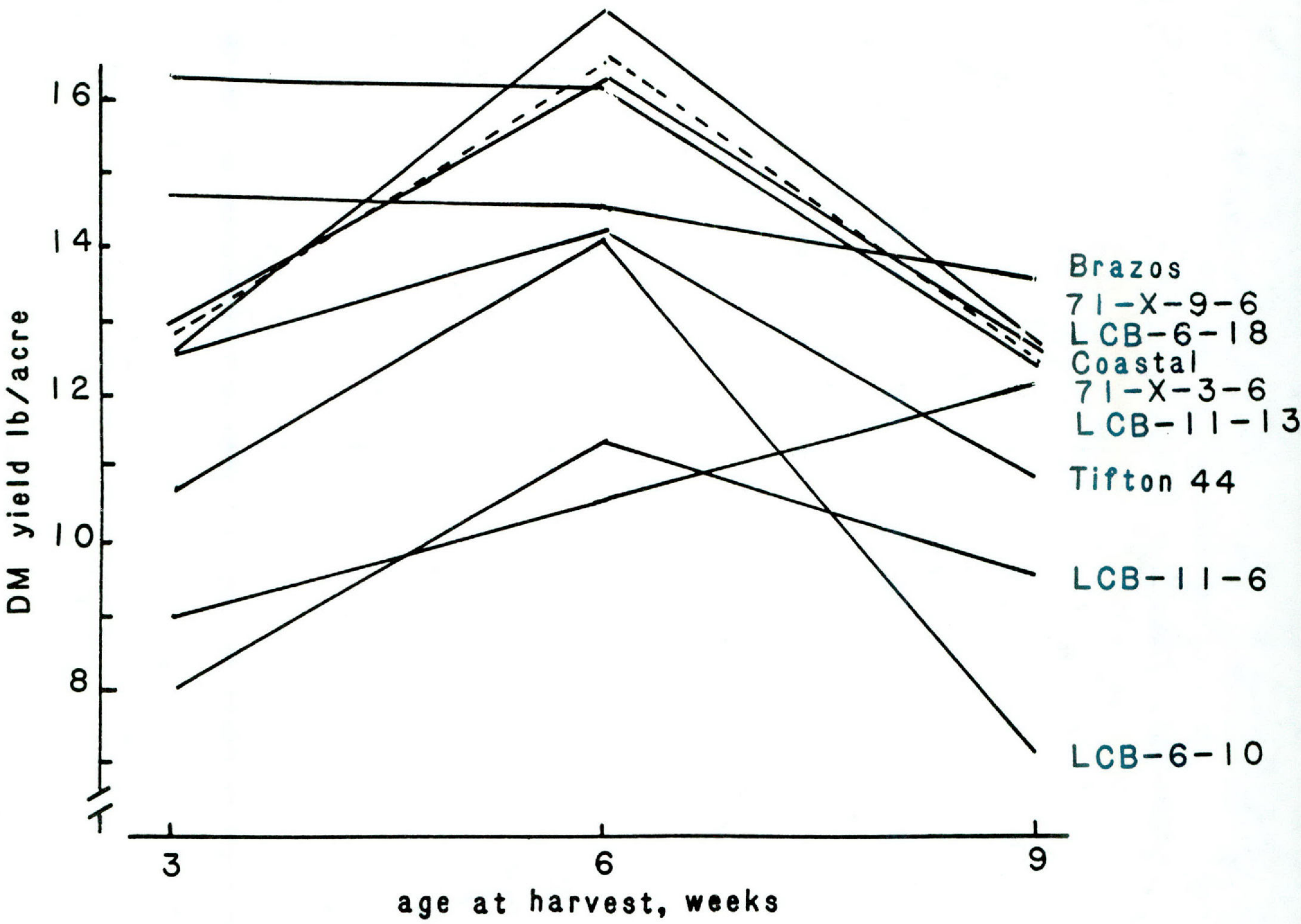

Figure 2. The influence of age at harvest on dry matter yield of bermudagrass hybrids in 1981.

Performance of Bermudagrass Cultivars (1982)

E. C. Holt and B. E. Conrad

SUMMARY

Fifteen bermudagrass hybrids not previously tested at College Station along with nine other previously tested hybrids and cultivars were evaluated for yield, low temperature survival and several agronomic characteristics. Yields ranged from 5 tons per acre to 10.6 tons per acre. At least three Georgia hybrids and all of Oklahoma origin hybrids including those with a previous P (Pybas) designation showed excellent field survival at -14°C temperature. Three Oklahoma hybrids and one Georgia hybrid numerically exceeded Coastal in dry matter yield. Tifton 78 (tested as Tifton 78-22) produced about 0.6 tons less forage than Coastal and was equal to Coastal in low temperature field survival.

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 in South Texas. Forage quality is equally important wherever bermudagrass is grown.

EXPERIMENTAL PROCEDURE

Fifteen bermudagrass hybrids not previously tested at College Station, six hybrids from previous tests, and three standard cultivars (Coastal, Tifton 44, Brazos) were planted in 1982. Sources with the prefix Tifton (Table 2) were supplied by Dr. G. W. Burton, Tifton, GA. Entries 6 and 7 are the same as B-1 and B-2, respectively, in the 1980 test (see report entitled "Performance of bermudagrass hybrids and cultivars in the Brazos

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KEY WORDS: Bermudagrass hybrids/ forage yield/ density/ forage quality/ low temperature survival.

River bottom, 1981-1983). All sources with the prefix 74 (Table 2, 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 Gainesvile, Texas where they had survived two severe winters. Plots, 6 x 20 feet, 4 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 pounds 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.

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 ranged from 5.1 tons per acre to 11.6 tons per acre in 1983 (Table 1). Coastal produced 10.1 tons, Tifton 44 8.8 tons and Brazos 8.0 tons of dry matter per acre. Neither Brazos nor Tifton 44 developed a good stand in 1982. Yields of these cultivars, and especially Brazos, were much lower than Coastal at the first two cuttings but exceeded Coastal at the final two cuttings. The somewhat slower rate of spread and the wider leaves and stems of Brazos are indicated in the data in Table 2.

The excellent cold hardiness of Brazos, all Oklahoma sources and all Phybas entries is shown in Table 2. Coastal and Tifton 44 showed excellent field survival but slightly less laboratory freezer survival than some of the other sources. Tifton 79-17, and 78-22 showed excellent field survival but less laboratory freezer survival than Coastal and Tifton 44. It would appear that most of the other Tifton sources lack adequate cold hardiness. Tifton 80-12 performed differently in the two cold tests. Only 47% of the material survived in the field but all of the live sprigs survived the laboratory test.

Tifton 78-22 was released by USDA-ARS and the Georgia Coastal Plain Experiment Station in 1984 as Tifton 78. It produced 9.5 tons of dry matter in 1983 compared with 10.1 tons by Coastal and was equal to Coastal in low temperature survival in the field. Georgia results indicate that it has somewhat higher dry matter digestibility than Coastal with about 10% better animal gains than from Coastal.

Table 1. Forage yield of bermudagrass cultivars at College Station, 1983

	Cultivar	Date of Harvest May 27	June 23	July 26	Aug 24	Sept 29	Total
11	Tifton 80-10	6651	3856	5493	3015	4284	23299 a
16	74-x-17-8	6272	3270	5332	3677	3563	22114 a-b
14	74-x-12-12	6011	3354	4430	3166	4067	21028 a-c
15	74-x-8-1	7111	3337	4338	2442	3630	20858 a-d
1	Coastal	5572	3410	5525	2175	3135	20117 b-e
19	74-x-11-2	4105	3454	4458	2754	4343	19114 c-f
3	Tifton 78-22	4581	3600	4468	2960	3389	18998 c-f
8	Tifton 79-17	6533	2128	3825	2302	3982	18770 c-g
5	Tifton 79-9	5921	2689	4219	2381	3292	18502 c-h
7	Tifton 79-16	5183	2385	3698	2301	4452	18019 d-h
18	74-x-19-1	4362	1984	4879	2487	4070	17782 e-i
2	Tifton 44	4682	2895	4380	2309	3424	17690 e-i
6	Tifton 79-13	5898	2374	3797	1748	3847	17664 e-i
17	74-x-9-1	3742	2774	4168	2985	3388	17057 f-i
22	Pybas 2	2816	2420	4558	2989	4241	17024 f-i
24	Pybas 5	2609	3199	4780	2943	3340	16735 g-j
20	Brazos	2269	2072	3877	3671	4118	16007 g-k
23	Pybas 4	2878	2597	3995	2635	3894	15999 g-k
10	Tifton 80-5	5072	2328	2964	2061	3147	15572 h-k
21	Pybas 1	2118	2216	3871	2702	4479	15386 i-l
9	Tifton 80-2	3717	2422	3530	2047	2822	14538 j-m
4	Tifton 79-6	3768	2156	2913	1872	2311	13020 l-m
13	74-x-12-1	4717	1647	2076	2411	1832	12683 m
12	Tifton 80-12	3225	2167	2085	1214	1446	10137 n

Total yields followed by a common letter are not significantly different at the 0.05 level.

Table 2. Agronomic Characteristic ratings of bermudagrass hybrids, 1983

	Cultivar	Agronomic ratings, fall 1983					Low temp. survival	
		Spread 1=best	Density 1=dense	Texture 1=fine	Vigor 1=best	Growth Habit 1=short	Field %	Freezer %
1	Coastal	3	2	1	3	3	97	72
2	Tifton 44	3	1	2	4	1	97	79
3	Tifton 78-22	2	3	2	3	3	100	43
4	Tifton 79-6	5	4	5	3	5	67	55
5	Tifton 79-9	2	4	4	2	1	100	53
6	Tifton 79-13	2	4	4	2	3	37	9
7	Tifton 76-16	3	3	4	3	3	33	70
8	Tifton 79-17	4	3	5	1	3	100	80
9	Tifton 80-2	5		5	1	5	40	58
10	Tifton 80-5	3	4	4	2	1	60	44
11	Tifton 80-10	3	4	5	3	2	50	40
12	Tifton 80-12	5	5	5	4	4	47	107
13	74-X-12-1	1	2	1	3	2	100	87
14	74-X-12-12	4	5	4	2	5	100	90
15	74-X-8-1	2	2	3	3	3	100	93
16	74-X-17-8	2	2	4	2	3	100	77
17	74-X-9-1	2	2	3	3	2	100	90
18	74-X-19-1	2	2	2	3	3	100	87
19	74-X-11-2	4	3	4	2	4	100	100
20	Brazos	4	3	3	3		100	90
21	Pybas 1	1	2	1	2	4	100	75
22	Pybas 2	2	2	2	2	4	100	97
23	Pybas 4	1	3	2	1	2	97	97
24	Pybas 5	2	2	4	2	4	100	97

YIELD EVALUATION OF BERMUDAGRASS SELECTIONS

F. M. Rouquette, Jr. and M. J. Florence[1]

SUMMARY

Sixteen bermudagrass hybrids were evaluated for seasonal and total dry matter production. Yields were taken by hand-clipping small areas within each plot. Complete plot defoliation was accomplished using cows and calves as mob grazers which allowed the plants to respond to grazing pressure rather than mowing pressure. Two-year average yields ranged from approximately 10 tons per acre dry matter for selections T-14, T-7, T-13, and Coastal bermudagrass to approximately 7 tons per acre dry matter for Tifton 44, T-2, T-8, and T-1. The lower yielding selections were either late in making an abundance of growth, were adversely affected by the drought-like conditions of late summer-early fall, or a combination of these factors. From this two-year trial, Tifton 44 does not appear to be a suitable replacement for Coastal bermudagrass when using total yield as the primary selection criterion.

INTRODUCTION

Previous research has shown that significant improvements in nutritive value may be made with hybrid bermudagrasses. However, since Coastal bermudagrass has been the most extensively used hybrid bermudagrass used in the Southeastern U.S., any bermudagrasses to be released as a new variety should be equal to or better than Coastal as a pasture or hay crop. This trial was initiated to evaluate bermudagrass hybrids for dry matter production, vigor, and stand maintenance, and to use both Coastal and Tifton 44 bermudagrasses as standards.

PROCEDURE

Fourteen bermudagrass hybrids from Dr. Glenn Burton's breeding program (USDA, Tifton, Ga.), along with Coastal and Tifton 44 bermudagrasses, were planted in 8'x20' plots. An 8' fallow border was left between all plots to prevent plot contamination from the vigorous, stoloniferous types. Plots were established in 1981 and were not harvested until the 1982 and 1983 growing season. Two, one square foot, quadrates were hand-clipped from each plot when grass reached approximately 8 to 12 inches in height. During 1982, plots were harvested to a 2" stubble height; whereas, in 1983, plots were harvested to ground level (0" stubble height). After collecting yield data from the plots, cows and calves were allowed to graze the entire

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KEYWORDS: Bermudagrass/yield/dry matter/vigor

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 allowed to grow until the next harvest period. Fertilizer was applied six times during the growing season for annual rates of 580-100-100 and 340-100-100 lbs/ac N-P_2O_5-K_2O, respectively for 1982 and 1983. A high nitrogen rate was used during 1982 to discourage spot grazing due to defecation areas. During the second year, however, spot grazing was not a problem in the plots.

RESULTS AND DISCUSSION

Seasonal and total dry matter production for the 16 bermudagrasses are shown in Tables 1 and 2. Although there were some rank changes between the two years, those selections which produced top yields during the first year repeated this trait during the second year. Similarly, those selections which were low yielders the first year were also in the same category at the end of the second year. Table 3 shows the two-year average dry matter produced from these plots. The two-year average ranged from approximately 10 tons dry matter per acre (11.5 tons hay) for selections T-14, T-7, Coastal, and T-13. Those selections which were in the bottom 25% of the group and produced a two-year average dry matter yield of 6½ to 7 tons were Tifton 44, T-2, T-8, and T-1.

Tifton 44 ranked at the bottom of the group primarily due to a lack of production in September and October. During these two years, these months were below normal in rainfall. Thus, it may be concluded that although Tifton 44, released originally as a replacement for Midland bermudagrass, may be more winter hardy than Coastal, it does not withstand drought-like conditions which occur in late summer and early fall. Visual observations have substantiated that Tifton 44 is not as drought-tolerant as Coastal bermudagrass on sandy, upland soil types. From the data collected in this two-year trial it may be further concluded that on a total yield basis, Tifton 44 may not be a good replacement for Coastal bermudagrass in the lower Southeastern U.S.

The use of "mob grazers" served as a useful method of evaluating grasses under the influence of grazing pressure, and also as a means of cleaning off plots after yield samples had been taken. However, this technique as employed in these two years of data collection has probably simulated a semi-haying condition or rotational grazing pattern rather than continuous grazing. This, plus the fact that additional data such as quality, vigor, and stand maintenance have not been included may alter the final rankings and conclusions concerning those bermudagrasses worthy of achieving varietal status.

TABLE 1. FIRST YEAR DRY MATTER PRODUCTION OF BERMUDAGRASS SELECTIONS[1]

SELECTION	5-5	5-27	6-15	6-30	7-20	8-10	9-7	10-17	TOTAL
	(lbs/ac)								
T-7	3136	1133	2458	1328	3024	2474	1261	2230	17044 a[2]
T-9	2240	858	2220	1491	3443	2525	912	2336	16025 b
Coastal	1792	1050	2842	1488	2848	2723	1232	1453	15428 c
T-13	2688	1120	2339	1315	2989	2202	1469	1216	15338 c
T-14	2272	1078	2166	1574	3024	2285	1114	1664	15177 c
T-12	2464	1174	2506	1341	2610	2093	918	1322	14428 d
T-4	2496	784	2291	1174	2295	2531	1021	1738	14330 d
T-11	1568	1008	2480	1370	2797	2202	810	1443	13688 e
T-3	2656	970	1603	1238	2650	1792	1187	1562	13658 ef
T-5	2304	1072	2115	1309	2470	2051	557	1491	13369 f
T-10	1824	807	1866	1305	2243	1402	1510	1033	11990 g
T-6	2080	893	1994	1062	1837	1610	643	1728	11847 g
Tifton 44	2240	1117	1498	1184	2406	1731	874	755	11805 g
T-1	1194	960	1696	1123	1767	1546	1264	1536	11086 h
T-8	1600	1001	1552	1078	2029	1693	813	362	10128 h
T-2	2048	765	1110	935	1715	1450	727	1274	10024 h

[1]Plots harvested to a 2" stubble height and fertilized with 580-100-100 lbs/ac $N\text{-}P_2O_5\text{-}K_2O$.

[2]Means in the same column with different superscripts differ ($P<.05$) according to Duncan's Multiple Range Test.

TABLE 2. SECOND YEAR DRY MATTER PRODUCTION OF BERMUDAGRASS SELECTIONS[1]

SELECTION	5-25	6-8	7-5	8-3	9-6	11-8	TOTAL[2]
	(lbs/ac)						
T-14	4006	2271	4510	5036	5098	4433	25354
Coastal	3670	2129	5110	4858	5040	3888	24695
T-13	3655	2304	4164	5256	5239	3855	24473
T-12	3694	1932	4555	5117	4630	3706	23634
T-7	3384	2009	4431	4714	4253	4297	23088
T-11	3744	1678	4670	4795	4723	3358	22968
T-9	2361	1747	4507	4819	4263	4750	22447
T-6	2774	1618	3929	4512	4997	3703	21533
T-10	3089	1836	3941	4210	3792	2789	19657
T-4	2086	1531	3696	3938	4198	3084	18533
T-5	1742	1488	4032	4279	3936	3043	18520
T-3	2033	1339	3271	3574	4253	3562	18032
T-2	2691	1218	3763	3543	3226	3168	17607
T-8	2585	1462	3883	3701	3552	2242	17425
Tif 44	3228	1788	4078	4051	3480	2537	16625
T-1	809	617	2911	3492	3240	3771	14840

[1]Plots harvested to ground level (0" stubble height) and fertilized with 340-100-100 lbs/ac N-P_2O_5-K_2O.

[2]Means in the same column with different superscripts differ ($P<.05$) according to Duncan's Multiple Range Test.

TABLE 3. TWO-YEAR AVERAGE OF BERMUDAGRASS YIELDS

SELECTION	Year 1	Year 2	AVERAGE
T-14	15177	25354	20266
T-7	17044	23088	20066
Coastal	15428	24695	20062
T-13	15338	24473	19906
T-9	16025	22447	19236
T-12	14428	23634	19031
T-11	13688	22968	18328
T-6	11847	21533	16690
T-4	14330	18533	16432
T-5	13369	18520	15945
T-3	13658	18032	15845
T-10	11990	19657	15824
Tif-44	11805	16625	14215
T-2	10024	17607	13816
T-8	10128	17425	13777
T-1	11086	14840	12963

Clover Variety Trials in Southeast Texas

Gerald W. Evers[1]

Summary

Varieties of eleven clover species were evaluated for forage production in the Upper Gulf Coast of Texas at Angleton. Subterranean clovers were the most productive species with 11 varieties yielding in excess of 5000 pounds dry matter per acre. There was an additional 2000 to 3000 pounds below the 1 inch cutting height at the last harvest. Of the other clover species, Bigbee berseem clover was the most productive with 5400 pounds per acre. Other high yielding clovers were Yuchi arrowleaf, Dixie crimson and red clover varieties.

Introduction

The combination of climate and soil types dictate which forages will grow in an area and how productive they will be. The better adapted a particular clover is, the less management (fertility, weed control, grazing systems, etc.) is required to maintain that forage. The climate of southeast Texas is subtropical in nature with annual rainfall ranging from 36 to 55 inches. Approximately 75 percent of the soils in the area have a claypan layer 10 to 14 inches below the soil surface. This claypan restricts the downward movement of water and root growth. It is responsible for the poor drainage in the winter and poor plant growth during low rainfall periods in the summer. Because of this unique environment, cool season annual clover variety trials were conducted to determine the best adapted cultivars for the area.

Procedure

Because of the large number of entries the subterranean clovers were in one test and all other clovers in a second test. Management practices and harvest dates were identical. The study site was a Lake Charles clay which was fertilized with 60 pounds of phosphorus and 40 pounds of potassium per acre before planting. Subterranean clovers were seeded at 20 pounds per acre. Seeding rates of the other clovers are reported in Table 1. All seed were inoculated with their proper Rhizobium strains using the Pelinoc-Pelgel system and planted on 15 Oct. 1982. Plots consisted of six-8 in. rows, 15 ft. long. Experimental design was a randomized block with four replications. One pound of Basagran per acre was applied on December 7 for broadleaf weed control. Plots were harvested with a flail mower at a 1 inch cutting height. Harvest dates were 14 Feb., 22 Mar., 15 May, and 8 June. Only the red clover cultivars were harvested on the last harvest date. Because of the prostrate

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KEY WORDS: Cool season annual clovers/forage yield.

type growth of subterranean clovers, a 12 x 16 inch sample of the forage below the cutting height was hand clipped after the last harvest.

Results and Discussion

Bigbee berseem, Dixie crimson, and Yuchi arrowleaf produced significantly more forage at the first harvest than the other clovers (Table 1). Early production is very important because it occurs at a time when livestock are normally fed stored forages and protein supplements. Previous studies at this location have shown Yuchi arrowleaf to have only moderate early production. The high yield at the first harvest in this study can be attributed to the unusually mild winter.

Bigbee berseem clover was the most productive clover in the study. It's seedling vigor and early production is impressive. At this time it appears to be adapted to a wide range of soils and climate conditions. Red clovers were the next highest yielding. Initial production is low but they will grow through the early summer if adequate moisture is available. April, May and June of 1983 were very dry with only .16, 1.45, and 1.68 inches of rain, respectively. Yields of the late maturing clovers such as red and arrowleaf were lower than normal because of the poor moisture conditions. Yuchi arrowleaf and Dixie crimson produce 4100 pounds per acre which was not significantly different from red clover production.

