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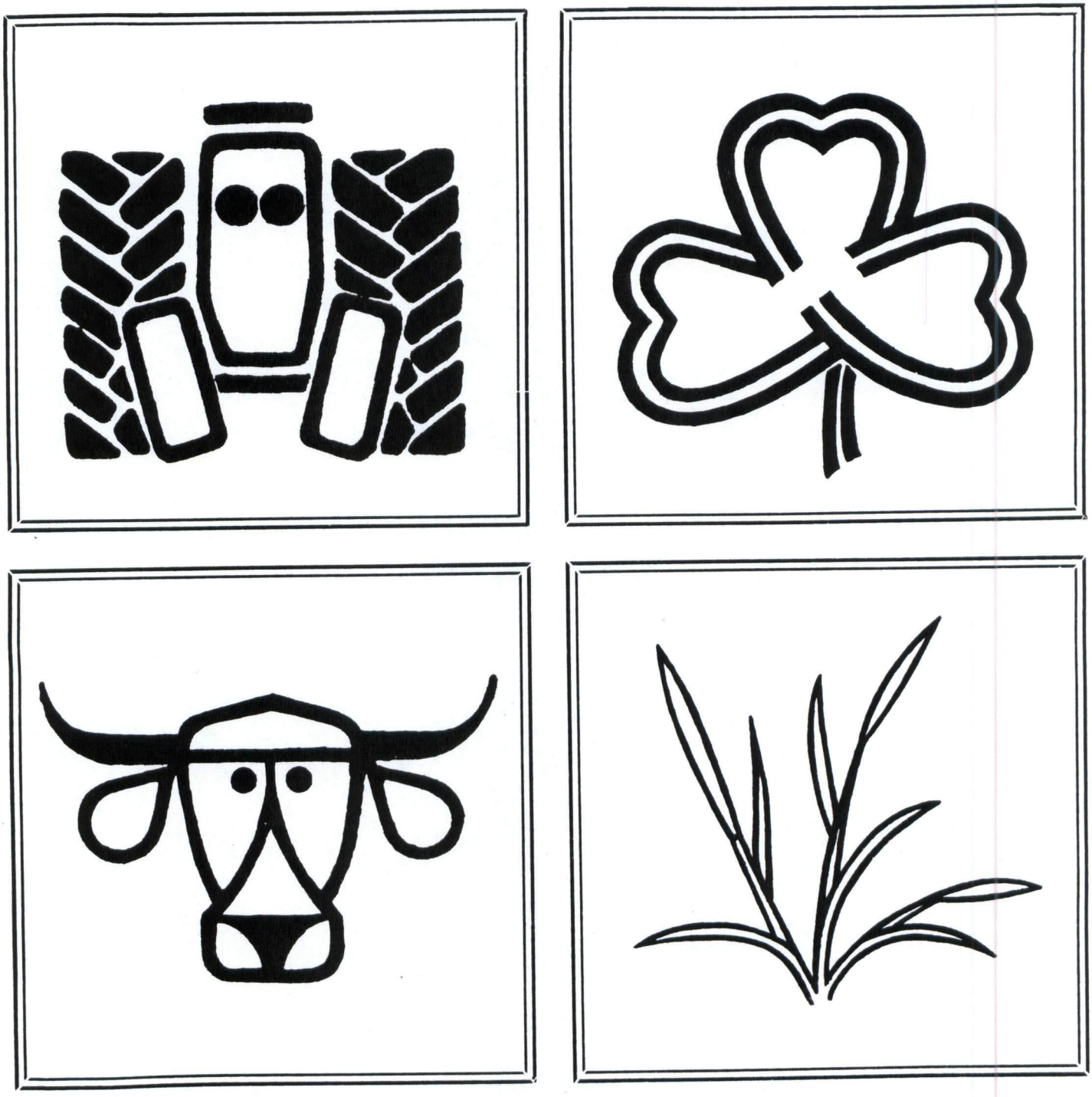

Forage Research in Texas

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Influence of Source and Rate of Nitrogen on Coastal Bermudagrass Forage Grown on Two Soil Types

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SUMMARY

Nitrogen was applied at 200 and 400 lbs/acre as ammonium nitrate, urea, ammonium nitrate sulfate, urea ammonium phosphate, and calcium-protected urea to Coastal bermudagrass growing on a Darco soil. The same nitrogen sources were applied to Coastal bermudagrass growing on a Cuthbert soil at rates of either 150 or 300 lbs N/ac. Percent nitrogen of the forage was analyzed at each harvest date. In general, bermudagrass growing in the check plot (0 rate of nitrogen) on the Cuthbert soil produced more forage than that from the check plot on the Darco soil. In general, the yield differences between rates (1X vs 2X) were greater than that of nitrogen source. With respect to forage yield expressed as a function of fertilizer nitrogen applied, the bermudagrass growing on a Cuthbert soil was a more efficient utilizer of nitrogen as compared to bermudagrass growing on a Darco soil.

Introduction

Forage-based livestock operations in the Southeastern U.S. have been heavily dependent upon nitrogen fertilizer for quality and quantity hay production. With increased costs of fossil fuels, the continued use of relatively high rates of nitrogen will be significantly influenced by the efficiency of both the rate and source of fertilizer material. The primary objective of this trial was to examine two nitrogen rates commonly used in commercial hay production, and six sources of nitrogen fertilizer on bermudagrass growing on two soil types.

Procedure

Nitrogen (N) was split applied to Coastal bermudagrass at 0, 200, or 400 lbs/ac as ammonium nitrate (33.5-0-0), urea (46-0-0), Ortho ammonium nitrate sulfate (30-0-0-6), Nipak urea ammonium phosphate (30-15-0), and Fenn's calcium-protected urea (28-0-0). All rates of nitrogen were broadcast applied with the exception of Treatment 10 which was banded (Table 1). Nitrogen was applied in equal applications at the beginning of the growing season and after each harvest date except the last harvest. Bermudagrass growing on the Darco soil received only 75% of the total N rate (150 and 300 lbs/ac) during the first year because of drought-like conditions (Table 2), but received the planned rates of N (200 and 400 lbs/ac) during the second and third growing seasons. Because of the dry conditions during the first year and labor-related management problems during the second year, the bermudagrass growing on the Cuthbert soil received total N rates of 150 and 300 lbs/ac during both