Entries of the subterranean clover variety test consisted of eight varieties from Australia, one from Mississippi, and five plant introductions selected by Dr. Ray Smith at the TAMU Res. & Ext. Center at Overton. Production at the first harvest of PI 168638, Woogenellup, Mt. Barker, Nungarin, and PI 184962 were equal to Bigbee berseem, Yuchi arrowleaf and Dixie crimson in the other variety test. Production of most subterranean clovers at the second and third harvest was equal to or greater than the other clover species.

Total dry matter production was closely related to maturity with the late maturing Tallarook and PI 168638 being the highest yielding. Nungarin, the earliest variety, was the least productive except for Clare. Larisa, and especially Clare, had poor stands due to low seed germination. Except for Nungarin, Larisa, and Clare, harvested forage of subterranean clovers equalled or exceeded other clovers.

The large amount of forage below the one inch cutting height at the last harvest was surprising. Dry matter per acre ranged from 2000 to 3000 pounds except for PI 209924. As subclovers mature, the stems and leaves form a thick mat on the soil surface. Even though livestock may not be able to utilize all of this forage, it can improve soil fertility. When added to the harvested forage, the total forage produced by the late maturing cultivars exceeded 8000 pounds per acre. High forage yields coupled with a unique form of seed production indicate a great potential for subterranean clover in southeast Texas.

Table 1. Production of cool season clovers at Angleton 1982-83.

Variety	Seeding rate	14 Feb.	22 Mar.	15 May	8 June	Total
	lb/ac	----	----	lb D.M./ac	----	----
Bigbee berseem	18	1316 a[1]	1492 bc	2564 a	0 c	5372 a
Nolin's red	12	588 c-f	1407 cd	2386 ab	568 b	4949 ab
Florie red	12	575 c-f	1035 ef	2228 a-c	869 a	4707 ab
Kenstar red	12	418 ef	1283 c-e	2068 a-d	735 a	4504 bc
Pawera red	12	379 f	1198 d-f	2056 a-d	752 a	4385 bc
Kenland red	12	596 c-f	1174 d-f	1769 c-e	752 a	4291 bc
Florex red	12	554 c-f	973 f	1960 b-d	768 a	4255 b-d
Tensas red	12	638 c-e	1236 c-f	1877 b-e	484 b	4235 b-d
Dixie crimson	18	1158 a	1698 b	1298 e-h	0 c	4154 b-d
Yuchi arrowleaf	9	1150 a	1237 c-f	1735 c-f	0 c	4122 b-d
Abon Persian	9	380 f	1186 d-f	2162 a-d	0 c	3728 c-e
Kondinin rose	18	784 bc	2021 a	658 i	0 c	3463 d-f
Wilton rose	18	544 c-f	1492 bc	1171 f-i	0 c	3207 e-g
Palestine strawberry	15	701 b-d	973 f	1343 e-h	0 c	3017 e-h
La. S-1 white	5	481 d-f	1258 c-e	1151 g-i	0 c	2890 f-h
Hubam sweetclover	15	892 b	561 g	1093 h-g	0 c	2546 gh
Lappa clover	5	690 b-d	671 g	1002 hi	0 c	2363 h

[1]Yields within a column followed by the same letter are not significantly different at the .05 level, Duncan's Multiple Range Test.

Table 2. Dry matter production of subterranean clovers at Angleton 1982-83.

Variety	14 Feb.	22 Mar.	15 May	Harvested forage	Forage below cutting height[1]	Total forage
	------------------------------------ lb D.M./ac.					------------------------------------
PI 168638	1412 a[2]	1832 a	3271 ab	6515 a	2322 ab	8837 a
Tallarook	1063 b-d	1876 a	3560 a	6499 a	2106 ab	8605 ab
PI 184962	1128 b-d	1909 a	3051 a-c	6088 ab	2664 ab	8752 ab
Mt. Barker	1148 b-d	1908 a	2911 b-d	5967 ab	2502 ab	8469 ab
PI 209924	588 f	1627 ab	3494 a	5709 bc	1674 b	7383 bc
Woogenellup	1307 ab	1840 a	2556 c-e	5703 bc	2808 ab	8511 ab
PI 239907	1056 b-d	1937 a	2666 c-e	5659 bc	2898 ab	8557 ab
Nangeela	1012 cd	1756 ab	2870 b-d	5638 bc	3006 a	8644 ab
Meteora	948 de	1908 a	2490 c-e	5346 bc	3132 a	8478 ab
PI 209927	729 ef	1522 ab	2909 b-d	5160 c	2826 ab	7986 a-c
Miss. Ecotype	906 de	1839 a	2281 e	5026 c	2790 ab	7816 a-c
Larisa[3]	270 e	1614 ab	2401 de	4285 d	2610 ab	6895 c
Nungarin	1148 b-d	1373 b	0 f	2521 e	2772 ab	5293 d
Clare[3]	933 de	1566 ab	0 f	2499 e	2700 ab	5199 d

[1]Estimated from a 12 x 16 in. sample.

[2]Values within a column followed by the same letter are not significantly different at the .05 level, Duncan's Multiple Range Test.

[3]Poor stand because of poor seed germination.

The Evaluation of Leucaena as a Warm-Season Legume

E. C. Holt and M. W. Michaud[1]

SUMMARY

Twenty-eight sources of *Leucaena leucocephala*, 6 sources of *L. pulverulenta*, and 2 sources of *L. retusa* were evaluated for vigor, winter survival, leaf percentage and yield and forage digestibility. *L. leucocephala* varied in total dry matter production from 4.7 and 10.7 tons per acre harvested monthly and bimonthly, respectively, to 1.6 and 1.8 tons. *L. pulverulenta* varied from 4.0 and 4.8 tons to 1.2 and 2.4 tons, while *L. retusa* generally produced less than 1.0 ton. At 4 weeks of growth leaves and succulent stems made up 71 to 48% of dry matter but at 8 weeks of growth, only 59 to 38%. All of the sources survived the mild winter of 1982-83. *L. retusa* showed recovery growth in March 1984 following a severe winter for this location. One source each of *L. leucocephala* and *L. pulverulenta* showed some growth initiation from below ground on April 1, 1984. Percentage survival and regrowth vigor of all accessions will be evaluated later in the spring but it appears that at least some accessions will survive most winters as far north as 31° latitude. Forage digestibility analyses are not completed.

INTRODUCTION

Most tropical legumes lack winter hardiness and therefore have limited usefulness in most of Texas. Several Leucaena species are native to Texas and may have potential value. Leucaena is a woody plant and will require special management both for stand survival and for accessibility of acceptable plant parts (leaflets) to grazing animals. It is a legume and, when inoculated and nodulated fixes nitrogen. The seed are of acceptable size for wildlife use. Thus, the plant has some dual use potential, but information must be developed on adaptation, establishment and management before that potential can be realized.

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KEY WORDS: Warm-season legumes/ Leucaena/ Drymatter production/ Clipping

MATERIALS AND METHODS

Thirty-six sources of three Leucanea species (leucocephala, pulverulenta and retusa) (Table 1) were established in the field at College Station by transplanting individual seedlings April 30, 1982. The seedlings were established in 10 plant plots 40 inches apart in 40-inch row spacings, 2 replications. Following irrigation for establishment the plants have been grown without irrigation or fertilization. Plant height was measured on August 11 and one-half (5) of the plants in each plot were cut back to a 12-inch height. Plant heights were again measured on November 13.

In March 1983 the old top growth on all plots was removed at a 12-inch height. Plants in one-half of each plot were cut on July 1, August 3, September 6 and September 30 while plants in the other half of each plot were cut on August 3 and September 30. Dry master yields were determined and a sample from each plot was separated into leaves and succulent stems versus hard stems to determine percentage of animal acceptable dry matter. The leaf and stem samples were saved for protein and digestibility analyses.

RESULTS

Plants had reached an average height of 4.5 feet with a range in height from 1.5 feet to 6.7 feet by August 10 (Table 2). The L. leucocephala sources were taller on the average than L. pulverulenta sources which were taller than the L. retusa sources. Also, five L. leucocephala sources had 5 to 35% of the plants in the bloom or late stages of maturity on that date.

One half of the plants were cut to a 12-inch stubble height on August 11. On November 13 regrowth of the cut plants had an average height of 4.6 feet with a range of 1.7 to 7.0 feet. Plants that were not cut during the growing season had an average height of 7.4 feet and a range of 2.9 to 11.0 feet. L. leucocephala plant heights generally exceeded L. pulverulenta which exceed L. retusa for both regrowth and uncut plants. The regrowth (plant height) following cutting is shown in Figure 1(a) as a percentage of the source making the most regrowth. The sources are arranged in decreasing order of regrowth. The L. retusa and four of the L. pulverulenta sources were in the ranges of 40 to 60% of the check (source 26). L. pulverulenta K340 (Hutton) was approximately 82% of the check. The relative ranking of uncut plant for increase in plant height after August 11 is shown in Figure 1b. A few of the L. leucocephala and most of the L. pulverulenta and L. retusa sources showed limited increases in plant height in late summer and early fall.

Almost all of the L. leucocephala sources had some plants with well developed seed pods by mid-November (Table 2) while only one L. pulverulenta source had plants in that stage and none of the L. retusa plants reached the flowering stage.

Dead tops of the plants were removed in March 1983. Essentially all of the plants survived the mild 1982-83 winter. Yield data were collected at monthly and bimonthly intervals beginning in July, 1983. Whole plant data are shown in Table 3. Two harvests at 8-week intervals resulted in 86% more dry matter production than four harvests at 4-week intervals. Yields in excess of 10 tons per acre were produced in two 8-week harvests while maximum yield were about 4.5 tons per acre with 4-week cutting intervals. Twenty-one L. leucocephala sources produced numerically more than the highest L. pulverulenta source, which follows the height pattern in 1982. The L. retusa sources were the lowest yielding materials in the test.

At eight weeks of age the woody stems of some sources exceeded 1 inch in diameter at the cutting height. Obviously, the woody material would not be acceptable forage. Leaf + succulent stem separations were made to determine the percentage of acceptable material in the harvested dry matter. The leaf material contains some petiole and succulent stem sections and represents an estimate of material acceptable to animals.

Material harvested at 4 weeks of age contained 60% leaf-succulent stems with a range of 34% to 71% while the 8-week material averaged 39% with a range of 27% to 52% (Table 3). There did not appear to be any appreciable relationship between yield or vigor among sources and percentage leaf-succulent stems. It is assumed that the leaf material and some succulent stems are acceptable to livestock and highly digestible. Much of the stem material even at 4 weeks would not be ingested by livestock because of its woody nature.

Since leaf-succulent stem material makes up the major component of usable forage, the yield of this material at 4 and 8 weeks of age was calculated from percentages and total dry weights (Table 4). Leaf-succulent stem yields ranged from 0.1 to 2.6 tons per acre at 4 weeks of age and 0.2 to 4.5 tons per acre at 8 weeks of age. While infrequent harvesting (8 weeks) versus frequent harvesting (4 weeks) resulted in an 86% increase in leaf-succulent stem percent, it resulted in a 23% increase in leaf-succulent stem production. Much of the growth after 4 weeks evidently was in the form of hard stems.

Ultimately it will be necessary to determine how to manage Leucaena to maintain stands and how to utilize it in a livestock program to provide an optimum amount of usable forage. These studies indicate that within a growing season, Leucaena plants will tolerate considerable defoliation. However, the effect of management on winter survival and on long-term survival of climatically adapted material must yet be determined and requires more comprehensive studies. At least one source each of _L. leucocephala_ and _L. pulverulenta_ showed some new growth from below ground on April 1, 1984. More detailed studies will need to be conducted on materials that have the ability to survive temperatures in the range of 10 to 15°F or lower.

Record of Fund Distribution

Item	Amount
Credit	
Grant	11239.12
Expenditures	
Salaries (Graduate Assistant)	3325.00
Wages (includes fringe benefits)	5770.46
Travel	0.00
Supplies and Materials	1626.45
Services	1057.88
Capital Equipment	0.00
Indirect cost	1465.00
	13244.79

Note: Expenditures above the grant amount were from other fund sources

Table 1 Identification of Leucaena materials in evaluation trials at College Station

ID No.	Species	PI, other accession no., and source[1]
1	L. leucocephala	PI 443614 3225 III (Florida)
2	L. leucocephala	78-24c Yucatan (Hutton)
3	L. leucocephala	PI 281607 2571 I (Florida)
4	L. leucocephala	PI 414742 2671 II (Florida)
5	L. leucocephala	K 132 U.H., Vera Cruz (Hutton)
6	L. leucocephala	N.E. Brazil (Hutton)
7	L. leucocephala	Tree at Mc Carty Hall, Univ. of Fla. (Florida)
9	L. leucocephala	PI 281784 2593 VIII (Florida)
10	L. leucocephala	PI 331797 2659 V (Florida)
11	L. Leucocephala	K72 U.H. Salvador (Hutton)
12	L. leucocephala	Campina grande (Hutton)
13	L. leucocephala	PI 322552 2657 IV (Florida)
15	L. leucocephala	78-10 Salvador, Sta., Cruz Portillo STA. (Hutton)
16	L. leucocephala	78-15 Salvador, Jocoro (Hutton)
18	L. leucocephala	Pinaciaba (Hutton)
19	L. leucocephala	78-11c Salvador, Sta. Cruz Portillo, Sta. (Hutton)
20	L. leucocephala	78-85 Colombia, Plamira (Hutton)
21	L. leucocephala	PI 415703 2673 var. Cunningham (Florida)
22	L. leucocephala	PI 288004 2619 VIII (Florida)
23	L. leucocephala	K-8 Salvador (Hutton)
24	L. leucocephala	K341 Hawaii-Hawaii Island (Hutton)
26	L. leucocephala	Colombias no espinal Colombia-common (Hutton)
27	L. leucocephala	78-50 Tuxtla, Chiapas, Mexico (Hutton)
30	L. leucocephala	Belem (Hutton)

[1] Information in parenthesis indicates location or person supplying the seed.

Table 1 Identification of Leucaena materials in evaluation trials at College Station (Continued)

ID No.	Species	PI, other accession no., and source[1]
33	L. leucocephala	PI 3043650 3642 VI (Florida)
34	L. leucocephala	U.H., Australia, K4 (Hutton)
35	L. leucocephala	78-30 Yucatan (Hutton)
36	L. leucocephala	78-19 Belize (Hutton)
8	L. pulverulenta	Lot #0999 (TX A&I, Peter Felker)
14	L. pulverulenta	Lot #1000 (TX A&I, Peter Felker)
17	L. pulverulenta	AJO 3279 (Hutton)
29	L. pulverulenta	K340 (Hutton)
31	L. pulverulenta	Lot #1001 (TX A&I, Peter Felker)
32	L. pulverulenta	Lot #1002 (TX A&I, Peter Felker)
25	L. retusa	(Collected from Abilene ST School - orig. from Juntion, Kimball Co.)
28	L. retusa	(Ueckerd collected 11-26-80, 11 miles S. of Balmorhea, Texas)

[1] Information in parenthesis indicates location or person supplying the seed.

Table 2. Average plant heights and stage of maturity

ID No.	Species	Height ft. Aug 10	Height ft. Nov. 13 Regrowth	Height ft. Nov. 13 uncut	Maturation stage % Aug 10 Flower +	Maturation stage % Uncut plants Nov. 13 Veg	Maturation stage % Uncut plants Nov. 13 Flower	Maturation stage % Uncut plants Nov. 13 Pod
1	L. leucocephala	5.2	5.5	8.4	5			100
2	L. leucocephala	4.7	5.0	6.8	0	50	10	40
3	L. leucocephala	4.9	4.7	7.4	0	60	10	30
4	L. leucocephala	4.7	5.6	8.3	0			100
5	L. leucocephala	4.7	5.2	9.3	0	60		40
6	L. leucocephala	5.2	6.1	9.7	0	10		90
7	L. leucocephala	5.0	5.0	8.8	0	50		50
9	L. leucocephala	2.7	3.3	5.0	5	10	10	80
10	L. leucocephala	6.5	5.3	8.9	0	50		50
11	L. leucocephala	5.4	5.2	8.2	0	100		
12	L. leucocephala	5.9	6.2	9.6	0	50	10	40
13	L. leucocephala	4.8	4.3	6.4	0	80	20	
15	L. leucocephala	5.2	5.7	10.1	0	80		20
16	L. leucocephala	6.6	6.2	11.0	0	90	10	
18	L. leucocephala	5.3	5.0	7.2	0	90	10	
19	L. leucocephala	4.8	4.7	7.0	40	10	40	50
20	L. leucocephala	3.7	4.0	6.1	30	10		90
21	L. leucocephala	4.8	4.9	6.2	0	50		50
22	L. leucocephala	3.4	3.2	4.7	35	40	10	50
23	L. leucocephala	6.7	5.9	10.6	0	10	20	70
24	L. leucocephala	5.9	4.9	10.0	0		20	80
26	L. leucocephala	5.8	7.0	9.1	0	20	30	50
27	L. leucocephala	5.7	5.2	10.1	0	50	10	40
30	L. leucocephala	4.6	4.4	7.0	0	60		40
33	L. leucocephala	3.6	3.7	5.9	0			100
34	L. leucocephala	4.5	4.7	8.9	0	50		50

Table 2. Average plant heights and stage of maturity (Continued)

ID		Height ft.			Maturation stage %			
			Nov. 13			Uncut plants		
					Aug 10	Nov. 13		
No.	Species	Aug 10	Regrowth	uncut	Flower +	Veg	Flower	Pod
35	L. leucocephala	4.5	4.2	8.6	0	10	10	80
36	L. leucocephala	4.0	4.6	7.9	0	10	50	40
8	L. pulverulenta	2.2	3.1	4.1	0	100		
14	L. pulverulenta	4.6	4.7	7.8	0	50	30	20
17	L. pulverulenta	3.8	4.1	6.2	0	100		
29	L. pulverulenta	4.2	4.2	6.5	0	80	20	
31	L. pulverulenta	2.7	2.6	4.5	0	100		
32	L. pulverulenta	2.7	2.5	3.9	0	100		
25	L. retusa	2.2	1.7	2.9	0	100		
28	L. retusa	1.5	1.9	3.7	0	100		

Table 3 Yield and percentage of leaves and succulent stems of Leucaena species harvested at two frequencies, 1983

Source ID	Species	PI or source	DM yield 4-wk	DM yield 8-wk	DM yield avg		Percentage leaves and succulent stems 4-wk	Percentage leaves and succulent stems 8-wk	Percentage leaves and succulent stems avg
			--------tons/acre---------				-----------%-----------		
5	L. leucocephala	K123 UH	4.1	10.7	7.4	a	58	38	48
18	L. leucocephala	Pinaciaba	3.5	10.6	7.1	a-b	69	42	56
3	L. leucocephala	281607	4.4	9.6	7.8	a-c	55	41	48
15	L. leucocephala	78-10 Salvador	4.1	9.5	6.8	a-d	57	36	47
7	L. leucocephala	Univ. Fla.	4.4	9.1	6.8	a-d	55	36	46
6	L. leucocephala	N. E. Brazil	4.7	7.9	6.3	a-e	56	36	46
11	L. leucocephala	K-72 UH	4.2	7.3	5.8	a-f	53	35	44
23	L. leucocephala	K-8 Salvador	3.3	8.0	5.7	a-f	60	36	48
16	L. leucocephala	78-15 Salvador	4.0	7.2	5.6	a-f	53	35	44
12	L. leucocephala	Campina grande	4.3	5.9	5.1	a-g	56	35	46
26	L. leucocephala	Colombia	2.9	7.2	5.1	a-h	54	33	44
1	L. leucocephala	443614	3.6	6.4	5.0	a-h	58	41	50
10	L. leucocephala	31797	3.3	6.3	4.8	b-i	53	36	45
30	L. leucocephala	Belem	3.6	5.8	4.7	b-j	56	36	46
27	L. leucocephala	8-5- Taxtia	3.1	5.8	4.5	c-j	65	39	52
21	L. leucocephala	415703	3.1	5.6	4.4	d-j	59	52	56
24	L. leucocephala	K341 Hawaii	4.4	4.2	4.3	d-j	55	33	44
34	L. leucocephala	K4 UH	3.0	4.6	4.3	d-j	63	40	52
13	L. leucocephala	322552	2.7	5.7	4.2	d-j	55	34	45
4	L. leucocephala	414742	3.0	4.9	4.0	e-j	60	34	47
2	L. leucocephala	78-24c	2.7	4.5	3.6	f-j	68	40	54
33	L. leucocephala	304650	2.0	5.0	3.5	f-j	71	42	57
35	L. leucocephala	78-30 Yucatan	2.1	4.8	3.5	f-j	71	40	56
22	L. leucocephala	288004	1.8	4.3	3.1	g-k	64	40	52
36	L. leucocephala	78-19 Belize	2.8	3.3	3.1	g-k	61	40	51
20	L. leucocephala	78-15 Colombia	2.2	3.3	2.8	g-k	70	48	59

Table 3 Yield and percentage of leaves and succulent stems of Leucaena species harvested at two frequencies, 1983 (Continued)

			DM yield				Percentage leaves and succulent stems		
Source ID	Species	PI or source	4-wk	8-wk	avg	xxx	4-wk	8-wk	avg
			--------tons/acre--------				----------%----------		
9	L. leucocephala	281784	1.7	3.5	2.6	g-k	62	53	58
19	L. leucocephala	78-11 Salvador	3.2	1.8	2.5	h-k	60	40	50
17	L. pulverulenta	AJ03279	4.0	3.1	3.6	f-j	58	38	48
14	L. pulverulenta	Lot 1000	2.5	4.5	3.5	f-j	61	39	50
29	L. pulverulenta	K340	2.3	4.0	3.2	f-k	62	44	53
32	L. pulverulenta	Lot 1002	1.6	3.8	2.7	g-k	62	41	52
8	L. pulverulenta	Lot 0999	1.2	3.3	2.2	i-k	55	56	56
31	L. pulverulenta	Lot 1001	2.0	2.4	2.2	j-k	61	47	54
28	L. retusa	Junctron	0.3	1.1	0.7	k	60	31	46
25	L. retusa	Balmorhea	0.1	1.2	0.7	k	48	27	38

Table 4 Leaflet yield of Leucaena species harvested at two frequencies, 1983

Source ID	Species	PI or source	Leaf and succulent stems DM yield 4-wk	8-wk	avg
			----------tons/acre----------		
5	L. leucocephala	K123 UH	2.4	4.1	3.3
18	L. leucocephala	Pinaciaba	2.4	4.5	3.5
3	L. leucocephala	281607	2.4	3.9	3.2
15	L. leucocephala	78-10 Salvador	2.3	3.4	2.9
7	L. leucocephala	Univ. Fla.	2.4	3.3	2.9
6	L. leucocephala	N. E. Brazil	2.6	2.8	2.7
11	L. leucocephala	K-72 UH	2.2	2.6	2.4
23	L. leucocephala	K-8 Salvador	2.0	2.9	2.5
16	L. leucocephala	78-15 Salvador	2.1	2.5	2.3
12	L. leucocephala	Campina grande	2.4	2.1	2.3
26	L. leucocephala	Colombia	1.6	2.4	2.0
1	L. leucocephala	443614	2.1	2.6	2.4
10	L. leucocephala	31797	1.7	2.3	2.0
30	L. leucocephala	Belem	2.0	2.1	2.1
27	L. leucocephala	8-5- Taxtia	2.0	2.3	2.2
21	L. leucocephala	4157031.8	1.8	2.9	2.4
24	L. leucocephala	K341 Hawaii	2.4	1.4	1.9
34	L. leucocephala	K4 UH	1.9	2.2	2.1
13	L. leucocephala	322552	1.5	1.9	1.7
4	L. leucocephala	414742	1.8	1.7	1.8
2	L. leucocephala	78-24c	1.8	1.8	1.8
33	L. leucocephala	304650	1.4	2.1	1.8
35	L. leucocephala	78-30 Yucatan	1.5	1.9	1.7
22	L. leucocephala	288004	1.2	1.7	1.5
36	L. leucocephala	78-19 Belize	1.7	1.3	1.4
20	L. leucocephala	78-15 Colombia	1.5	1.6	1.6
9	L. leucocephala	281784	1.1	1.8	1.5

Table 4 Leaflet yield of Leucaena species harvested at two frequencies, 1983 (Continued)

Source ID	Species	PI or source	Leaf and succulent stems DM yield 4-wk	8-wk	avg
			----------tons/acre----------		
19	L. leucocephala	78-11 Salvador	1.9	.7	1.3
17	L. pulverulenta	AJO3279	2.3	1.2	1.8
14	L. pulverulenta	Lot 1000	1.5	1.8	1.7
29	L. pulverulenta	K340	1.4	1.8	1.6
32	L. pulverulenta	Lot 1002	1.0	1.7	1.4
8	L. pulverulenta	Lot 0999	.7	1.8	1.3
31	L. pulverulenta	Lot 1001	1.2	1.1	1.2
28	L. retusa	Junctron	.2	.3	.3
25	L. retusa	Balmorhea	.1	.2	.2

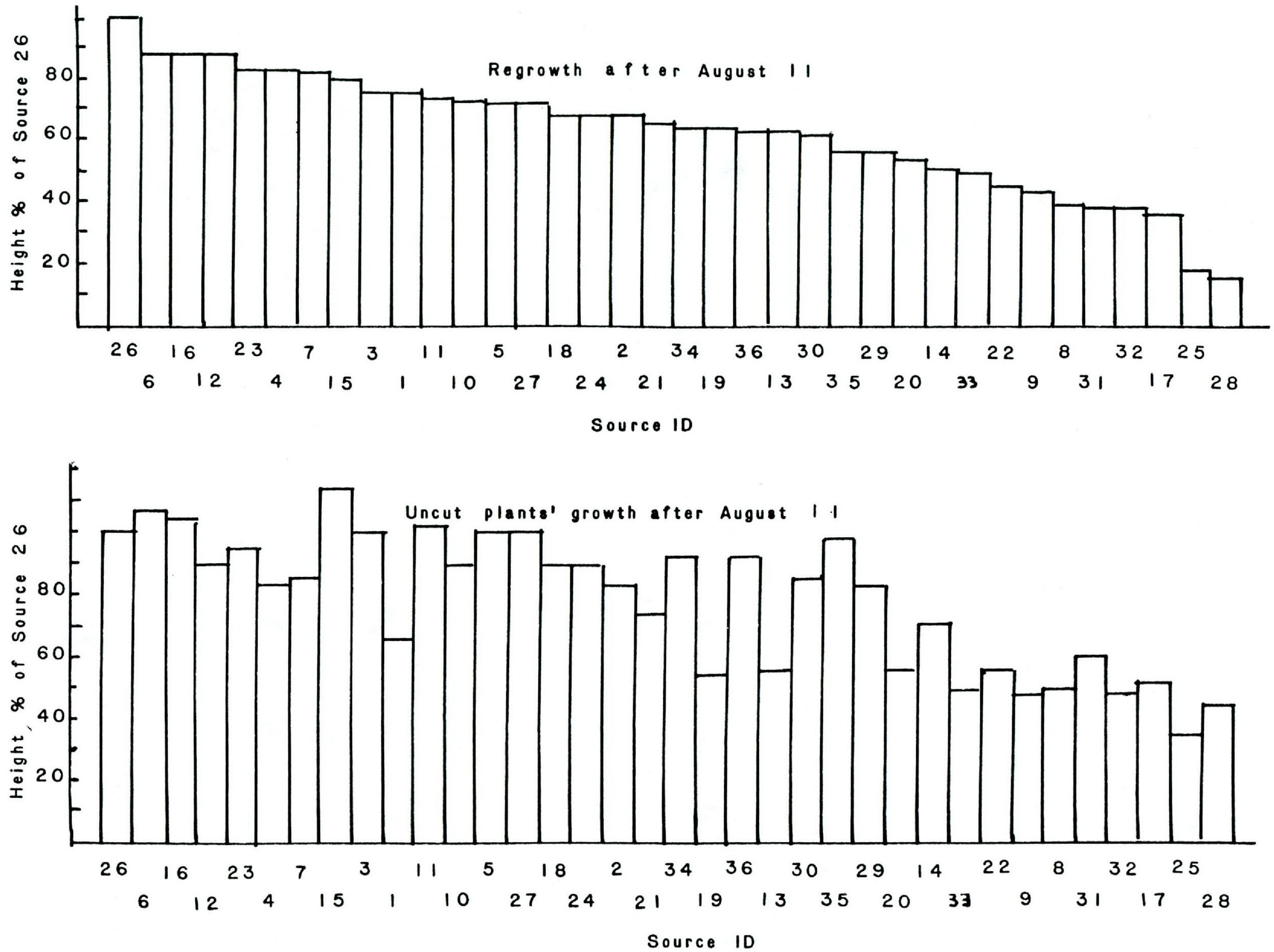

Figure 1. Relative growth and regrowth of Leucaena sources in 1983.

Germination of Four Warm-Season Legumes

Randy L. Dovel[1]

SUMMARY

The germination of four warm-season forage legumes was characterized at 20° and 30°C. The percent germination and time to reach 50 percent germination were determined for each temperature. Alysicarpus rugosus has a germination temperature requirement above 20°C. Desmanthus illinoenis, Leucaena leucocephala, and Rhynchosia minima had 59, 57, and 56 percent germination respectively. All species except R. minima declined in percent germination with decreasing temperature. The time required to reach 50 percent germination increased with decreasing temperatures for all species.

INTRODUCTION

The quality of warm-season grasses often drops below optimal production levels for most classes of animals and may drop below their minimal maintenance requirements in mid and late summer (Ellis and Lippke, 1976). The inclusion of legumes in warm-season forage production systems can increase animal performance (Whiteman, 1980). Legumes raise the protein content of the sward due to their ability to symbiotically fix nitrogen. The dry matter digestibility (DMD) of grasses and legumes may be similar in the early spring; however, grasses decline in DMD at a much faster rate than do legumes (Holt, 1977). Forage legumes are more highly digestible than warm-season grasses in mid and late summer and provide more energy per pound of forage for animal production.

From the above, the inclusion of legumes in forage production systems seems desirable. However, the establishment of several promising warm-season legumes has been difficult. Stylosanthes guianensis and Stylosanthes hamata emerge late in the growing season due to a high germination temperature requirement (Dovel, 1983). This requirement has also been observed in Alysicarpus vaginalis. Emergence at such a late date is detrimental to stand establishment because of competition with warm-season gasses, which begin active growth much earlier. Therefore, the ability of warm-season legumes to germinate and emerge at temperatures corresponding to those of early spring

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KEY WORDS: Warm-season legumes/ Seed germination/ Temperature requirements

would be a good criterion for the screening of warm-season legumes. In this study the rates of germination and percent germination of four legume species were examined at various temperatures.

MATERIALS AND METHODS

The legume species included in this study were Alysicarpus rugosus, Desmanthus illinoensis, Leucaena leucocephala, and Rhynchosia minima. Twenty six assessions of D. illinoensis were included, four of these assessions were divided into heavy, medium, and light seed lots. Eleven assessions of L. leucocephala were observed. Five assessions of L. leucocephala were divided into seed lots of different seed weights. Only one assession each of A. rugosus and R. minima was used in this study.

The seed of A. rugosus were mechanically scarified for twenty seconds. L. leucocephala seed were scarified in water heated to 80°C for three minutes. D. illinoensis and R. minima received no scarification treatment.

The seed lots were placed on moistened filter paper in petri dishes. They were treated with a two percent solution of Captan and placed in a growth chamber. The rates of germination were noted at constant temperatures of 30° and 20°C. Further observations will be made at 40°, 35°, 25°, 15°, and 10°. The seeds were allowed 14 days to germinate. Seeds were considered germinated when the radicle protruded 1 mm or more past the seed coat. Percent germination in 14 days and time required to reach 50 percent of that germination were determined. Fifty percent germination was defined as 50 percent of the total germination in each 14-day week period.

RESULTS AND DISCUSSION

All species except R. minima showed a decline in percent germination with decreasing temperature. A. rugosus declined sharply in percent germination, dropping from 98 percent germination at 30°C to only 4 percent, germination at 20°. D. illinoensis and L. leucocephala decreased in percent germination by 20 and 30 percent respectively. D. illinoensis and L. leucaeana exhibited variation within species in the decline of percent germination with decreasing temperature.

Decreasing temperature increased the time required to reach 50 percent germination in all species. The effects of decreasing temperature were most pronounced on A. rugosus, which took only 18 hours to reach 50 percent germination at 30°C but 240 hours at 20°C. The time required to reach 50 percent germination in L. leucocephala was increased from 61 to 240 hours; D. illinoensis showed an increase from 12 hours to 75 hours. R. minima was the least affected, increasing from 18 hours to only 42 hours. Both D. illinoensis and L. leucocephala showed variability within species in the change in time required to reach 50% germination with decreasing temperature.

Although these results are limited in scope, several conclusions can be tentatively drawn from these findings. A. rugosus has a germination temperature requirement that is above 20°C. This would preclude its use as a warm-season forage legume in many situations due to late emergence after warm-season grasses are actively growing. All three of the remaining species studied germinated well at 20°C. Further testing at lower temperatures will be needed to better characterize their abilities to germinate under early spring conditions. Observations of the various assessions within D. illinoensis and L. leucocephala indicate that there is sufficient variability within each species to select for early spring germination. It must be reiterated that these results are incomplete and further testing and analysis of the data will be required before these conclusions can be substantiated.

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Table 1. Germination Characteristics of Warm-season Legumes

Assession	Percent Germination 30°C	Percent Germination 20°C	Hours to 50% Germination 30°C	Hours to 50% Germination 20°C
A. rugosus	98	4	18	240
R. minima	56	56	18	42
L. leucocephala				
81-1.2	74	77	60	216
81-1.3	82	73	45	216
81-1.0	98	82	72	216
81-11.1	80	63	60	240
81-11.2	92	84	60	240
81-13.3	66	63	60	216
81-17.1	84	39	60	264
81-17.2	88	69	60	264
81-17.3	94	61	60	264
81-19.1	46	1	72	240
81-19.2	52	1	72	288
81-19.3	46	3	84	288
81-20.2	90	37	72	288
81-20.3	96	51	60	264
81-22.2	90	47	48	264
81-26.0	94	59	36	264
81-35	70	21	72	288
81-100	100	91	36	192
Average	82	57	61	240
D. illinoensis				
80-1	90	68	12	96
80-2	58	46	12	90
80-3	86	78	12	84
80-4	68	64	12	90
80-5	36	24	12	120
80-6.1	80	60	12	120
80-6.2	70	76	12	96
80-6.3	80	60	12	72
80-7	86	74	12	48
80-8	66	68	12	84

Table 1. Germination Characteristics of Warm-season Legumes (Continued)

Assession	Percent Germination		Hours to 50% Germination	
	30°C	20°C	30°C	20°C
D. illinoensis (cont)				
80-9	90	80	12	48
80-10	62	56	12	90
80-11	78	80	12	48
80-12	82	56	12	96
80-13	70	70	12	84
80-14.1	88	86	12	120
80-14.2	86	82	12	96
80-14.3	94	76	12	90
80-16.1	80	56	12	60
80-16.2	90	64	12	60
80-17	68	48	12	66
80-19	60	42	12	66
80-20	70	66	12	48
80-21.1	76	76	12	84
80-21.2	84	80	12	60
80-21.3	88	70	12	66
80-22	78	68	12	60
80-23	82	68	12	60
80-24	68	66	12	60
80-25	86	30	12	60
80-27.1	36	20	12	84
80-27.2	38	38	12	96
80-27.3	52	28	12	60
Average	74	59	12	75

Seed Weight and Plant Vigor in Illinois Bundleflower

E. C. Holt[1]

ABSTRACT

Approximately 100 seedlings were started in cones in the greenhouse from each of 38 sources of Illinois bundleflower. Based on plant height per day of age, the top 10 seedlings from each source were transplanted to the field. Mature plant weight, seed yield, weight/seed, percent of heavy seed, and heavy seed weight were determined. Weight per seed, percent of heavy seed, and weight of heavy seed (wt/seed) were related to parent weight per seed. Seed yield and mature plant weight (vigor) showed no relationship to parent seed weight. These data indicate that selection for seed weight may be effective. The interrelationship of seedling vigor and mature plant vigor require more study. Further, a pilot study of seedling vigor using 1983 seed from 24 individual plants showed a good relationship of seed weight to seedling vigor.

INTRODUCTION

Illinois bundleflower has been recognized as having dual value; forage for livestock and seed for game birds. Additionally, it has the attribute of biological nitrogen fixation. Recent observations indicate that at least under some conditions, individual plants and possibly stands may be relatively short lived. It has also been observed to have relatively low yield potential. On the positive side, volunteer stands have been observed to develop fairly readily at least under cultivated and semi-cultivated conditions.

We assume that the potential use of Illinois bundleflower will be predominantly under range conditions and that establishment, and certainly reestablishment from volunteering, will be under competition conditions. Seedling vigor and/or other characteristics that enhance the survival and competitiveness will contribute to establishment.

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KEY WORDS: Desmanthus Illinois/ warm-season legume/ mature legume/ seed weight/ seedling vigor/ establishment

Earlier evaluations of some 30 collections indicated a wide range in vegetative and seed production. Seed from collections and individual plants in that evaluation form the base for this study, which has the objective of determining the potential for improving seed weight, uniformity of seed weight, seedling vigor, and mature plant vigor in Illinois bundleflower.

PROCEDURE

Based on previous studies and seed availability of Illinois bundleflower accession, fifteen original collections and additional individual selected parents within these collections contributed 38 parental sources for this study. Average seed weight (mg/seed) was determined for each source followed by germination of approximately 100 seed in individual cones that were 1 inch in diameter at the top and 7 inches long. Date of emergence was noted and seedling height measured at 14 days post emergence. The ten tallest seedlings from each source were saved and transplanted to the field.

At seed maturity in the field, plant survival was noted, plants were cut at about 1-1/2 inches above ground, and the harvested plant material dried and weighed. The harvested seed was threshed, cleaned in an air column to remove trash and weighed. Average weight per seed was determined. Light seed were removed from each sample in an air column and the weight of the remaining (heavy) seed determined. Weight per seed of the heavy seed was then measured. The values of the 10 progeny within a source were averaged to give a source value for each of the measured characteristics.

Twenty-four individual plants representing a range in plant size, seed yield and seed size in 1983 were chosen for a pilot study to evaluate the relationship of seed size to early seedling vigor. Single seed were germinated in cones as described above. Fifteen cones in each of two replications represented each source. The seedlings were removed at the ground level 14 days post emergence, fresh weight of individual seedlings and total dry weight of the 15 seedlings in each replication was determined.

Parent and progeny relationships were evaluated by correlation and regression analyses.

RESULTS

The progeny averages for sources varied for each of the characteristics measured or calculated (Table 1). Average plant weights varied from 7 grams to 58 grams while seed yields ranged from <1 gram to >10 grams. Average weight of clean seed varied more than average weight of the heaviest seed.

Correlation and regression analyses of these data are given in Table 2. There was a tendency for both the average weight of progeny seed and the average weight of the progeny heavy seed to be related to parent seed weight. While the relationship is not very close the data indicate some potential for improving seed size by selection which should enhance the gamebird value of the seed.

There was no relationship of progeny plant weight to parent seed size. There are at least two mitigating factors involved. The most vigorous seedlings were selected initially in each source and this could have reduced some of the potential differences in seedling vigor related to seed size. Furthermore, the plant weights are of mature plants and mature plant weight may show a poor relationship to seedling weight if conditions are suitable for seedling survival and growth.

Two relationships are shown between progeny measurements. In the relationship of seed yield/plant to percent of heavy seed and seed yield per plant to DM yield/plant, both the linear and quadratic relationships were significant. The rate of increase in seed yield declined with a high percentage of heavy seed to the point of decreasing with the highest percentage of heavy seed. If this relationship holds with further testing, it indicates some problem of producing a high yield of seed with a high percentage of heavy seed. However, the pattern may have developed through degree of determinancy. More determinate plants might be limited in the amount of large seed that could be matured at one time.

The second intraprogeny quadratic relationship is between seed yield per plant and DM yield per plant. However, the quadratic pattern is not very marked and seems to be brought about by one source which had by far the largest plants but not the highest seed yield per plant. Otherwise, within this population, seed yield increased as plant size increased. However, it may be possible for plant size to decrease with selection pressure for seed production and this relationship requires continuous monitoring.

Average 14-day post emergence seedling weight (Table 3) showed a good relationship to average weight of seed from which the seedlings were produced. Seedling size also differed within sources (Table 3). Seed from each source were selected randomly and not weighed individually. Thus, the variation within sources could not be related to seed size but likely much of the variation was probably due to seed size. Except for two sources, average seed seedling weight was less than 13 mg from seed weighing less than 5 mg (Figure 1). These data indicate that selection for seed size should be effective in increasing early seedling vigor as indicated by top growth. Further evaluation will determine whether root development is closely associated with top development.

Table 1. Illinois bundleflower progeny averages within lines for plant and seed measurements, 1983

	Source	Parent Seed wt.	Progeny survival	DM yield/ plant	Seed yield/ plant	Heavy seed yield/ plant	Percent heavy seed	Average seed wt.	Average wt.heavy seed
		mg/seed	%	g	g	g	%	mg/seed	mg/seed
1	00000	-	100	17	2.22	.45	20	5.03	6.28
2	80-11	6.88	100	17	2.78	.34	12	5.24	6.88
3	80-14	7.59	80	10	1.80	.21	21	5.73	5.71
4	80-15-10	6.58	80	20	2.65	1.07	40	4.96	5.80
5	80-15-18	6.31	90	19	2.63	.40	15	3.96	5.19
6	80-15-6	6.04	100	17	1.29	.13	10	3.91	6.46
7	80-15-9	6.93	100	23	4.10	1.01	26	5.38	5.96
8	80-16	6.98	90	23	5.95	2.73	46	5.15	6.30
9	80-16-2	7.03	40	8	.27	.04	15	4.21	-
10	80-16-3	7.34	90	33	12.29	5.56	45	5.62	6.31
11	80-17-7	6.06	80	28	4.56	1.33	29	4.63	5.88
12	80-17-2	6.81	80	20	2.89	1.89	65	3.56	5.36
13	80-17-3	6.70	90	31	3.38	.66	19	4.21	5.51
14	80-17-5	6.82	80	18	1.81	.17	9	3.50	5.23
15	80-18	9.07	100	11	4.19	.46	11	7.36	8.32
16	80-20	7.38	80	38	4.05	.60	15	5.84	7.33
17	80-20-1	7.31	80	11	3.23	.31	10	5.94	6.18
18	80-20-10	7.23	100	36	9.58	3.39	35	5.63	6.81
19	80-20-12	6.24	100	11	2.95	.74	25	5.62	7.10
20	80-20-3	6.70	90	37	8.94	2.23	25	5.47	6.54
21	80-20-5	6.82	100	42	8.03	3.02	38	5.75	6.76
22	80-20-7	6.67	100	37	10.54	3.57	34	5.57	6.72
23	80-21	6.93	100	7	1.18	.15	13	5.30	6.23
24	80-22	6.93	30	13	3.96	.10	2	4.29	-
25	80-23	6.99	80	13	5.75	1.72	30	4.74	5.84
26	80-24	6.86	70	10	4.36	2.17	50	5.32	6.10

Table 1. Illinois bundleflower progeny averages within lines for plant and seed measurements, 1983 (Continued)

	Source	Parent Seed wt.	Progeny survival	DM yield/ plant	Seed yield/ plant	Heavy seed yield/ plant	Percent heavy seed	Average seed wt.	Average wt.heavy seed
		mg/seed	%	g	g	g	%	mg/seed	mg/seed
27	80-25-1	6.90	100	27	5.30	2.30	43	4.07	5.37
28	80-25-14	6.31	100	21	4.68	1.15	24	4.80	5.64
29	80-25-3	7.05	90	9	1.55	.37	24	3.92	5.72
30	80-35	6.55	90	58	6.08	.87	14	4.99	6.55
31	80-35-3	-	90	18	3.32	.39	12	3.92	5.21
32	80-35-4	7.10	80	12	.77	.07	9	4.31	-
33	80-4	6.94	100	24	5.57	3.25	58	4.41	5.40
34	80-4-12	5.96	60	20	2.78	.43	15	3.97	4.93
35	80-4-3	6.97	50	12	2.07	.62	30	3.84	5.31
36	80-7	7.37	80	42	6.36	1.27	20	5.21	6.22
37	80-8	6.90	100	9	1.41	.15	10	5.02	6.11
38	80-9	6.90	90	17	2.88	1.20	42	5.37	6.52

Table 2. Regression analysis and R^2 values for selected relationships

		Coefficient for		
Regression	Intercept	X	X^2	R^2
Average seed wt. on Parent seed wt.	-0.134	0.907		0.34**
Average wt. of heavy seed on Parent seed wt.	0.156	0.660		0.27**
DM yield/plant on Parent seed wt.	0.0897	-0.061		0.015
Seed yield per plant on parent of heavy seed	-0.064	0.274	-0.003	0.26**
Seed yield/plant on DM yield/plant	-1.431	161.246	-708.854	0.53**

Table 3. The relationship of 14-day post emergence seedling weight to seed weight in Illinois bundleflower

Source	wt./seed	No. Seedlings	Green wt./seedling		Dry wt./seedling
			Range	average	average
	Mg	No.	Mg		
80-4-3-4	4.1	19	11.4 - 72.5	43.0	12.3
80-15-9-1	5.4	22	19.9 - 82.2	55.4	15.4
80-16-4	6.8	29	40.9 - 119.0	69.6	21.1
80-16-5	5.8	27	8.6 - 79.5	51.6	15.2
80-16-3-3	6.2	13	34.1 - 78.2	60.3	20.3
80-17-17-8	5.3	27	36.7 - 90.0	63.2	18.8
80-18-2	7.8	28	36.8 - 96.5	61.6	22.0
80-18-10	8.1	20	36.4 - 107.5	79.1	25.1
80-20-1-1	1.9	25	15.0 - 118.7	74.8	17.8
80-20-1-3	5.8	23	41.8 - 83.8	69.5	17.5
80-20-3-3	4.3	15	49.9 - 88.8	69.1	17.9
80-20-5-4	6.3	19	52.3 - 101.4	75.3	19.0
80-20-6	7.3	28	52.2 - 110.4	75.3	19.2
80-20-7-1	5.1	22	24.7 - 86.4	56.7	15.8
80-20-7-2	6.2	18	24.0 - 92.8	62.7	18.5
80-20-10-4	4.0	13	14.6 - 63.8	42.5	11.0
80-20-10-5	-	10	42.9 - 89.3	58.4	15.6
80-22-1	4.3	17	16.1 - 58.4	35.7	10.4
80-23-6	3.3	22	11.5 - 52.2	30.8	9.9
80-24-8	5.3	20	18.5 - 59.4	41.3	12.5
80-25-1-2	3.3	13	25.8 - 65.1	37.4	10.7
80-25-3-2	3.3	27	15.5 - 54.0	33.7	10.3
80-35-1	5.9	18	37.3 - 96.4	69.2	19.7
80-35-7	3.7	7	25.5 - 53.7	40.3	11.3
80-35(ck)	-	6	47.8 - 96.5	60.8	20.9

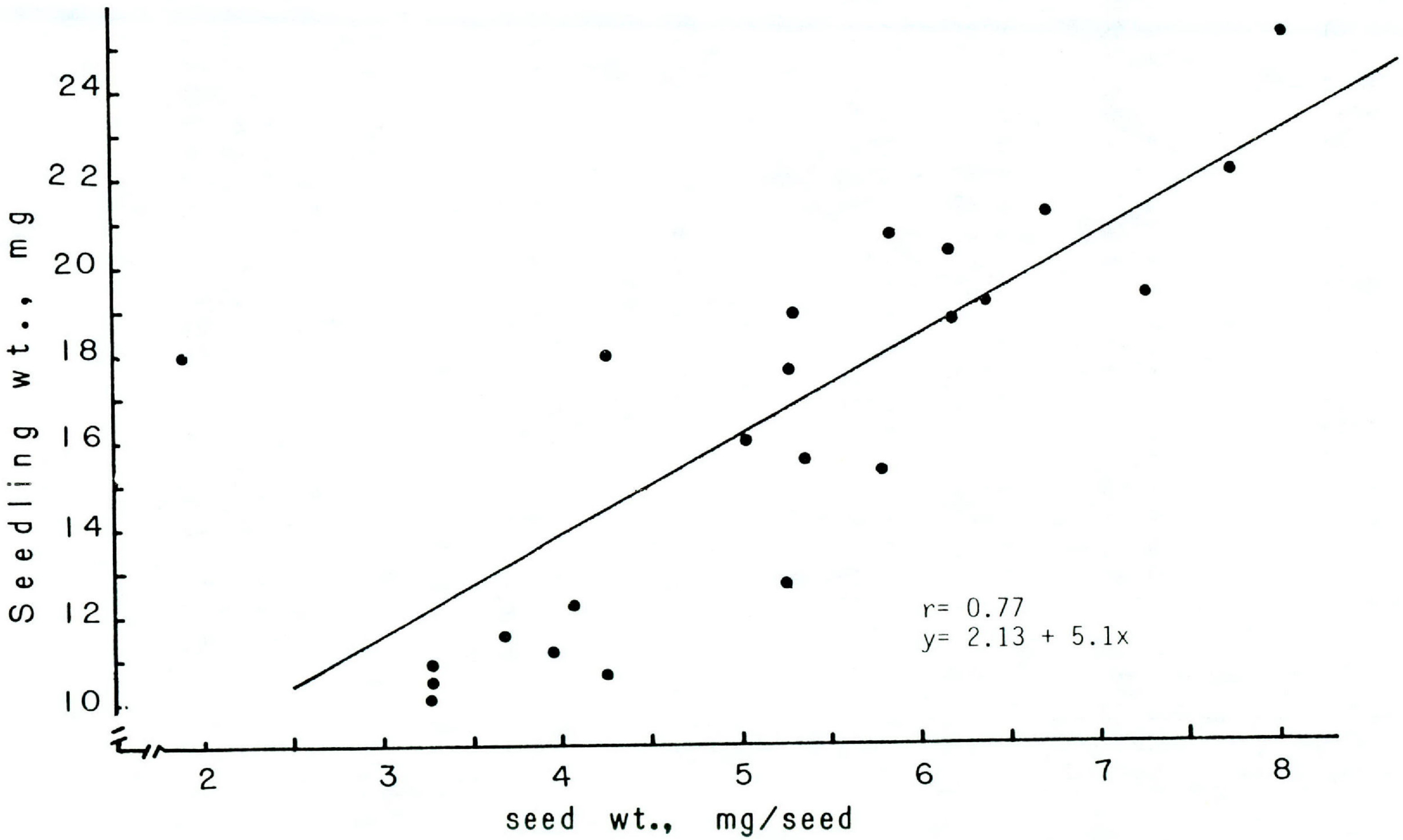

Figure 1. The relationship of Illinois bundleflower seedling weight to seed size.

Performance of Native Warm-season Legumes

E. C. Holt[1]

ABSTRACT

Species and varieties of eight genera of legumes native to Southern U. S. were evaluated for forage and seed production. Some of the varieties (Cunningham and K-8 Leucaena, Verano Stylo and Q-10042 Stylo) were introduced but all of the species are native. Following establishment in mid-June, some of the species had produced 1,000 to 1,500 pounds of dry matter per acre by September 1, and 100 to 225 pounds of seed per acre. Desmanthus, Rhynchosia, Dalea, Indigofera and Leucaena species were the highest yielding. Psoralea failed to survive and some sources of _Leucaena retusa_, _Stylosanthes hamata_, _S. scabra_ and _S. viscosa_ were low yielding.

INTRODUCTION

Warm-season legumes are needed to grow in mixed stands with warm-season and native grasses to contribute nitrogen to the ecosystem, possibly improve protein content of the total forage, and contribute high quality seed to wildlife (gamebird) diets. Introduced tropical legumes generally lack cold tolerance for survival in most of Texas. Warm-season annual legumes such as hairy indigo and alyce clover germinate too late in the spring for the seedlings to compete with actively growing warm-season grasses. Thus, native species seem to offer the best potential of meeting the need for warm-season legumes.

RESULTS

Yield data are shown in Table 1. While dry matter production was relatively low but, the plots were not established until June 13. Production in the range of 1,000 to 1,600 pounds in the 75-day period is acceptable in the presence of a relatively dry July and early August. Some entries of Dalea, Desmanthus, Indigofera, Leucaena, Rhynchosia, Stylosanthes exceeded 1,000 pounds per acre of dry matter production.

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KEY WORDS: Warm-season legumes/ Yield/ Seed production/ Adaptation

Sabine Illinois bundleflower was the highest yielding Desmanthus but Velvet bundleflower produced higher seed yields than Sabine. Velvet bundleflower makes prostrate growth and may be more resistant to defoliation than Illinois bundleflower.

Coast indigo has not been evaluated at this location previously. It made acceptable growth but matured little or no seed. Western indigo has performed well at locations further west and north but did not do well in this study.

The Leucaena species are native to Texas but leucocephala and pulverulenta apparently are winter hardy only in South Texas while retusa is hardy further north in the state. The Hawaii variety K-8 was the highest yielding. The native retusa sources developed very slowly. Retusa apparently is not very well adapted this far East (see Leucaena report).

Members of the genus Stylosanthes are found in Texas but not the species in this study. However, all the species in this study are found in Florida. Stylosanthes hamata 7838 is a native Florida fine stemmed type and was the highest yielding Stylosanthes in this study. Verano is an Australian variety and performed fairly satisfactorily. A previous study with Verano reported much higher yield but involved a longer growing season with irrigation. The highest yielding Stylosanthes scabra (Q-10042) also is an Australian variety.

Previously tested Stylosanthes species have not survived even relatively mild winters in Texas, and field seed germination from previous year shattered seed did not occur until about June 1. This test will determine whether native Stylosanthes species survive and/or volunteer earlier than the plant introductions.

The Desmanthus species and Rhynchosia texana were the only legumes producing significant amounts of seed. However, earlier establishment might result in better seed production.

This study indicates that silktop dalea, Velvet bundleflower, Coast indigo, Texas snoutbean and Stylosanthus hamata 7838, which had not been evaluated previously show promise for either forage production, seed production or both. Illinois bundleflower and least snoutbean, from earlier studies, produce acceptable yields of dry matter. Illinois bundleflower is also a good seed producer, but it loses vigor in the fall, often sheds its leaves, and may recover poorly in the spring. Illinois bundleflower has good seedling vigor and, because of high seed production, may reestablish stands from volunteer seedlings in the spring.

Table 1. Performance of Native and Introduced Warm-season Legumes, 1984

Species	Common Name	Source	Sept. 1 DM lb/ac	Sept 14 Seed lb/ac
Dalea aurea	Silktop Dalea	PMT-4131	1002	
Desmanthus illinoensis	Illinois bundleflower	Sabine(80-35)	1233	100
Desmanthus illinoensis	Illinois bundleflower	80-20	774	49
Desmanthus velutinus	Velvet bundleflower	80-28	636	204
Indigofera minita	Coast indigo	PMT-2528	1155	
Indigofera minita	Coast indigo	PMT-2535	915	7
Indigofera leptospala	Western indigo	PMT-1051	93	1
Leucaena leucocephala		K-8	1020	
Leucaena leucocephala		Cunningham	328	
Leucaena pulverulenta	Great leadtree		732	
Leucaena pulverulenta	Great leadtree	AJO-3279	155	
Leucaena retusa	Little leadtree	PMT-632	30	
Leucaena retusa	Little leadtree	Balmorhea	62	
Psoralea tenifolia	Slimleaf scurfpea	PMT-2280	93	
Psoralea tenifolia	Slimleaf scurfpea	PMT-4457	0	
Psoralea sp.	Slimleaf scurfpea	T-4151	0	
Rhynchosia minima	Least snoutbean	80-73	1636	8
Rhynchosia texana	Texas snoutbean	PMT-3100	1346	226
Stylosanthes hamata		Verano	810	3
Stylosanthes hamata		7303	221	
Stylosanthes hamata		7731	208	
Stylosanthes hamata		7742	107	
Stylosanthes hamata		7838	1073	
Stylosanthes viscosa		Q-10042	604	
Stylosanthes scabra		8250	87	
Stylosanthes scabra		8292	156	

CLOVER-GRASS MIXTURES AND NITROGEN RELATIONS

G. R. Smith, F. M. Rouquette, Jr., and R. W. Weaver[1]

SUMMARY

Sod-seeded arrowleaf clover, ryegrass and arrowleaf-ryegrass mixtures were compared under varying N fertility treatments. Sod-seeded subterranean (sub) clover and sub clover-ryegrass mixtures were compared to ryegrass with different N fertility treatments. Nitrogen fertilizer increased grass yields but had little effect on clover yields in pure stands. In mixtures of arrowleaf and ryegrass, nitrogen fertilizer depressed clover production, increased grass production and, at 100 lbs N/acre, increased total production only slightly. Ryegrass yield in clover-ryegrass mixtures was decreased compared to ryegrass receiving no nitrogen.

INTRODUCTION

Annual clovers are often planted in mixtures with ryegrass or other annual grasses. Recommendations for nitrogen fertilization of these clover-grass mixtures are varied. Relatively little is known concerning the effects of biological nitrogen fixation, in the clover-Rhizobium symbiosis, on nitrogen nutrition of associated grasses. The data reported here is the initial result of nitrogen cycling research with annual clovers and companion grasses. The objectives of this research were: 1) to determine the effects of fertilizer nitrogen on seasonal production of arrowleaf clover, ryegrass and arrowleaf-ryegrass mixtures; 2) to measure the effect of fertilizer nitrogen on botanical composition of arrowleaf-ryegrass mixtures; 3) to compare ryegrass yield at varying levels of N fertility to sub clover-ryegrass mixtures.

PROCEDURE

Arrowleaf clover, ryegrass and a mixture of arrowleaf and ryegrass were drilled into a Coastal bermudagrass sod in 5x15 foot plots November 2, 1981. Ryegrass was seeded at 25 lbs/acre and arrowleaf, inoculated with Nitragin type O peat inoculant, at 14 lbs/acre. Three hundred pounds per acre of 0-25-25 were applied prior to planting. One and one-half tons of lime were applied in late July. Three nitrogen (as ammonia nitrate) treatments were imposed on plots containing arrowleaf alone, ryegrass alone and a mixture of arrowleaf and ryegrass. Treatments included no nitrogen, 50 lbs N/acre applied Feb. 12, 50 lbs N/acre applied April 8 and 50 lbs N/acre applied both Feb. 12 and April 8 (100 lbs total). Plots were harvested four times

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KEYWORDS: Annual clover/clover-grass mixtures/nitrogen/sward composition/plant competition

beginning in mid-March. Botanical separations were made, each component was dried at 70°C for 48 hours and lbs DM/acre calculated.

Subterranean (sub) clover, ryegrass and sub clover-ryegrass mixtures were drilled into a native sod (common bermudagrass and Paspalum setaceum) in 5x7 foot plots October 13, 1982. Planting rates for the sub clover and ryegrass were 20 and 25 lbs/acre, respectively. The sub clover was inoculated with Nitragin type WR peat inoculant. Soil test ratings of phosphorus and potassium were low and medium, respectively. Soil pH of the Bowie fine sandy loam was 7.1. Four hundred and fifty pounds per acre of 0-20-20 fertilizer were applied prior to planting. The sod was mowed to two inches prior to planting. Ryegrass with five different nitrogen treatments was compared to sub clover alone and ryegrass-sub clover mixtures. The nitrogen treatments included 220 lbs N/acre applied in three split applications, 100 lbs N/acre applied in two split applications, 50 lbs N/acre applied Feb. 14, 50 lbs N/acre applied March 18 and zero nitrogen. The plots were harvested four times beginning in December.

RESULTS AND DISCUSSION

In the arrowleaf-ryegrass experiment, nitrogen application on ryegrass (RG) alone increased yields from 1282 to 3374 lbs DM/acre for 0 and 100 total lbs N/acre, respectively (Table 1). Nitrogen fertilizer on arrowleaf (AL) depressed clover yields but increased bermudagrass yields with the result that total forage yield from AL + 0 lbs N/acre was not different from AL + 100 lbs N/acre. Both early and late spring applications of 50 lbs N/acre depressed AL production and total plot yields were lower than on AL + 0 lbs N/acre (Table 1).

Arrowleaf clover production in AL + RG + 0 lbs N/acre was depressed due to competition from the grasses. As N levels were increased in the mixed plots, the clover component decreased. The late application of N on the mixture allowed more clover production than the early or the early and the late N treatments (Table 1).

Seasonal distribution of forage production from RG was affected by N fertilizer levels and time of application. Fifty lbs N/acre applied to pure ryegrass in early spring resulted in production more evenly distributed over the season than 50 lbs N/acre applied late (Table 2).

Total dry matter yield (including both clover and Coastal bermudagrass) from AL plots was not affected by N applications. Slight depression of yield at the April and May harvests was noted on AL plots receiving N fertilizer. Forage yield was increased at the last harvest of AL + 100 lbs N/acre primarily due to response of Coastal bermudagrass to the available N (Table 2). Total forage yield from AL + RG + 100 lbs N/acre was higher than AL + RG + 0 lbs N/acre or AL + RG + 50 lbs N/acre (Feb.). No significant differences were noted between AL + RG + 100 lbs N/acre and AL + RG + 50 lbs N/acre (April) or AL alone with no nitrogen. Nitrogen applied early (Feb.) to the mixture resulted in yield depression at the May harvest (Table 2). Arrowleaf + ryegrass with 0 lbs N/acre produced slightly less total forage than AL + 0 lbs N/acre.

Sod-seeded mixtures of Mt. Barker sub clover and ryegrass with no N produced total forage yields equal to ryegrass + 220 lb N/acre (Table 3). These ryegrass yields were lower than normal considering the quantity of N applied. Late planting and competition from the sod may account for these differences. Mt. Barker sub with 0 lbs N/acre produced more clover than the Mt. Barker-ryegrass mixture, but total forage yields were not significantly different. Ryegrass-Nungarin sub clover (an early variety of sub) produced less forage than Mt. Barker sub or Mt. Barker-ryegrass mixture. Nungarin sub clover matures and dies too early to take advantage of our growing season.

The data examined in these two experiments indicated that ryegrass grown in combination with arrowleaf or sub clover did not benefit from the association. The ryegrass yield component in clover-ryegrass mixtures was depressed compared to ryegrass alone + 0 lbs N/acre. This was a plant competition effect. Nitrogen applied to AL + RG mixtures depressed clover production, increased grass production and at high N rates, increased total production. However, N fertilized AL + RG mixtures were not significantly higher in total season dry matter yield compared to AL + 0 lbs N/acre.

TABLE 1. THE EFFECT OF NITROGEN APPLICATIONS ON COMPONENT FORAGE PRODUCTION OF ARROWLEAF CLOVER, RYEGRASS, AND ARROWLEAF RYEGRASS MIXTURES OVERSEEDED ON COASTAL BERMUDAGRASS SOD

Treatment[1]	Clover	Grass: Ryegrass	Grass: Coastal	Total
	lb DM/acre			
AL + RG 50-50	724	1422	1540	3686 a[2]
RG 50-50	-	2171	1203	3374 ab
AL 50-50	1590	-	1712	3302 ab
AL + RG 0-50	1323	833	1017	3173 abc
AL 0-0	2172	-	954	3126 abc
AL 50-0	1780	-	1205	2987 bc
AL + RG 0-0	1694	378	816	2888 bc
AL + RG 50-0	996	1003	810	2809 bc
RG 0-50	-	1390	1311	2701 bc
AL 0-50	1626	-	1009	2635 bc
RG 50-0	-	1512	1014	2526 c
RG 0-0	-	581	701	1282 d

C.V. = 8.9%

TABLE 2. THE EFFECT OF NITROGEN APPLICATIONS ON SEASONAL FORAGE PRODUCTION OF ARROWLEAF CLOVER, RYEGRASS AND ARROWLEAF-RYEGRASS MIXTURES OVERSEEDED ON COASTAL BERMUDAGRASS SOD

Treatment[1]	Harvest Date: 3-16-82	4-6-82	5-11-82	6-15-82	Total
	lb DM/acre				
AL 0-0	232 a[2]	466 ab	1759 ab	667 bc	3126 abc
AL 0-50	202 abc	390 b	1336 cd	707 bc	2635 bc
AL 50-0	246 a	358 b	1522 abc	859 b	2987 bc
AL 50-50	235 a	398 b	1490 abcd	1179 a	3302 ab
RG 0-0	55 bc	128 c	548 e	551 c	1282 d
RG 0-50	53 c	116 c	1770 abc	762 bc	2701 bc
RG 50-0	219 ab	515 ab	1124 d	668 bc	2526 c
RG 50-50	290 a	504 ab	1852 a	728 bc	3374 ab
AL + RG 0-0	232 a	433 ab	1662 a	561 c	2888 bc
AL + RG 0-50	207 abc	429 ab	1848 a	689 bc	3173 ab
AL + RG 50-0	337 a	540 ab	1386 bcd	546 c	2809 bc
AL + RG 50-50	295 a	608 a	1869 a	911 b	3686 a

[1] 50 lbs N/acre was applied 2-12-82 (50-0), 4-8-82 (0-50), both 2-12-82 and 4-8-82 (50-50) or no nitrogen was applied (0-0).

[2] Yields followed by the same letters are not significantly different at the 0.01 level using the Student Newman-Keuls Multiple range test.

TABLE 3. COMPARISON OF COMPONENT FORAGE PRODUCTION OF N-FERTILIZED RYEGRASS TO RYEGRASS-SUB CLOVER MIXTURES

Treatment	Clover	Ryegrass	Total
	----	lb DM/acre	----
RG + 220 N[1]	-	4410	4410 a[5]
RG + Mt. Barker Sub	3337	985	4322 a
Mt. Barker Sub	4058	-	4058 ab
RG + 100 N[2]	-	3421	3421 b
RG + 50 N[3]	-	2689	2689 c
RG + 50 N[4]	-	2495	2495 c
RG + Nungarin Sub	629	1612	2241 c
RG + 0 N	-	1920	1920 c
Nungarin Sub	993	-	993 d

C.V. = 12.9%

[1]Applied in three splits (100-60-60) on 10-22-82, 2-14-83 and 3-18-83

[2]Applied in two splits (50-50) on 2-14-83 and 3-18-83

[3]Applied 2-14-83

[4]Applied 3-18-83

[5]Yields followed by the same letters are not significantly different at the 0.01 level using the Student Newman-Keuls Multiple range test.

SEASONAL FORAGE PRODUCTION OF ANNUAL CLOVERS

G. R. Smith and C. Gilbert[1]

SUMMARY

Forty-nine varieties or experimental lines of annual clover were evaluated for seasonal forage production at Overton in 1982-83. Sixteen entries of subterranean clover were evaluated as reseeding stands on plots established in 1981. Fifteen experimental lines and 3 standard varieties of sub clover were established in 1982. Yields of reseeding sub clover ranged from 4186 to 2748 lbs DM/acre. Yields of newly established sub clover ranged from 2945 to 1729 lbs DM/acre. Twenty annual clover varieties of arrowleaf, crimson, rose, ball, berseem and persian clover were evaluated with total yields from four harvests ranging from 4758 to 2448 lbs DM/acre.

INTRODUCTION

Annual clovers have the potential for improving forage quality and cool-season production of Texas forage systems without increased inputs of fertilizer nitrogen. Commercial clover varieties, experimental germplasm and breeding lines are evaluated each year at Overton to provide current information for producers and to support the forage legume breeding program. 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 subterranean clover varieties and experimental lines.

PROCEDURE

Twenty annual clovers were drilled into a native sod (common bermuda and *Paspalum setaceum*) in 5x7 foot plots October 13, 1982. Six double-disk openers, spaced nine inches apart, on a small-plot drill were used to place the seed at a one-half inch depth. Soil test ratings of phosphorus and potassium were low and medium, respectively. Soil pH (0-6 inches) was 7.1. Prior to planting, 450 lbs/acre of 0-20-20 fertilizer were applied to the Bowie fine sandy loam soil. The grass was mowed to two inches prior to sod-seeding.

Fifteen experimental lines and three standard varieties of sub clover were broadcast seeded in 5x7 foot plots on a prepared seedbed October 13, 1982. Two-foot borders were left between plots to help prevent variety mixing. Soil test ratings were very low and medium for phosphorus and potassium, respectively. Soil pH (0-6 inches) was 7.1. Four hundred and fifty pounds per acre of 0-20-20 fertilizer

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KEYWORDS: Annual clover/forage production/sodseeding/reseeding

were applied and incorporated prior to planting. Reseeding plots of sub clover were fertilized at the same rate and summer growth of grass and weeds removed by mowing at two inches.

Seeding rates and Rhizobium inoculant type for each clover species in all three experiments are shown in Table 1. Peat inoculant was supplied by the Nitragin Co. Pelgel solution was used as an adhesive to stick inoculant to the seed and 0.15 grams of inoculant was applied per gram of seed.

The clover lines in all three experiments were arranged in randomized complete block designs with four replications. The sub clover plots were harvested at 1.25 inches and the annual clover plots harvested at 2.25 inches, both with a rotary mower. 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.

RESULTS AND DISCUSSION

Total production in the sod-seeded annual clover test ranged from 4758 to 2448 lbs DM/acre for Meechee arrowleaf and Segrest ball clover, respectively (Table 2). All the annual clover varieties or lines produced their largest yield at the May 9 harvest with most yields at this harvest higher than 2000 lbs DM/acre. Crimson and rose clover were the highest producing species at the April 19 harvest followed by arrowleaf. Tibbee and Dixie crimson and Amclo arrowleaf were the highest yielding at the first harvest. Poor stands affected the performance of 287973 rose clover and Abon persian clover.

From the thirteen new sub clover experimental lines seeded in 1982, yields ranged from 2781 to 1729 lbs DM/acre for LO 589 and LO 993, respectively (Table 3). Twelve of these lines were selected in 1981-82 from 133 sub clover plant introductions from Spain. Yields were low in these newly established plots compared to production from reseeding stands (Table 4). These plots will be managed for reseeding and evaluation continued.

Production of sub clover varieties and lines in their first reseeding stand ranged from 4186 to 2748 lbs DM/acre for line 209924 and 311498, respectively. The reseeding sub clover test (first reseeding year) was harvested four times compared to three harvests on the newly established sub clover (Table 4). While weather conditions are not favorable for this early production of sub clover every year, thick stands are required to take advantage of this potential growth. In the 1982-83 growing season reseeded stands of Woogenellup sub clover produced 2362 lbs DM/acre by March 7 compared to total season production of 2945 lbs DM/acre for the same variety newly established in the fall.

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

Species	Seeding Rate	Inoculant Type[1]
	--lbs/acre--	
Arrowleaf	14.2	0
Crimson	19.6	R
Subterranean	19.6	WR
Rose	19.6	WR
Berseem	19.6	R
Ball	3.5	B
Persian	7.1	R

[1]Supplied by the Nitragin Co., Milwaukee, WI.

TABLE 2. SEASONAL PRODUCTION OF SOD-SEEDED ANNUAL CLOVERS AT OVERTON, TX. 1982-83

Variety	Harvest Date				Total
	3-18	4-19	5-9	6-8	
	---lbs DM/acre---				
Meechee[2]	460	1062	3236	0	4758 a[1]
Kondinin Rose	735	1304	2700	0	4739 a
Dixie[3]	802	1576	2312	0	4690 ab
Yuchi[2]	713	1131	2821	0	4665 ab
RRPS-5[2]	668	1234	2672	0	4574 ab
Overton-2[2]	689	1173	2660	0	4522 ab
Tibbee[3]	820	1617	2044	0	4481 ab
Overton-3[2]	741	1125	2606	0	4472 ab
Amclo[2]	834	1186	2378	0	4398 ab
Wood Co.[3]	383	1362	2651	0	4396 ab
Autauga[3]	620	1620	2150	0	4390 ab
CH-N[3]	446	1428	2428	0	4302 ab
Chief[3]	517	1456	2308	0	4281 ab
Wilton Rose	349	1311	2520	0	4180 abc
BE-1[2]	506	986	2567	0	4059 abc
W. H. Berseem	390	736	1975	736	3837 abc
287973 Rose	236	830	2414	0	3480 abcd
Abon Persian	238	481	1758	818	3295 bcd
Comm. Ball	0	0	2789	0	2789 cd
Segrest Ball	0	0	2448	0	2448 d

C.V. = 13.4%

[1]Yields followed by the same letters 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 SUBTERRANEAN CLOVER AT OVERTON, TX. 1982-83

Variety	Harvest Date 3-14	4-11	5-19	Total
	----------	lbs DM/acre	----------	
Woogenellup	968	1799	178	2945 a[1]
LO 589	646	1593	542	2781 ab
LO 712	593	1729	363	2685 ab
Nangeela	723	1680	267	2670 ab
401567	768	1664	235	2667 ab
LO 32	451	1571	596	2618 ab
LO 593	476	1416	709	2601 ab
LO 596	624	1428	547	2599 ab
401573	446	1426	596	2468 ab
Mt. Barker	540	1617	222	2379 ab
209927	127	1288	799	2214 ab
Meteora	163	1415	577	2155 ab
401568	504	1479	110	2093 ab
291917	341	1489	255	2085 ab
233868	440	1612	0	2052 ab
209924	422	1478	149	2049 ab
LO 1598	332	1480	173	1985 ab
LO 993	99	1056	574	1729 b

C.V. = 18.6%

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

TABLE 4. SEASONAL PRODUCTION OF RESEEDING SUBTERRANEAN CLOVER AT OVERTON, TX. 1982-83

Variety	Harvest Date 12-6	3-7	4-11	5-18	Total
	----------	----------	lbs DM/acre	----------	
209924	575	1491	2120	0	4186 a[1]
Miss. Ecotype	541	946	2255	356	4098 a
Woogenellup	593	1769	1632	97	4091 a
Nangeela	518	1032	2009	382	3941 a
209927	301	364	2374	795	3834 a
311499	412	907	2060	385	3764 a
291917	674	635	1853	576	3738 a
Tallarook	701	596	1987	421	3705 a
168638	349	791	2020	531	3691 a
Mt. Barker	380	1004	2062	231	3677 a
184962	364	936	2008	193	3501 a
319146	359	792	1804	417	3372 a
239907	723	610	1426	432	3191 a
319145	244	671	1749	340	3004 a
311498	184	708	1472	384	2748 a
Nungarin	0[2]	0	0	0	

C.V. = 22.1%

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

[2]Did not reseed in 1981-82.

PERFORMANCE OF RANGE FORAGE SPECIES INTERSEEDED IN COASTAL BERMUDAGRASS ON LIGNITE OVERBURDEN [1/]

J. G. Skousen and C. A. Call[2/]

SUMMARY

Illinois bundleflower, sericea lespedeza, western indigo, and Maximilian sunflower were interseeded in Coastal bermudagrass sod on 2 year-old and 8 year-old lignite overburden spoils near Fairfield, Texas. Cultural treatments included herbicidal suppression of bermudagrass prior to seeding, and fertilization at time of seeding. Seedlings of the interseeded species were only observed in herbicide treated plots. Establishment and growth of Maximilian sunflower was better on fertilized plots, whereas legume establishment and growth was better on older, non-fertilized plots.

INTRODUCTION

Coastal bermudagrass (*Cynodon dactylon*) is the most widely used plant species in mine-land revegetation programs in Texas. Under intensive management, Coastal achieves excellent ground cover, maintains high yields and satisfactory forage quality, and hence provides a solid base for erosion control and year-round grazing. However, it may be desirable to establish other plant species, primarily perennial legumes, in Coastal bermudagrass pastures to: increase forage quality for livestock, provide food and cover for wildlife, and supplement fertilizer inputs through atmospheric nitrogen fixation. The objective of this study was to determine the cultural requirements for establishing low-maintenance species in Coastal bermudagrass sod.

PROCEDURE

Illinois bundleflower (*Desmanthus illinoiensis*), sericea lespedeza (*Lespedeza cuneata*), western indigo (*Indigofera miniata*), and Maximilian sunflower (*Helianthus maximiliani*) were interseeded separately at rates of 1.5, 5.0, 2.0, and 1.0 pounds PLS per acre, respectively, in Coastal bermudagrass sod on 2 year-old and 8 year-old overburden sites near Fairfield, Texas on March 15, 1983. Each species was interseeded on 20-inch row spacings into herbicide-treated (glyphosate sprayed in 10-inch bands at 5 quarts per acre) and untreated sod. Fertilizer treatments

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1/ This study is supported by the Texas Utilities Generating Company Research Fellowship Program.

2/ Graduate Research Assistant and Assistant Professor, Range Science Department.

(0-0-0 pounds N-P-K per acre and 40-40-40 pounds N-P-K per acre) were applied at the time of interseeding. Plots (66 feet by 6.6 feet) were arranged in a split-plot design with three replications per treatment. Plant density (number of plants per 40 inch row length) and aboveground biomass were measured for each species in late October 1983.

Analysis of soil samples indicated no significant differences in pH, N, P, K, Ca and Mg at both sites. However, management practices prior to the initiation of this research were different at the two sites. The 8 year-old site had been grazed at a stocking rate of 2.7 acres per AUY, while no grazing had occurred on the 2 year-old site. During the year prior to the establishment of the plots (1982), the 2 year-old site received 90 pounds of N-P-K per acre, while the 8 year-old site received 60 pounds of N-P-K per acre.

RESULTS AND DISCUSSION

Interseeded species were only observed in Coastal bermudagrass sod which had been suppressed by glyphosate herbicide. Fertilization had a variable effect on plant establishment in bermudagrass sod on the different aged overburden sites (Table 1). Applied fertilizer enhanced Maximilian sunflower establishment and biomass production on the 2 year-old overburden site, but not on the 8 year-old overburden site. Non-fertilized Maximilian sunflower plants had greater density and biomass on the 8 year-old site as compared to the 2 year-old site. Illinois bundleflower failed to establish on the 2 year-old site, and establishment and yield were negatively affected by applied fertilizer on the 8 year-old site. Sericea lespedeza failed to establish in fertilized plots on either site, and showed greater density and biomass in unfertilized plots on the 8 year-old site as compared to the 2 year-old site. Western indigo, a cool-season legume, failed to establish on the 2 year-old site, and showed poor establishment on the 8 year-old site, regardless of fertilization treatment.

Coastal bermudagrass on the 2 year-old site had greater biomass production than older, previously grazed Coastal on the 8 year-old site (Table 2). Herbicide suppression and limited competition from interseeded species reduced Coastal bermudagrass biomass production by 14% and 38%, respectively, on fertilized and non-fertilized plots on the 2 year-old site, and by 25% and 32%, respectively, on the 8 year-old site (Table 2).

The poor establishment and low biomass production of the interseeded legume species can be related to the competitive nature of established Coastal bermudgrass and to the lack of precipitation during the seedling establishment period in April, 1983 (Table 3). The greater establishment and biomass production of interseeded Maximilian sunflower plants can be related to their rapid seedling growth, aggressive rhizomes, and drought tolerance.

These species will be incorporated into mixtures with native, warm-season perennial grasses and interseeded in Coastal bermudagrass sod on lignite overburden in follow-up studies.

Table 1. Density and aboveground biomass production of species interseeded into Coastal bermudagrass sod on 2 year-old and 8 year-old lignite overburden sites

Site/Treatment*	Density**	Biomass (lb./ac.)
	Maximilian sunflower	
2 year/fertilized	14.3^{a*}	1403^{a+}
2 year/non-fertilized	1.5^{a}	43^{b}
8 year/fertilized	3.1^{a}	204^{ab}
8 year/non-fertilized	7.6^{a}	289^{ab}
	Illinois bundleflower	
2 year/fertilized	0^{b}	0^{a}
2 year/non-fertilized	0^{b}	0^{a}
8 year/fertilized	$.5^{b}$	4^{a}
8 year/non-fertilized	4.7^{a}	257^{a}
	Sericea lespedeza	
2 year/fertilized	0^{b}	0^{a}
2 year/non-fertilized	$.4^{b}$	5^{a}
8 year/fertilized	0^{b}	0^{a}
8 year/non-fertilized	4.9^{a}	346^{a}
	Western Indigo	
2 year/fertilized	0^{a}	0^{a}
2 year/non-fertilized	0^{a}	0^{a}
8 year/fertilized	$.2^{a}$	4^{a}
8 year/non-fertilized	$.1^{a}$	4^{a}

* Fertilized treatment received 40-40-40 lb. N-P-K/ac. at time of interseeding.

** Average number of plants per 40 inches of row length.

+ Means followed by the same letter in the same column for each species are not significantly different at $p \leq .05$.

Table 2. Coastal bermudagrass biomass production, alone or in combination with interseeded species

Site/Treatment*	Biomass (lb./ac.) with interseeded species	Biomass (lb./ac.) without interseeded species
2 year/fertilized	8764	10207[a]**
2 year/non-fertilized	3793	6068[bc]
8 year/fertilized	5153	6886[b]
8 year/non-fertilized	2789	4093[c]

* Fertilized treatment received 40-40-40 lb. N-P-K/ac. at time of interseeding.

**Means followed by the same letter are not significantly different at $p \leq .05$.

Table 3. Monthly rainfall at Fairfield, Texas during spring 1983

Month	Inches
January	1.0
February	5.5
March	4.0
April	.2
May	8.0

Soil Fertility Management for Selected Forages: Yield Response and Quality of Five Improved Forage Cultivars

A. S. Mangaroo*

SUMMARY

The forage yield of Callie, Tifton-44 and SS-16 bermudagrass, Klein and Limpo were significantly increased by N fertilization. A significant N x P interaction was observed in the yields of Callie bermudagrass. Crude protein concentration was significantly increased by N fertiliztion and for Tifton-44, Callie and SS-16 bermudagrasses ranged from 11.8 to 13.5% whereas for Klein and Limpograss it ranged from 7.2 to 10.7%. Relative ground cover establishment, like the seasonal forage yields, was significantly influenced by soil N level. The bermudagrasses, particularly Tifton-44, showed complete cover whereas Klein and Limpo showed significantly less.

PROCEDURE

Kleingrass (*Panicum coloratum*), Limpograss (*Hermarthria altissima*), and three bermudagrasses (*Cynodon dactylon*) - Callie, SS-16, and Tifton-44, were studied in a field experiment on the Hockley Prairie soil of the Prairie View A&M University Cooperative Research Center. The performance of these forages was tested for dry matter yields (DMY) and protein concentration at different soil N and/or P levels using a randomized split block design. This is the 3rd year of a 3-year study, so that the respective forages have been similarly treated for the last 3 years (1981-83). The treatments were as follows: There were 3 plots of each forage in each of 4 blocks (replications) representing 3 soil N levels of 22, 262 and 504 kg/ha N applied as NH_4NO_3. The first level was native N and the others being split applications of 60 and 120 kg/ha each in early spring and following each harvest. Each block was split in 3 equal portions to accommodate soil P levels of 7, 207 and 407 kg/ha P added as superphosphate, the first level being native P and the others being split application of 50 and 100 kg/ha each in the spring and following each harvest. In the spring all the plots were similarly

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treated once with K at 120 kg/ha and limed to pH 6.2. Cuttings were taken in May, June, July, August and September and dry matter yields (DMY) and crude protein determined. After the last cutting was taken a measurement of relative ground cover establishment was taken. On a scale of 1 to 10, 10 was used if the plot was completely covered and 1 was assigned if the plant stands were sparse.

RESULTS

The mean seasonal DMY of the cultivars for '80, '81, '82 and '83 regardless of N and/or P fertilization is presented in Table 1. A decrease in DMY was obtained in 1983 from Limpo, Klein, and Callie even though 5 harvests were obtained in 1983 as compared to 4 in other years. In Limpograss, for example, there was a significant decrease in DMY from 16,106 kg/ha in 1982 to 12,844 kg/ha in 1983. Possible explanations are: (1) Since there was no drought in late July to August 1983 the usual flush in late summer growth observed in other years following that drought period was absent. 2) Also, some forage plots now show poorer stands.

Table 1. Comparison of the seasonal DMY of the cultivars of 1980, 1981, 1982 and 1983

Variety	1980	1981	1982	1983	Mean
	*	**	***		
Limpo	10,106	9,553	16,106	12,844	12,127
Klein	9,842	9,426	14,629	14,152	12,010
Callie	7,972	9,543	14,678	14,541	11,684
Tifton-44	7,386	9,414	15,5422	15,518	11,865
SS-16	5,037	8,178	14,012	14,411	10,410
Mean	8,049	9,023	14,968	14,293	

The yields of all the grasses were significantly influenced by soil N level and in some cases a significant N x P interaction was observed. The mean seasonal DMY of the five forage cultivars as a function of soil N and P levels are given in Table 2. It can clearly be observed from the data that, except for Callie bermudagrass, all cultivars showed their most significant mean seasonal DMY at the 502 kg/ha soil N level and the native soil P level (7 kg/ha). In other words, these forage cultivars showed no significant response to soil P. In the case of Callie, the most significant response was found at the same soil N level but when the soil P level was increased to 207 kg/ha. The mean seasonal DMY for the forages being referred were: Limpo-15,774, Klein-18,026, Callie-18,675, Tifton-44-20,658 and SS-16-18,070 kg/ha. The lowest mean seasonal DMY on all of these 5 forage cultivars

Table 2. Mean seasonal DMY matter yield of the five forage cultivars as a function of soil nitrogen and phosphorus levels

Fertility level kg/ha	Limpo	Klein	Callie	Tifton-44	SS-16
N-P-K	kg dry forage per hectare				
	*	*	*	*	*
502-407-120	16647 a	21011 a	18320 a	20979 a	18294 a
502-207-120	16195 a	19729 a	18675 a	20128 a	18447 a
502-7-120	15774 a	18026 a	17242 b	20658 a	18070 a
262-407-120	14952 b	15635 c	16993 b	16897 b	16671 b
262-207-120	13037 b	15288 c	16259 b	17510 b	15884 b
262-7-120	11411 c	15005 c	17283 b	17222 b	16181 b
22-407-120	9741 d	8038 d	8566 c	8382 c	8525 c
22-207-120	9660 d	8286 d	8781 c	9007 c	8961 c
11-7-120	9180 d	7349 d	8749 c	8879 c	8663 c

* Values in a column with the same letter are not significantly different at 0.05 level. (Duncan's Multiple Range Test).

obtained when soil N level was not increased. As expected, the data further indicated that increasing soil P level without increasing soil N level did not result in significant increases in seasonal DMY.

The mean crude protein concentration of the various forages as a function of soil N and P levels are shown in Table 3. The greater, more significant percentages occur in the bermudagras forages where 12 and 13% are quite common. The average protein contents of Klein and Limpograss were significantly lower with values ranging only from 7 to 9.4%.

The effect of soil N and P levels on the relative ground cover establishment of the cultivars is shown in Table 4. Like the seasonal DMY of the cultivars the relative ground cover was significantly influenced by soil N level and dependent on variety. The Tifton-44 bermudagrass showed the most complete relative ground cover, so a value of 10 was assigned at the height N (502 kg/ha. To those plots with the next lower level (262 kg/ha) that showed relative ground cover values of ± 9.0 were found which were not significantly lower than the values at the higher soil level. When no nitrogen was applied (22 kg/ha), relative ground cover was found to decrease to ± 8.5, but the latter relative ground cover values were not significantly lower. Callie and SS-16 showed equally significant ground cover of almost 10 for the two higher N levels (502 and 262 kg/ha), then a more drastic and significant decrease to less than 4 with a decrease in soil N to the native soil N (22 kg/ha). Limpo and Kleingrass showed relative standability values of ± 7.5 when the soil N level was 502 kg/ha and both indicated significantly decreased to ± 2 when the N was applied. It is quite evident that ground cover establishment of these forages, except Tifton-44, is significantly increased by increases in soil N level, but not affected by increases in soil P level.

Table 3. Mean crude protein concentration (%) of the five forage cultivars as a function of soil nitrogen and phosphorus levels

Fertility kg/ha N-P-K	Limpo	Klein	Callie	Tifton-44	SS-16
	*	*	*	*	*
22-207-120	7.0 f	7.2 f	12.4 b	12.4 b	11.6 c
22-207-120	7.4 f	8.0 e	13.0 b	13.6 a	7.0 f
22-407-120	7.4 f	9.4 d	10.8 c	10.0 d	8.0 e
262-7-120	7.0 f	7.0 f	10.0 d	12.6 b	12.2 b
262-207-120	8.2 e	7.0 f	13.8 a	12.5 b	13.7 a
262-407-120	7.4 f	8.0 e	13.2 a	13.0 b	13.0 b
502-7-120	7.6 f	8.0 f	12.4 b	12.2 b	12.0 b
502-207-120	8.2 e	7.0 f	11.4 c	12.8 b	11.2 c
502-407-129	7.4 f	8.2 e	12.7 b	13.4 a	12.6 b

* Values in a column with the same letter are not significantly different at the 0.05 level (DMR Test).

Table 4. The effect of soil nitrogen and phosphorus levels on relative ground cover of the cultivars

Soil levels	Forage Cultivars				
N - P	Klein	Limpo	Callie	SS-16	Tifton-44
	*	*	*	*	*
502-407	7.1 a	7.2 a	9.9 a	9.5 a	10.0 a
502-207	7.3 a	7.5 a	10.0 a	9.8 a	10.0 a
502-7	7.0 a	7.4 a	10.0 a	9.2 a	10.0 a
262-407	4.7 b	6.9 a	9.7 a	8.4 a	9.2 a
262-207	4.4 b	7.0 a	10.0 a	8.7 a	8.9 a
262-7	4.8 b	6.8 a	10.0 a	8.6 a	8.5 a
22-407	1.5 c	1.7 b	3.6 b	2.3 b	8.1 a
22-207	1.5 c	1.9 b	3.5 b	2.1 b	8.6 a
22-7	1.3 c	2.0 b	3.3 b	2.5 b	8.3 b

* Values in column with the same letters are not significantly different at the 0.05 level, (Duncan's Multiple Range Test).

EFFECTS OF CLIPPING HEIGHT AND NITROGEN ON YIELDS AND PROTEIN CONTENT OF CALLIE BERMUDAGRASS

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SUMMARY

Callie bermudagrass was clipped at 3 different heights (1, 2 and 3 inches above the soil surface) to determine the effect of clipping height on dry matter yields and crude protein content. The study shows that yield increased as clipping height was reduced. Protein content was not affected by clipping height. During 1983, 35.2 percent more dry matter (3583 lbs/ac) was harvested from plots clipped 1 inch compared to plots clipped 3 inches above ground level. The 2-inch clipping treatment provided 29.1 percent more forage (2690 lbs/ac) than the 3-inch clipping treatment, and 4.6 percent less forage (623 lbs/ac) than the 1-inch clipping treatment. Yields were slightly reduced (by 580 lbs/ac or 11.0%) during the spring on 1-inch plots compared to 2-inch plots, but this slight depression was overcome after June. Findings in this study suggest that lower clipping heights result in greater yield increases under low soil nitrogen levels and longer harvest intervals. Findings also suggest that longer harvest intervals combined with low clipping heights and adequate soil moisture are more important to good late summer and fall production of Callie bermudagrass than additional nitrogen fertilization.

INTRODUCTION

Bermudagrasses are the most widely used cultivars for permanent pastures in most of the southern region of the U. S. In a continuing effort to further increase the efficiency of production and quality of these grasses, many new varieties are being developed and tested. Previous research and observations have shown that the production of some grasses may be improved by management practices such as fertilization, clipping frequency and clipping height. This study was designed to determine the effects of different clipping heights as a factor with nitrogen level on dry matter yield and crude protein content of Callie bermudagrass.

PROCEDURE

This study was initiated during August 1982 in an existing stand of Callie bermudagrass, established in 1977. The stand was divided

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KEYWORDS: Callie bermudagrass/clipping height/nitrogen/yields/protein

into 16 main plots arranged in a randomized complete block design consisting of 4 replications of 4 nitrogen treatments. Each main plot (8 by 10 ft.) was subdivided into 3 subplots to accommodate the 3 clipping height treatments, which consisted of clipping the forage at 1, 2 and 3 inches above the soil surface during harvesting. Nitrogen treatments consisted of initial applications of 22.5, 45, 90 and 180 pounds of nitrogen per acre as ammonium nitrate, with additional applications of these amounts after each harvest except the last fall harvest in 1982. During 1983, nitrogen treatments were applied only in April (initially) and immediately following the harvest in May. Clipping was accomplished by using a sickle bar mower fitted with adjustable skids at each end of the 28-inch bar. Clippings were raked onto a canvas and weighed in the field. Approximately 1/2 pound of material from each harvested subplot was bagged, sealed and used for determination of percent dry matter, and percent crude protein using the Kjeldahl nitrogen procedure. Harvests during 1982 were taken monthly from September through November. In 1983, harvests were taken during May, June, August and November.

RESULTS AND DISCUSSION

Dry matter yields of Callie bermudagrass significantly increased as clipping height was reduced. The lower clipping height treatments (1 and 2 in.) provided more forage each harvest than the higher clipping height treatment (3 in.). During the 1982 fall season (a 90-day period), yields were 1932, 1689 and 1185 pounds of dry matter per acre for the 1, 2 and 3-inch treatments, respectively (Table 1). Results for the entire 1983 growing season (April through November) exhibited a similar trend to the previous autumn results except for the magnitude of yield. Total dry matter yields harvested over this season were 13,752, 13,129 and 10,169 pounds per acre, respectively, for increasing clipping heights (Table 2). The 3-inch clipping treatment provided significantly lower total yields than the 2-inch treatment which did not differ significantly from the 1-inch treatment. Forage harvested during the month of May was essentially the same amount for all treatments and was very low due to cool spring temperatures and an early harvest designed to evaluate previous fall treatments on early spring results. These data, along with that collected for the next 30-day period (June harvest), indicate a slight retardation in spring growth on plots clipped during the fall and spring at 1 inch above ground level. The second 1983 harvest, taken in June, provided the highest yields for the year which were 4680, 5260 and 3961 pounds of dry matter per acre, respectively, for the 1, 2, and 3-inch treatments. The 2-inch treatment provided significantly higher yields over this 30-day period than the 1 and 3-inch treatments. Dry matter yields decreased after the harvest in June due to a rust-like infestation of the grass and periods of moisture stress.

For the periods ending in August and November 1983, yields were significantly different for each of the three clipping height treatments. The distinct expression of each clipping height treatment on yields during these periods, compared to earlier in the season, may be related to nitrogen depletion in addition to season, since harvest date interacted significantly with both nitrogen and clipping height treatments. The harvest date factor interaction with clipping height was probably influenced by nitrogen, as all nitrogen in 1983 was applied prior to June, and had only minor effects on yields after the harvest in June and no effect after August (Table 4). However, nitrogen alone or combined with harvest date did not significantly interact with the clipping height effect on yields. Harvest interval was found to affect clipping height treatment and total yields, as fall yields over a 3-month period taken in a single harvest in November 1983 were almost double those for each respective clipping height treatment in 1982 for the corresponding fall period, but taken in 3 separate monthly harvests (Tables 1 & 2). These 1983 fall yields were obtained when nitrogen effects were nil following the last nitrogen application in May, whereas, during 1982 nitrogen applications were 1.5 times greater and all applied after July (Tables 3 & 4). Although considerably more rainfall occurred during 1983, compared to 1982, these results suggest that lower clipping heights result in greater increases in yields under longer harvest intervals and lower soil nitrogen levels; and that these factors along with adequate soil moisture are more important for good late summer and fall production of Callie bemudagrass than nitrogen fertilization.

As shown in Tables 3 and 4, yields increased with increasing nitrogen application both years, but only through August in 1983 because the last nitrogen application for the year was made in May. Nitrogen rates ranging from 45 to 360 pounds per acre increased yields from 9,081 to 15,063 pounds per acre during the 1983 season (Table 4). Protein was also positively correlated with nitrogen. The r-values were 0.77 and 0.84 for 1982 and 1983, respectively. Protein content increased from 7.9 to 19.7 percent with increasing nitrogen during fall 1982, and from 7.7 to 20.7 percent with increasing nitrogen application for the first 2 harvests in 1983. Protein content was not influenced by clipping height treatments during either harvest and had a mean value of 13.5 percent during each year over all treatment factors.

Table 1. Mean dry matter yields of Callie bermudagrass by harvest month during fall as affected by clipping height, 1982

Clipping height above surface	[1]Dry matter yields, fall 1982 Sep	Oct	Nov	Totals
-- inches --	------ [2]pounds per acre ------			
1	962 a	398 a	572 a	1932 a
2	787 b	411 a	491 a	1689 b
3	656 b	326 a	203 b	1185 c

[1]Means within a column not followed by the same letter differ at the 0.05 level according to the Duncan Multiple Range test.

[2]Mean of 4 replications of 4 different nitrogen treatments.

Table 2. Mean dry matter yields of Callie bermudagrass by harvest month as affected by clipping height, 1983

Clipping height above surface	[1]Dry matter yields, 1983 May	Jun	Aug	Nov	Totals
-- inches --	------- [2]pounds per acre -------				
1	341 a	4680 b	5510 a	3221 a	13,752 a
2	324 a	5260 a	4806 b	2799 b	13,129 a
3	264 a	3961 b	3755 c	2129 c	10,169 b

[1]Means within a column not followed by the same letter differ at the 0.05 level according to the Duncan Multiple Range test.

[2]Mean value of 4 replications of 4 different nitrogen treatments.

Table 3. Mean dry matter yields of Callie bermudagrass by harvest month during fall as affected by level of soil applied nitrogen

Nitrogen level	[1]Dry matter yields, fall 1982			
	Sep	Oct	Nov	Totals
- lbs N per acre -	------- [2]pounds per acre -------			
540	1068 a	533 a	701 a	2302 a
270	901 ab	471 a	547 b	1919 a
135	667 b	317 b	294 c	1278 b
68	572 b	190 b	146 c	908 b

[1]Means within a column not followed by the same letter differ at the 0.05 level according to the Duncan Multiple Range test.

[2]Mean value of 4 replications of 3 clipping height treatments.

Table 4. Mean dry matter yields of Callie bermudagrass by harvest month as affected by level of soil applied nitrogen, 1983

Nitrogen level	[1]Dry matter yields, 1983				
	May	Jun	Aug	Nov	Totals
- lbs N per acre -	------- [2]pounds per acre -------				
360	560 a	6017 a	5500 a	2986 a	15,063 a
180	213 b	5064 ab	4994 ab	2926 a	13,010 ab
90	192 b	4442 b	4686 ab	2650 a	12,246 b
45	184 b	3012 c	3581 b	2304 a	9,081 c

[1]Means within a column not followed by the same letter differ at the 0.05 level according to the Duncan Multiple Range test.

[2]Mean value of 4 replications of 3 clipping height treatments.

Nitrogen and Phosphorus Fertilization of Wheat Cultivars

J.E. Matocha

SUMMARY

Comparison of fluid ammonium polyphosphates with new granular urea phosphates sources in topdressed post-emergence applications is essential for development of fertilization practices for wheat production in South Texas.

In addition to evaluation of fertilizer sources this study also involved determining the effects of wheat genotypes on fertilizer response and wheat yields. Forage yields were collected from the winter variety in seasons where soil moisture was adequate while grain yields were collected in all seasons.

Nitrogen fertilizer increased grain yields only when accompanied by phosphorus. When both grain and forage yield were measured, grain yields varied less with treatment than forage yields. Generally, 20 lb/A phosphorus (P_2O_5/A) increased wheat yields in most years. Response from high phosphorus rates was erratic. A recently introduced Mit variety appeared to utilize fertilizer phosphorus as well or better than the older variety.

KEYWORDS

Grain yields, forage yields, variety effect, percent nitrogen, nitrogen uptake, phosphorus uptake

INTRODUCTION

The development of new disease resistant winter wheat varieties with lower vernalization requirements and the introduction of short-season wheats have increased the interest in wheat production in South Texas. Small grain crops such as wheat can fit into a rotation scheme with other cash crops such as sorghum and cotton. The recent introduction of urea phosphates (UP) has brought a number of questions concerning their effectiveness as sources of both N and P.

Urea phosphate sources have not been evaluated in field trials on cool season annual grasses in the South Texas region. In the predominantly dryland farming area, moisture conditions can range from moisture deficiency at seeding time to sufficiency and excess soil moisture conditions. Generally, the moisture regimes will be limiting in many years. Because surface soil moisture deficits often present a

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problem for good stand establishment producers are interested in delaying surface application of all or a part of the fertilizer until after stand establishment. In many cases a tillage operation used in fertilizer incorporation can deplete the surface moisture to a level that will not permit stand establishment.

This study was set up to determine (1) effect of rate and source of topdressed N and P fertilizer on forage and grain production, (2) wheat cultivar differences in fertilizer response.

PROCEDURE

Field experiments were established in South Texas on a Clareville sandy clay loam (Hyperthermic family of the Pachic Argiustolls) located at the Texas Agricultural Research Station at Beeville. The site had been previously summer-winter fallowed for a number of years. The new Texas A&M release Mit, which is a hard red winter wheat was used in comparison with a popular dual purpose wheat, Nadadores. Mit variety was selected as the winter variety because it has a low vernalization requirement for mild winters in South Central and South Texas. It is considered a dual purpose wheat which permits forage harvesting in winters where rainfall distribution is adequate.

Two granular urea phosphates (17-42-0, UP) and urea cogranulated with urea phosphate (34-17-0, UUP) were used in comparisons with fluid ammonium polyphosphate (APP,10-34-0). These were applied at 0, 20 and 40 lbs of P_2O_5/A. Nitrogen as UAN (32-0-0) solution or granular urea was used to achieve 40 and 80 units of N per acre. All fertilizer materials were topdressed subsequent to plant emergence in the two year study.

When rainfall was adequate during the winter to promote adequate early growth such as was the case in 1980-81, grazing was simulated on the wheat plots by clipping for forage yields. One portion of the plot was clipped for forage while the remainder of the plot was allowed to continue growth for later grain yield comparison with the clipped plots. Weather conditions during the fall and winter months in the second year of the study (1981-82) were not ideal for a good vegetative growth. Consequently, forage yields were not collected on either variety. However, plant samples were collected from all treatments at the preboot stage and subjected to N analysis.

Results and Discussion

Forage and grain yields as well as plant uptakes of N and P for the first season are shown in Table 1. The data show no significant response in wheat growth to N alone was measured regardless of the P source when P did not accompany the N.

Phosphorus concentration and uptake in the forage did not change when N was applied alone, though both tissue N level and N uptake increased significantly with applied N. Nitrogen whether applied as dry urea or fluid UAN increased N content and uptake identically . An addition of 20 lb P_2O_5/A as fluid APP resulted in a significant increase in forage production, however, similar increments of P as UP or UPP with urea, failed to influence forage yields. Higher P rates (40 lb P_2O_5/A) had no further influence on forage yields regardless of the P form. Phosphorus fertilization promoted substantial increases in P concentration with only slight differences in tissue P due to fertilizer source. However, source effects on uptake showed that dry forms of P doubled P uptake by the young wheat plants while fluid APP trippled P uptake.

Higher increments of P gave small increases in percent P and P uptake. Phosphorus applied as APP influenced forage yields and P uptakes more than granular UPP at both P rates when N was applied at 40 lb/A. However, the uptake advantage from fluid APP over UUP was not significant. The advantage of fluid APP over UPP was primarily due to an increase in forage yield. At high N rates, UUP showed somewhat greater forage yield and higher uptakes of N and P than other P sources. A possible explanation for the better performance from UUP is that less N may have been lost to ammonia volatilization with this source since the materials were topdressed.

In the second season, (Table 2) tissue N levels increased with N application except when P was applied. Apparently, due to a large P response in plant growth, a "dilution effect" occurred and tissue N levels failed to increase with N application. The fluid source of N and P gave slightly lower N readings than the UUP source, but compared favorably with those for the UP source. Generally, Mit variety produced forage with somewhat higher N content then the Nadadores variety. Although both varieties are classed as semi-winter types, the Nadadores variety is somewhat earlier in maturing and this may have accounted for the lower tissue N levels when samples were obtained in March or at the pre-inflorescence stage of growth.

Both wheat cultivars showed only a slight change in yield due to N fertilization. Granular UP fertilizers produced similar yields to the fluid source. A trend toward less response to P by "Nadadores" wheat than from the "Mit" variety may indicate a difference in genetic potential to P response between these two wheats.

Table 1. Effects of rates and source of N and P fertilizers on forage, grain yields, N and P concentrations and uptake by wheat

Rate	Source	Forage					Grain	
		Yield	N	N Uptake	P	P Uptake	Clipped	Unclipped
		lb/A	%	lb/A	%	lb/A	- - lb/A - -	
0- 0-0		371	2.5	9.0	0.18	0.65	522	824
40- 0-0	Dry (46-0-0)	595	3.1	18.4	.15	.87	851	975
40- 0-0	Fluid (32-0-0)	574	3.1	18.0	.13	.72	887	975
80- 0-0	Dry (46-0-0)	562	3.3	18.6	.13	.75	743	878
80- 0-0	Fluid (32-0-0)	573	3.5	19.9	.15	1.00	733	795
40-20-0	Dry (UP)	636	2.6	16.8	.22	1.43	521	674
40-20-0	Dry (UUP)	781	2.8	21.9	.21	1.65	519	785
40-20-0	Fluid	1003	2.6	28.1	.22	2.30	467	849
40-40-0	Dry (UUP)	947	2.6	20.6	.25	1.89	542	801
40-40-0	Fluid	1316	2.8	36.1	.22	2.88	491	887
80-20-0	Dry (UUP)	1340	3.3	45.3	.20	2.63	1041	1116
80-20-0	Fluid	1023	3.6	33.6	.20	2.06	1133	995
80-40-0	Dry (UUP)	1489	3.4	51.5	.25	3.76	647	983
80-40-0	Dry (UP)	1043	3.2	34.2	.24	2.52	602	869
80-40-0	Fluid	1309	3.2	44.6	.24	3.38	608	821
	LSD.05	406	0.40		0.04	0.95	362	322

Table 2. Yields from two wheat cultivars as influenced by fertilizer N and P rates and sources. 1981-82

Rate	Source	Forage		Grain	
		Mit	Nadadores	Mit	Nadadores
		- - - % N - - -		- - - lb/A - - -	
0- 0-0		2.17	2.01	781	737
40- 0-0	Dry (46-0-0)	2.73	2.52	974	824
40- 0-0	Fluid (32-0-0)	2.41	2.54	978	721
80- 0-0	Dry (46-0-0)	2.72	2.23	1061	961
80- 0-0	Fluid (32-0-0)	2.67	2.45	1211	1010
40-20-0	Dry (UP)	2.45	2.29	1704	1155
40-20-0	Dry (UUP)	2.69	2.42	1654	1209
40-20-0	Fluid	2.51	2.41	1586	1187
40-40-0	Dry (UUP)	2.78	2.60	1635	1206
40-40-0	Fluid	2.54	2.28	1478	1035
80-20-0	Dry (UUP)	3.05	3.06	1599	894
80-20-0	Fluid	2.97	2.95	1555	954
80-40-0	Dry (UUP)	3.12	2.99	1937	1070
80-40-0	Dry (UP)	2.71	2.63	2288	1236
80-40-0	Fluid	2.84	2.72	2005	1368
	LSD.05	0.61	0.44	595	515
	$\overline{X}$	2.69	2.54	1496	1038

Forage Legume Production as Influenced by Nitrogen and Phosphorus Fertilization

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SUMMARY

The influence of nitrogen and phosphorus fertilization on the forage production of six legume species was investigated. These legumes were grown on an alluvial calcareous silty clay soil with fairly good inherent soil fertility. The location was at the Texas A&M University Plantation River Bottom Farm. Inoculated seed of the six legume species was planted in early October and good stand establishment obtained before cessation of growth with the occurrence of winter weather. Spring regrowth was harvested April 2 and a second harvest of May 28. Although there was a slight tendency for phosphorus application to increase legume production, it was not statistically significant. The fact that legumes are quite self sufficient in N fixation coupled with the commonly inherent P and K fertility of alluvial soils eliminates much prospect for response to fertilization of alluvial soils. However, there were considerable yield differences between legume species. The total forage production in order of legume species was: Red Clover > Alfalfa = Yuchi arrowleaf = Hubam sweetclover > Mt. Barker subterranean > Madrid sweetclover.

INTRODUCTION

There is a lack of information concerning what response to fertilization various cool season legumes would have when grown on a rather fertile alluvial soil. Information was also sought on the comparative production of several legume species under the specific local climatic conditions.

PROCEDURE

Fertilizer sources were ammonium nitrate (34% N) and triple superphosphate (46% P_2O_5). Fertilizer treatments expressed in kg per hectare of elemental N-P-K were: (0-0-0), (0-50-0), (0-100-0), and (25-100-0). Fertilizer treatments were broadcast by hand and lightly incorporated with a rotera machine.

Seed was obtained from a commercial source for the following legume species: Yuchi arrowleaf clover (*T. vesiculosum*), Mt. Barker subterranean clover (*T. subterraneum*), 'Nolin' red clover (*T. pratense*), 'Florida 77' alfalfa (*Medicago sativa*), 'Madrid' sweetclover (*Melilotus officinalis*), and 'Hubam' sweetclover (*Melilatus alba*). Seed of each species was inoculated with the appropriate commercial strain of rhizobium before drill planting into a calcareous silty clay alluvial soil. Plot size was 5 rows wide (1 foot spacing) by 20 ft long.

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RESULTS AND DISCUSSION

Legume plant regrowth after the first harvest, on this calcareous silty clay soil site location, was sufficient to allow for a second harvest.

First harvest

Forage dry matter yield. Yield data for the different legume cultivars studied are shown in Table 1. Madrid sweetclover lacked sufficient growth at the time of the first harvest (April 2, 1983, approximately 6 months after planting) thus no yield data was collected. Plants were close to maturity when harvested due to continued wet weather that delayed harvest. Statistical analysis of the yield data showed no significant differences among fertilizer treatments at the 0.05 level. However, among species and cultivars there were significant differences, which suggest that the yield capacity of each cultivar, due to its genetic potential to produce, was not altered by fertilizer applications. Nolin red clover yield was significantly greater than the other legumes.

Tissue N, P, and K concentrations. Fertilizer applications tended to decrease the tissue N of legumes (Table 2). Averaged across cultivars, the mean N content (3.08%) of the unfertilized treatment was significantly greater (P = 0.05) than the P-100 treatments. This likely occurred from the increased growth by the P-100 treatments resulting in dilution of the N content. A similar situation occurred when comparing the legume cultivars, where the greater dry matter produced by the Nolin red clover may have resulted in a dilution effect, since percent N in tops was less as compared with those that produced lower dry matter yield (Hubam, Florida 77, and Yuchi) and which had higher N concentration in tops.

The tissue P concentrations are listed in Table 3. The high rate of P significantly increased P in the tops. In regard to the cultivars, Yuchi arrowleaf and Hubam sweetclover had the highest P concentrations. Again Nolin red clover was the lowest.

Tissue K concentration is shown in Table 4. Potassium was not applied as a fertilizer treatment because this soil had a high K level. Fertilization treatments did not significantly affect the K absorption from the soil. Among cultivars, Yuchi had the significantly highest K concentration. It has been characteristic of Yuchi to have higher N, P, and K percentage than other cultivars.

Second harvest

Forage dry matter yield. The second cutting occurred on May 28, 1983, approximately two months after the first cutting. A general increase in yield was obtained at the second harvest over the first harvest on all the cultivars, except Mt. Barker which showed a decrease in yield (Table 5). This exception was probably due to the earlier maturity of Mt. Barker than the other cultivars followed by growth cessation in later spring. As in the first harvest, there was no significant differences in yield among the fertilizer treatments. Even though there was a considerable increase in yield of Florida 77 alfalfa when fertilized with P alone (100 kg ha^{-1}) and especially with P plus N, it was not statistically significant. Previous work has shown that alfalfa requires high fertility for top production and sometimes needs N to increase yield.

Once again, legume cultivars showed significant differences in forage production. Florida 77, Yuchi, Hubam, and Nolin yielded significantly better than Mt. Barker and Madrid.

Tissue N, P, and K concentrations. Generally, the N, P, and K concentration in the tops decreased as compared with those values at the first harvest. This is attributed to the warmer temperatures and higher light intensities where the growth dilution resulted in a decrease in N, P, and K percentages (Tables 6, 7, and 8). As in the first harvest, the N, P, and K concentrations were not significantly influenced by the fertilizer treatments, but were by legume cultivars. Madrid sweetclover had the highest N percentage (Table 6), which was significantly different from the other legumes. Since Madrid had not been harvested previously as were the other legumes, it likely did not encounter the shock or reduction in root-nodule N fixation activity. Harvesting of legumes can result in sloughing off of root and nodule tissue, inhibiting the legume N_2-fixation until new leaf area is actively formed to supply carbohydrates to roots. Moreover, the little top growth made by Madrid may lead to N accumulation in plant tops.

The P concentration of Madrid also was the highest which may be attributed to the latter reason as for N concentration (Table 7). However Madrid was statistically similar to Yuchi arrowleaf in P content and different from the other legumes.

The K concentration of Madrid and Yuchi were significantly greater than the rest of legumes (Table 8). As in the first harvest, Yuchi arrowleaf tended to accumulate the highest N, P and K concentration during this experiment, which makes it a high quality forage.

Accumulative harvest

The total accumulative forage yield showed significant differences among cultivars but not among fertilizer treatments (Fig. 1). Nolin red clover produced significanlty more forage than other cultivars. Madrid sweetclover was the least productive cultivar, attributed to slow growth and establishment which resulted in only one harvest occurring at the time of the second harvest of the other cultivars. Madrid sweetclover tends to have less top growth than other sweetclovers, but a more extensive root system, suggesting that in the present study, this cultivar was still in the vegetative stage, and maximum yield response was not obtained. Previous field observations have shown that this cultivar makes little growth during the first year of establishment, but higher yields are expected the following growing season, probably due to its extensive root system. Hubam sweetclover, on the other hand, is a fast growing legume, which explains its high productivity.

Lack of legume response to P fertilizer in previous work on this clay type of soil indicates that it has a fairly adequate amount of P for establishment and production of legumes during the first one or two years, but after that, P fertilization was necessary for sustained production of high yields. The ability of legumes to deplete soil P and K levels must be recognized in order to maintain adequate production of the growing legume. Continued cropping without applying P could eventually deplete fertility of the soil and reduce crop production.

TABLE 1. Forage dry matter yield of legume cultivars grown in a calcareous silty clay soil as affected by fertilization (1st. Harvest)

Fertilizer			Legume cultivars					
N	P		Fl 77	Yuchi	Barker	Hubam	Nolin	Mean
			kg ha^{-1}					
0	0		3800	3564	3360	2922	4582	3647a*
0	50		3930	3084	3507	2823	4841	3637a
0	100		3678	3840	3873	3035	4882	3861a
25	100		3580	3254	3442	3938	4947	3832a
		Mean	3743b*	3433b	3539b	3181b	4809a	

C.V.=17.04

* Means within row or column with the same letter do not differ significantly by Duncan's Multiple Range Test (P=0.05).

TABLE 2. The N (%) concentration of legume cultivars grown in a calcareous silty clay soil as affected by fertilization (1st. Harvest).

Fertilizer N	Fertilizer P	Legume cultivars: Fl 77	Yuchi	Barker	Hubam	Nolin	Mean
kg ha^{-1}		- - - - - - -	- - - - - - -	%	- - - - - - -	- - - - - - -	- - - - - - -
0	0	3.10	3.06	3.17	3.18	3.18	3.08a*
0	50	3.00	3.06	3.08	3.26	2.67	3.01ab
0	100	3.10	2.95	2.58	3.11	2.69	2.88b
25	100	3.00	2.94	2.84	3.07	2.79	2.92b
	Mean	3.05a*	3.00a	2.91ab	3.15a	2.76b	

C.V.=3.91

* Means within row or column with the same letter do not differ significantly by Duncan's Multiple Range Test (P=0.05).

TABLE 3. The P (%) concentration of legume cultivars grown in a calcareous silty clay soil as affected by fertilization (1st. Harvest)

Fertilizer			Legume cultivars					
N	P		Fl 77	Yuchi	Barker	Hubam	Nolin	Mean
kg ha^{-1}			----------------	----------------	%	----------------	----------------	----------------
0	0		0.30	0.30	0.30	0.31	0.24	0.29b*
0	50		o.29	0.33	0.31	0.32	0.24	0.29b
0	100		0.30	0.32	0.31	0.35	0.27	0.31ab
25	100		0.30	0.37	0.34	0.36	0.26	0.32a
		Mean	0.29b*	0.33a	0.31ab	0.33a	0.25c	

C.V.= 5.33

* Means within row or column with the same letter do not differ significantly by Duncan's Multiple Range Test (P=0.05).

TABLE 4. The K (%) concentration of legume cultivars grown in a calcareous silty clay soil as affected by fertilization (1st. Harvest)

Fertilizer			Legume cultivars					
N	P		Fl 77	Yuchi	Barker	Hubam	Nolin	Mean
kg ha^{-1}			----------	----------	%	----------	----------	----------
0	0		3.26	4.09	3.58	3.60	3.66	3.63a*
0	50		3.25	4.23	3.61	3.29	3.48	3.75a
0	100		3.28	3.47	3.43	3.23	3.74	3.43a
25	100		3.01	3.72	3.61	3.56	3.86	3.55a
		Mean	3.02b*	3.87a	3.55ab	3.42ab	3.68ab	

C.V.=5.61

* Means within row or column with the same letter do not differ significantly by Duncan's Multiple Range Test (P=0.05).

TABLE 5. Forage dry matter yield of legume cultivars grown in a calcareous silty clay soil as affected by fertilization (2nd. Harvest)

Fertilizer		Legume cultivars						
N	P	Fl 77	Yuchi	Barker	Madrid	Hubam	Nolin	Mean
		kg ha^{-1}						
0	0	6560	7551	3075	3043	7554	7803	5962a*
0	50	6542	7470	3458	2961	7761	7632	5970a
0	100	7225	6989	3254	2563	7787	7510	5888a
25	100	8120	6599	3848	2603	7535	7526	6038a
	Mean	7111a*	7152a	3049b	2791b	7706a	7616a	

C.V.=11.98

* Means within row or column with the same letter do not differ significantly by Duncan's Multiple Range Test (P=0.05).

TABLE 6 . The N (%) concentration of legume cultivars grown in a calcareous silty clay soil as affected by fertilization (2nd. Harvest).

Fertilizer		Legume cultivars						
N	P	Fl 77	Yuchi	Barker	Madrid	Hubam	Nolin	Mean
kg ha^{-1}		- - - - - - - - - - - - - - - - -	- - - - - - - -	%	- - - - - - - -	- - - - - - - -	- - - - - - - -	- - - - - - - -
0	0	2.47	2.03	2.51	3.39	2.49	2.38	2.54a*
0	50	2.35	1.99	2.35	3.04	2.82	2.17	2.63a
0	100	2.19	2.22	2.49	2.54	2.31	2.16	2.31a
25	100	2.29	2.28	2.45	3.45	2.11	2.05	2.43a
	Mean	2.32b*	2.40b	2.45b	3.10a	2.43b	2.19b	

C.V.= 8.64

* Means within row or column with the same letter do not differ significantly by Duncan's Multiple Range Test (P=0.05).

TABLE 7. The P (%) concentration of legume cultivars grown in a calcareous silty clay soil as affected by fertilization (2nd. Harvest)

Fertilizer N	Fertilizer P		Legume cultivars Fl 77	Yuchi	Barker	Madrid	Hubam	Nolin	Mean
kg ha^{-1}			%						
0	0		0.20	0.22	0.20	0.31	0.19	0.19	0.21a*
0	50		0.21	0.26	0.20	0.28	0.19	0.21	0.22a
0	100		0.21	0.25	0.18	0.26	0.20	0.18	0.21a
25	100		0.20	0.25	0.20	0.31	0.20	0.19	0.22a
		Mean	0.20b*	0.24a	0.19b	0.29a	0.19b	0.19b	

C.V.=7.86

* Means within row or column with the same letter do not differ significantly by Duncan's Multiple Range Test (P=0.05).

TABLE 8. The K (%) concentration of legume cultivars grown in a calcareous silty clay soil as affected by fertilization (2nd. Harvest)

Fertilizer N	Fertilizer P		Legume cultivars: Fl 77	Yuchi	Barker	Madrid	Hubam	Nolin	Mean
kg ha^{-1}			%						
0	0		2.63	2.66	2.26	3.52	2.56	3.04	2.77a*
0	50		2.74	2.42	2.21	3.03	2.63	3.05	2.84a
0	100		2.47	3.09	2.14	2.84	2.66	2.77	2.66a
25	100		2.52	3.14	2.22	3.08	2.35	2.82	2.68a
		Mean	2.59bc*	3.28a	2.20c	3.11a	2.55bc	2.92ab	

C.V.=6.54

* Means within row or column with the same letter do not differ significantly by Duncan's Multiple Range Test (P=0.05).

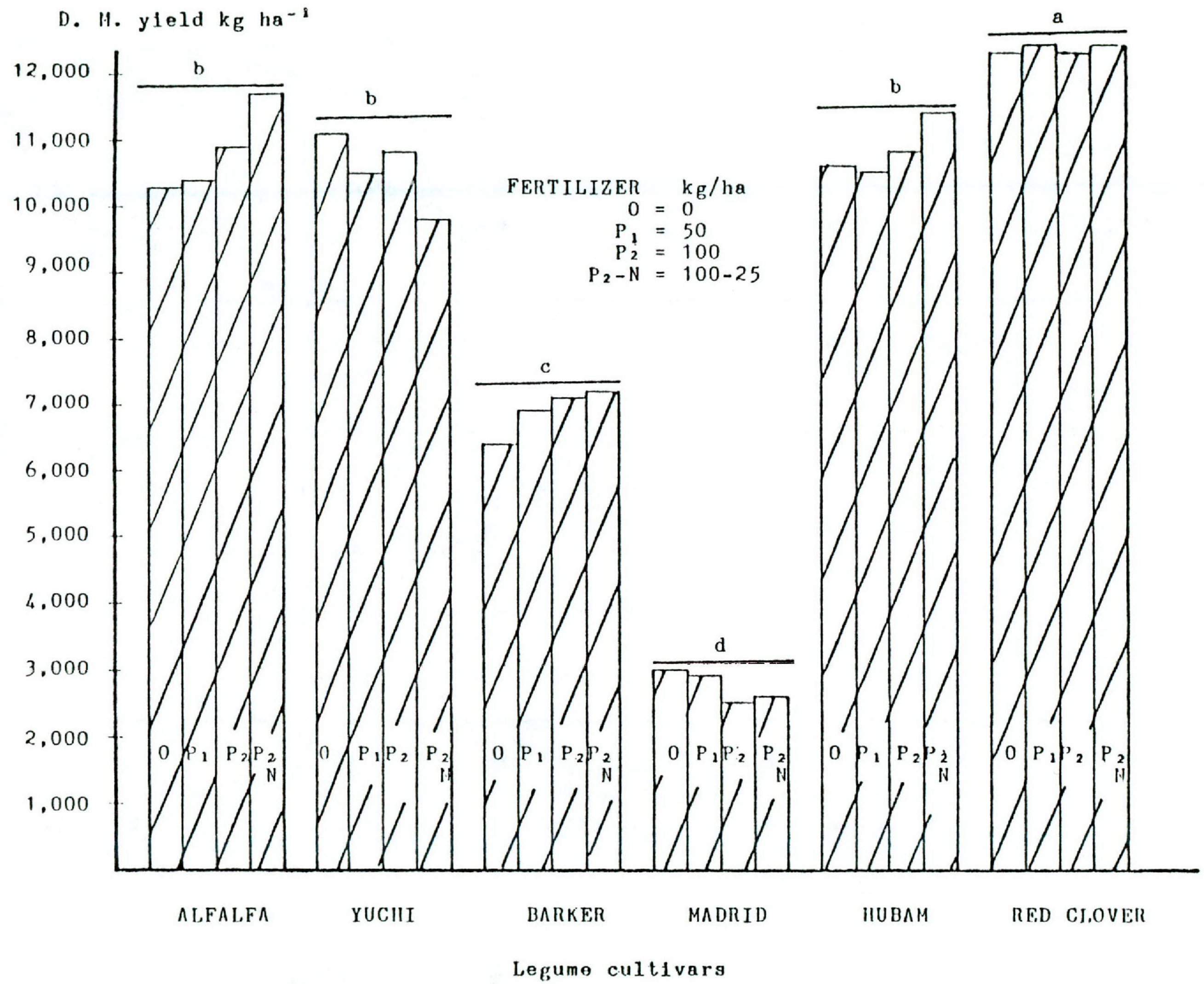


Fig 1. Accumulative dry matter yield of legume cultivars grown in a calcareous silty clay soil as affected by fertilization.

Field Efficiency of Nitrogen Fertilizers Surface Applied on Bermudagrass

T.E. Kunkel and W.B. Anderson

SUMMARY

Four nitrogen fertilizers [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 $CaCl_2$ increased plant response to urea fertilization. Individual experiments were initiated successively throughout two growing seasons on two diverse soils to encompass the differing environmental conditions which might influence NH_3 volatilization.

Data indicates the relative efficiency of the N sources on Ships C (a calcareous clay) to be UREA = AN = UAN > AS. On Lufkin fsl (an acid sandy loam) relative efficiency was UREA = AN = AS = UAN. Although $CaCl_2$ additive with urea reduced N losses from surface applied urea in the laboratory, it failed to significantly increase bermudagrass yield in 30 field tests conducted in the College Station, Texas area over two growing seasons. Nitrogen uptake data indicated no increased plant response to urea when supplemented with $CaCl_2$. It is hypothesized that significant N loss from surface applied urea due to NH_3 volatilization did not occur because soil surface (0-0.5 cm) moisture at the time of fertilizer application was insufficient to allow rapid urea hydrolysis and subsequent large NH_3 losses.

INTRODUCTION

In recent years, urea has gained importance among N fertilizers because of its low cost per unit of nitrogen. However, because of numerous studies citing decreased plant response (yield, N uptake) to urea as a nitrogen fertilizer, especially when surface applied, producers are hesitant to use this source in situations where fertilizer cannot be incorporated. Nitrogen losses as high as 70 percent have been recorded 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 N 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 N 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.

Graduate Student and Associate Professor, Soil & Crop Sciences Department, College Station, TX.

PROCEDURES

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 1982 and 1983 growing seasons. A total of 15 experiments per year were staggered throughout the two seasons to encompass the varying environmental conditions which might 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 4 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 (>10 mm). 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 N content using a common micro Kjeldahl method.

RESULTS AND DISCUSSION

Statistical analysis of bermudagrass dry matter yield for the two soil types is included in figure 1. The values of bermudagrass yield produced on Ships C are means of 22 experiments each with 4 treatment replications over both growing seasons. Yield values for Lufkin fsl include 8 experiments conducted over the same two growing seasons.

No significant difference is indicated among the AN, UAN, urea and urea + $CaCl_2$ treatments of Ships C. The AS treatment is comparable to AN, urea, and UAN. However, urea + $CaCl_2$ performed significantly better than AS (Duncan's multiple range test, $\alpha = 0.05$). In individual experiments of Ships C conducted during the two seasons, bermudagrass fertilized with AS produced lower yields than one or more of the other N sources in 15 of the 22 experiments. In 5 of 22 experiments, AS gave significantly lower yields than all other N sources. The lower yields are attributed to NH_3 volatilization losses when AS is applied to a calcareous soil.

The three urea products (urea, UAN, and urea + $CaCl_2$) gave consistantly comparable bermudagrass yields to those of AN throughout the two growing seasons. Contrary to most field comparisons between urea and AN, urea performed as well as or better than AN in all of the 22 individual experiments. Only minimal NH_3 volatilization losses are expected from AN. This suggests that NH_3 volatilization losses from urea were insignificant during the two growing seasons. Although urea supplemented with $CaCl_2$ effectively decreased NH_3 volatilization losses in laboratory and greenhouse experiments, no evidence is indicated for the necessity of $CaCl_2$ supplemented urea under environmental and soil conditions similar to those existing in the College Station, Texas area.

The comparison of bermudagrass yields on Lufkin fsl with different N sources indicates no significnt differences among sources (Duncan's multiple range test, $\alpha = 0.05$).

Plant tissue nitrogen concentration with varied N sources is depicted in Figure 2. Nitrogen content values are means of all 30 experiments conducted, each consisting of 4 treatment replications. Plant tissue nitrogen concentration is elevated from approximately 1.0% to 1.3% by N fertilization. However, no significant differences are indicated among N sources.

Nitrogen uptake by bermudagrass for the various N sources is depicted in Figure 3 for both soils. On Ships C, N uptake by bermudagrass was significantly lower from AS than from the other N sources. All other N sources (UAN, urea, AN, and urea + $CaCl_2$) were comparable. No significant difference among N sources was indicated on Lufkin fsl.

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	28.5
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	Rate (kg N ha^{-1})	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 + $CaCl_2$*	100	liquid	surface band
Control	0		

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

Fig. 1 BERMUDAGRASS YIELD

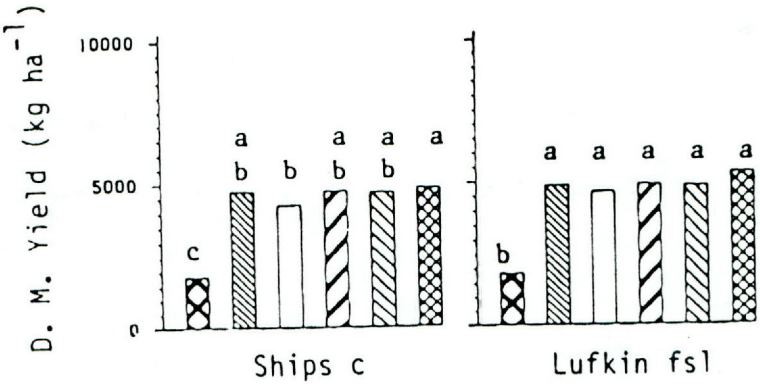


Fig. 2 PLANT TISSUE NITROGEN

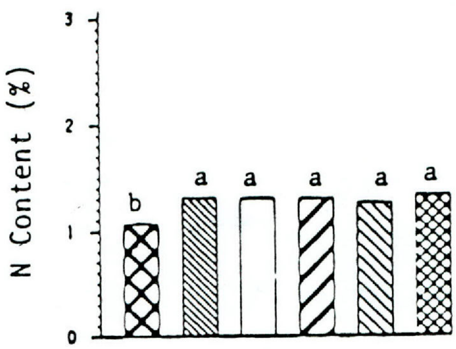
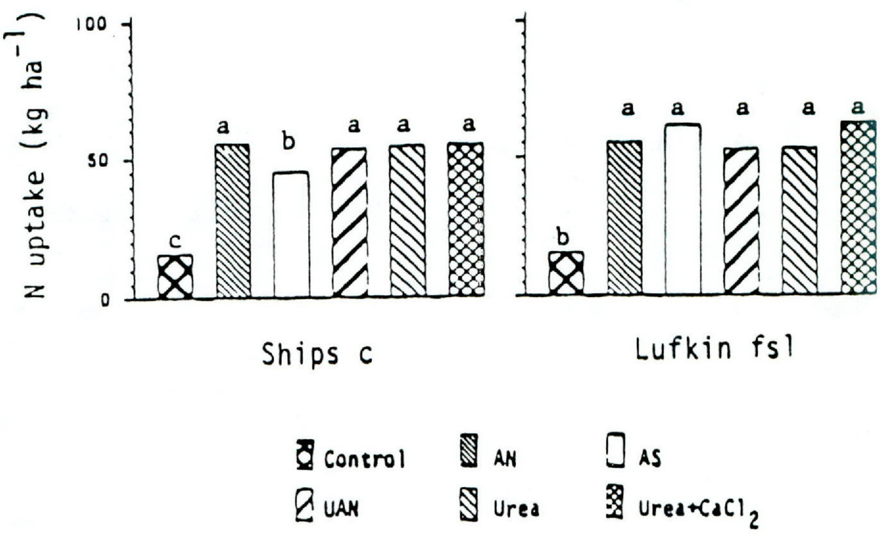


Fig. 3 NITROGEN UPTAKE BY BERMUDAGRASS



N rate = kg ha^{-1}

PHYTOTOXICITY OF LEACHATE FROM COASTAL BERMUDAGRASS ROOTS ON GERMINATION AND ROOT GROWTH OF GRASS AND CLOVER

L. R. Nelson, G. R. Smith and Cathy Bateman[1]

SUMMARY

Coastal bermudagrass roots were soaked in distilled water for either 24 or 48 hours. Leachate was filtered and utilized to wet germination pads. Four grass species (Gulf ryegrass, Bradford and Coker 762 wheat and Mesquite oats) and three clovers (Chief crimson, Yuchi arrowleaf, and Mt. Barker sub. clover) were treated with distilled water, 24 hours leachate and 48 hour leachate. Results from this study indicate that germination of the grass or clover was not reduced by the leachate. In addition, root length of the grass species was not reduced by the leachate compared to the control.

INTRODUCTION

During the past few years there has been an increasing interest and research on allelopathy. Allelopathy is the injurious or toxic effects on plants caused by release of toxic substance or compounds from other plants. Many species release toxic chemicals that will not allow certain other plants to grow within that area (3). Hoveland (2) studied the effect of root extract (ground root tissues) of bermudagrass, bahiagrass, dalligrass, johnsongrass, sorghum almum and tall fescue on germinating seed of white, ball, crimson clover, and alfalfa. He reported that johnsongrass and sorghum almum extracts caused the most severe reduction in germination and seedline vigor. Bermudagrass was the next most toxic grass followed by dalligrass and bahiagrass, with tall fescue having little effect. Germinating clover seedlings reacted differently to source of extract. Cope (1) studied the effect of leachate from germinating seed of eight grass and clover species on all eight species. Germination and seedling growth of a species was not inhibited by leachate from its own seeds. There was no phytotoxicity of any grass to other grass species. Cope found that leachate from one commercial lot of annual ryegrass seed almost completely inhibited germination and root growth of each of the legumes. Other cultivars of ryegrass varied in their phytotoxicity of their leachate. The objectives of this study were to determine if leachate from Coastal bermudagrass roots would delay or reduce germination of wheat, ryegrass, oats or clovers and to determine whether leachate from Coastal bermudagrass would affect seedling root length of the above species.

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[1]Associate Professor, Assistant Professor and Technical Assistant II, respectively, The Texas Agricultural Experiment Station, Overton.

KEYWORDS: Leachate/ germination/ wheat/ oats/ clovers

PROCEDURE

Coastal bermudagrass roots and rhyiomes were collected and washed in distilled water. Leaf blades were partly removed, leaving approximately 3 cm. At a ratio of 100 g plant material per liter of water, the bermudagrass was soaked in distilled water. Treatment #1 was distilled water which was a control; treatment #2 was the bermudagrass soaked for 24 hrs; and treatment #3 was a 48 hr soak. Once the plant material had soaked the respective time it was removed and the leachate filtered through a medium-fast qualitative filter paper and stored at 4°C. Seeds were germinated in petri dishes on germination pads. Twenty-five seed per petri dish were watered with 5 mls of fresh leachate of the respective treatments. Each dish was randomly placed (within a replication) in a seed germinator for 50-60 hrs at 22°C. Percent germination was determined at this time. The grass seedlings were given an additional 5 ml of leachate to prevent drying and returned to the germinator. Root lengths were then determined in 24-48 hrs.

This study was observed in 5 replications (blocks), 3 treatments and 7 varieties. The study was conducted in September and repeated in December to determine if leachate from dormant bermudagrass would be different than leachate from actively growing bermudagrass.

In order to make comparisons between the 3 treatments the percent seed germinated from the distilled water treatments were given the value of 100 percent. The other treatments were a percentage of that and in some cases were greater than the control or greater than 100%.

RESULTS AND DISCUSSION

Percent germination: Although there was some slight variation, there was no significant difference for percent germination caused by leachates from bermudagrass (Table 1.). This was true for leachate from both the active and dormant bermudagrass. Neither the grass or legumes were affected by these treatments.

Root lengths: There were no significant differences (0.05 level) for root length between leachate treatments for any of the 4 grasses (Table 2). Therefore, the leachate from Coastal bermudagrass as obtained in this study did not reduce early seedling root length. With Coker 762, there may have been a slight stimulation by the leachate in both the active and dormant sod.

These results do not agree with the findings of Hoveland (2) or Cope (1); however, Hoveland used leachate from ground tissue and Cope used leachate from seeds. We believe the technique we followed more closely relates to conditions found in a sod under field conditions than either of their studies. Our data indicates that allelopathy is probably not a problem when planting the species in this study into a Coastal bermudagrass sod.

LITERATURE CITED

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TABLE 1. PERCENT GERMINATION OF WHEAT, RYEGRASS, OATS, RED CLOVER, AND ARROWLEAF IN EXTRACTS FROM ACTIVE AND DORMANT TILLERS OF COASTAL BERMUDAGRASS SOD

	Active bermudagrass			Dormant bermudagrass		
	Harvest date 9-30-83			Harvest date 12-9-83		
Forage variety	Distilled water	24 hr. soak	48 hr. soak	Distilled water	24 hr. soak	48 hr. soak
Ryegrass - Gulf	100	97	95*	100	101	99*
Wheat - Bradford	100	100	99*	100	97	98*
Wheat - Coker 762	100	99	99*	100	99	101*
Oat - Mesquite	100	98	97*	100	97	95*
Mean (grass)	100	99	99*	100	98	98*
Clover - Chief	100	109	105*	100	119	114*
Clover - Yuchi	100	99	102*	100	110	100*
Clover - Mt. Barker	100	102	99*	100	92	89*
Mean (clover)	100	103	102*	100	107	101*

*No significant differences in percent germination between the three treatments from either the active or dormant bermudagrass.

TABLE 2. ROOT LENGTHS OF 5 GRASSES GERMINATED AND GROWN IN A CONTROL AND 2 EXTRACTS FROM SOD OF ACTIVE AND DORMANT COASTAL BERMUDAGRASS

	Active bermudagrass				Dormant bermudagrass			
	Harvest date 9-30-83				Harvest date 12-9-83			
Forage - variety	Distilled water	24 hr. soak	48. hr soak	LSD	Distilled water	24 hr. soak	48 hr. soak	LSD
	cm				cm			
Ryegrass	2.9	2.8	3.8	0.65	2.9	2.8	2.6	0.63
Wheat - Tx-7393	4.8	5.3	4.9	0.65	4.2	4.6	4.5	0.63
Wheat - Coker 762	4.9	5.8	5.7	0.65	4.7	5.9	5.0	0.63
Oat - Mesquite	4.5	4.6	4.7	0.65	5.1	4.6	5.1	0.63
Mean	4.3	4.6	4.6	-	4.4	5.2	4.9	-

Water Use by Alfalfa Over Winter

D. J. Undersander

SUMMARY

The water used by an alfalfa crop during the 1983-84 winter was monitored at Bushland, Texas. From the last alfalfa harvest (September 14, 1983) to the beginning of spring growth (March 20, 1984) the total water use by alfalfa was 3.7 inches. This water loss occurrred during an unusually cold winter in which there was no growth from approximately November 1 to March 1.

INTRODUCTION

Many farmers neglect their alfalfa fields from the last harvest in the fall until spring growth has started. However, the alfalfa crop is alive and continuing to function at some reduced level over winter. This lack of attention, particularly with regards to irrigation, may cause the plant to become severely stressed towards spring and delay the onset of spring growth. Therefore, a study was initiated to measure water use by alfalfa over winter.

PROCEDURE

Ten access tubes for measurement of soil water by the neutron moderation method were installed to a depth of 6 feet in an established alfalfa stand to a. The alfalfa crop was irrigated to approximate field capacity after the last harvest on September 12, 1983. Soil water use by the alfalfa was monitored by periodic readings with a neutron probe. Precipitation was recorded in U. S. standard 8-inch rain gauges.

RESULTS AND DISCUSSION

The precipitation and change in soil water by approximate monthly periods are presented in Table 1. The change in soil water was subtracted from the precipitation to determine the total water use by the alfalfa crop for the same time periods. As can be seen from the table, the alfalfa crop used a significant amount of water over winter. The total water use by the alfalfa crop for the winter of 1983 was 3.7

KEYWORDS: irrigation, alfalfa production

inches. The large water use is suprising since the winter of 1983-1984 was unusually cold. The cold weather prevented regrowth after the last harvest. This accounts for some of the lack of water use immediately after the last cutting.

It is not known to what extent this water use by alfalfa is necesary. Alfalfa plants that are not water stressed have a greater degree of winter survival. However, it may not be necesary to give alfalfa all the water it can use over winter. The data indicated that alfalfa will largely deplete a soil profile of water over winter and that it is necesary to begin irrigating early in the spring to stimulate early growth of the alfalfa crop.

Table 1. Water use by alfalfa during the winter in North Texas

Time period	9/14-10/12	10/12-11/16	11/16-12/27	12/27-1/11	1/11-2/22	2/22-3/20	Total
	Inches						
Precipitation	0.1	2.1	1.7	0.0	0.6	0.0	4.5
Change in soil water *	0.1	0.7	-0.5	0.6	-0.3	0.2	0.8
Water use in alfalfa	0.0	1.4	2.2	0.0	0.9	-0.2	3.7

* To depth of 6 feet

Water Use By Alfalfa for Forage Production

D. J. Undersander and C. H. Naylor

SUMMARY

Four varieties of alfalfa were grown under a gradient irrigation system during the summer of 1983. There were differences in the water use efficiency (WUE) pounds of dry matter produced per inch of water used among harvests and among varieties within harvests. The range in WUE was from 275 for harvest 1 to 434 for harvest 2. The four varieties of the study showed variation in WUE.

INTRODUCTION

Increased energy costs have necessitated greater efficiencies in production of irrigated crops. Identification of varietal differences in water use efficiencies (WUE) (forage production/unit of water), could provide economic benefits to the farmer. Additionally, in the High Plains where the Ogalla aquifer is being depleted and, well capacities are declining, the question frequently asked is: how much alfalfa forage can be produced with a given well capacity? The objective of this research is to determine if varietal differences exist in WUE of alfalfa and to develop production functions for alfalfa forage production.

PROCEDURE

Four varieties of alfalfa (Vangard, Zia, Cody, Dawson) were planted under a gradient irrigation system in the fall of 1982 with two replicates. Catch cans were placed in the field at 3.3, 13.1, 23.0, 32.8 and 42.7 feet from the line source of sprinklers. Water collected in these containers was recorded after each irrigation or rainfall. Access tubes for measurement of soil water by the neutron moderation method were installed to 6-foot depths adjacent to the catch can.

The plots were irrigated two to three times a week to apply a range of approximately 0 to 10 acre-inches of water per harvest. Forage yields were determined by harvesting strips 3.3 feet wide by 17 feet long. Fifteen parallel strips were harvested across the width of the plot over the range of irrigations.

KEYWORDS: water use efficiency, irrigation.

RESULTS AND DISCUSSION

The seasonal forage yields ranged from approximately 500 pounds of dry matter per acre for unirrigated alfalfa to approximately 6,000 pounds for fully irrigated alfalfa. Little or no rainfall occurred during the three harvests reported here, thus the dryland forage yields came almost entirely from stored soil moisture.

All of the response curves indicate high water requirements per pound of forage produced. This was due to the unusually high temperatures and radient energy that occurred during most of the growing season. The correlation coefficients of the response curves were generally greater than 0.9, indicating a highly linear yield response from water. The data also indicated that, with the exception of one variety-harvest combination, the yield plateau was not reached and, therefore, higher levels of irrigation would have increased yields.

As Table 1 indicates, there was considerable variation between harvests in WUE. Generally, harvest 1, which was harvested July 18 and grew through the hottest temperatures, had the lowest WUE (275 lb/A-in). The second harvest (harvested August 8) had a much higher WUE (434 lb/A-in). The yield response curve would have been higher for harvest 2 except that Zia produced less forage per unit water compared to the first and third harvest while the other varieties produced more.

There also appeared to be some variation in the WUE of the four varieties examined (Table 2) Zia produced more forage per unit of water than the other three varieties in the study. The other varieties were similar in WUE.

In summary, WUE of alfalfa varied among harvests during the growing season of 1983. This was probably related to the temperature under which the crop grew. Additionally, there appeared to be some varietal differences in WUE of alfalfa.

Table 1. Variation in Water Use for Forage Production by Harvest

Harvest 1
Yield (lbs DM/A)* = 275 * Water **

Harvest 2
Yield (lbs DM/A) = 434 * Water

Harvest 3
Yield (lbs DM/A) = 345 * Water

* Pounds dry matter of forage per acre.

** Total inches of water per acre available for growth, includes, rain, irrigation and soil water.

Table 2. Variation in Forage Production by Variety.

VANGUARD
Yield (lbs DM/A)* = 306 * Water **

CODY
Yield (lbs DM/A) = 319 * Water

ZIA
Yield (lbs DM/A) = 375 * Water

DAWSON
Yield (lbs DM/A) = 345 * Water

* Pounds dry matter of forage per acre.

** Total inches of water per acre available for growth, includes rain irrigation and soil water.

The Growth Pattern and Protein Content of Amaranthus retroflexus

Everisus O. Mba and E. Brams

SUMMARY

The project was designed to define the growth pattern and measure the protein content of Amaranthus retroflexus (amaranth, redroot pigweed) as well as ascertain its palatability as a feed for dairy goats. Growth followed the classic sigmoidal curve. Analysis of the growth measured by plant biomass exhibited the initial slow start during the lag stage from 0 to 21 days after emergence followed by active growth period during 22 to 49 days after emergence reaching maturity between 50 to 91 days. Maximum protein content (7.86 percent) of top biomass including seed was obtained during the active growth stage. The protein content decreased by 25% as the plants reached maturity. Palatability of the plant measured by the relative consumption of Amaranthus retroflexus and Cynodon dactylon (Coastal bermudagrass) hay by four dairy goats showed that the goats consumed 7 times more amaranth hay than the bermuda hay. During the relatively short 11 day trial, the results indicated preference for amaranth as a dairy goat feed. However, research must be continued to measure the response to the oxalic acid content of amaranth on animal health and milk production.

INTRODUCTION

One of the leafy plants used as human food in some parts of the tropics is Amaranthus retroflexus (Amaranth, redroot pigweed). It is among the C-4 photosynthesizing plants. Its efficiency of converting incident solar energy is greater than that of common cereal plants (Zelitch, 1977). Although amaranth is considered a tropical plant, the plant grows well in the temperate climate of some mid-western areas of the United States. It has limited use as a warm-season substitute for spinach by amateur gardeners. As a farm crop, it is new to traditional American farmers but common among organic farming enthusiasts.

Amaranth grows profusely in South Texas where it is considered a noxious and troublesome weed with the result that

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KEY WORD: Amaranth/ Redroot pigweed/ Dairy goats/ Bermudagrass

little attention has been directed towards its nutritional potentials as a possible livestock feed. Fortunately, research conducted by the Organic Gardening and Farming Research Center (OGFRC) at Rodale Farms, Philadelphia, Pa. has revealed that amaranth leaves synthesize relatively high concentrations of protein. Hill and Rawate (1981) found that the vegetable parts of the plants are high in protein, calcium, potassium, iron and asorbic acid, indicating a high human food potential and feed for livestock. Since amaranth leaves provide a relatively high content of protein and the plant grows so easily in South Texas, it has the potential as a livestock feed. Because this potential has not been exploited, research relative to its use as a feed should be conducted.

Therefore, the objectives of this paper were to determine the growth pattern and protein content of amaranth. In addition, an experiment was conducted to ascertain the comparative palatability of amaranth to bermuda hay utilizing the goat as a test animal.

Experiment I

This study determined the growth pattern and protein content of Amaranth as responses to plant density and harvests conducted at the Prairie View A&M University Agricultural Experiment Station, Prairie View, Texas from May through September, 1983. The soil series is a Hockley fine sandy loam (siliceous, thermic, Plinthic Paleudalf). According to Brams and Anthony (1983) this soil has by a pH of 5.1, with 0.5 percent organic carbon, and a bulk density of 1.56. The soil is 61 percent sand, 25 percent silt and 14 percent clay with kaolinite as the dominant clay species. There was no planting of amaranth plants because they grow as volunteers readily at this station. Therefore, an area 29.8 m^2 located where amaranth plants grew during the last growing season was tilled and treated with 100 lb. 21-8-17 blended fertilizer broadcasted during the month of May, 1983. The amaranth germinated on June 2, 1983, which was noted as the day of emergence. Perennial rye grass (*Lolium perenne* L.) and Coastal bermudagrass (*Cynodon dactylon*) were the outstanding weeds. The dominant parasite observed was black cutworm larvae which pupated on the amaranth.

Experimental Design

The experiment tested the yield response of amaranth to two levels of density and two cutting treatments (none, except at maturity and 2 harvests during growth period) for a total of four treatments. The low density plot averaged 11 plants per M^2 and the high density plot averaged 38 plants per M^2. The experiment was a completely randomized split-plot design of four treatments of four replications per treatment for a total of sixteen experimental units. Main plots were identified as cutting treatments while the subplots were identified as the density of stand.

Experiment II

The experiment to test the palatability of the amaranth plant was conducted at the Prairie View A&M University International Dairy Goat Research Center at Prairie View, Texas. The experiment measured the consumption of amaranth and bermuda hay by allowing the goats to feed free-choice from the two feeds. Four Toggenburn female goats five months old were used for the study.

Each goat was separately housed and each provided with two separate feeders and a container of water. Before the feeding trial was started, each goat was fed 400 gm of amaranth hay and 400 gm of bermuda hay, mixed together each day for 7 days to condition the goats for the forthcoming feed trial. The palatability test was conducted by providing each goat at 7 a.m. a separate weighed amount of amaranth and bermuda hay (450 g. each). Goats were allowed to eat freely from any of the two feeds. At mid-day, the feed containers were switched to prevent goats from becoming use to any feed being kept in a particular feeder. The amount of each feed, (amaranth and/or bermuda) consumed was recorded before a new daily supply was made available. Body weights of the goats were taken on the first and the eleventh day. No supplement was fed.

The analysis of data in Table 1 shows the density of amaranth stand did not influence the dry matter yield (0.05 level of probability) where production averaged 1914 and 1929 kg/ha for both low and high density treatments for all cutting treatments. Production in the maturing plots under the density treatments averaged 1843 and 1718 kg/ha and was not significant (0.05 level). It can be assumed that the reduced number of plants in the low density stand resulted in more biomass per plant whereas the high density stand with a greater number of plants produced less dry matter per plant or thinner more succulent plants per unit area of ground.

The data in Table 2 are measurements of protein concentration in top biomass (including seeds) of amaranth as a function of growth and cutting. The protein concentration of amaranth samples taken 30 days after emergence averaged 7.68 and 7.65% in plots designated under cutting and maturing treatments (Table 2). Analysis of biomass taken 14 days after the first harvest of the cutting plots showed the protein concentration reached only 4.20%. Samples taken after 28 days growth indicated protein percent had increased to 7.40 and began a slow, but not significant decline to 6.78% after 56 days of growth following the first harvest (Table 2). The maturing plots which were not harvested until 86 days after emergence achieved an average protein concentration of 7.39% while the average protein in the plants that were harvested averaged 7.18%, a value not significantly different from the maturing plants.

The curves in Figure 1 show the relative consumption of amaranth and bermuda hay by the test goats. The consumption of amaranth exceeded that of bermuda by a factor of 7-fold during the course of the trial. The marked drop in amaranth consumption between day 3 and 6 could be attributed to an adjustment period to a new feed compared to bermudagrass which was the formal diet prior to the experiment. There also occurred a rise in air temperature during this period which adversely affected feed intake for both amaranth and bermudagrass (Figure 1).

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Table 1. Average Dry Matter Yields/Density Stand for Cutting Plots and Matured Plots

	Cutting Plots Yields Average Kg/Ha			Maturing Plots Yield Average Kg/Ha
	First	Second	Total Cutting	
	---Cuttings---			
High Density	940	974	1914a	1843b
Low Density	931	998	1929a	1818b

Values with the same letter are not significantly different at the 0.05 level (Duncan Multiple Range Test).

Table 2. Protein Content of *Amaranthus retroflexus* during growth period and after cutting

Treatment	Date of Measurement	Growth Period (Days)	Cutting Plots	Maturing Plots
			----- % Protein	-------
1st Harvest	6/30/83	30[1]	7.68	7.65
	------ Days of Growth After 1st Harvest ------			
	7/14/83	14[2]	4.20[2]	7.87
	7/28/83	28	7.40	7.82
	8/11/83	42	6.87	6.86
2nd Harvest	8/25/83	56	6.78	6.77
Average Means			$\bar{x}$ = 7.18	$\bar{x}$ = 7.39

1 After Emergence

2 Value not utilized in calculation of mean protein levels of cutting plots.

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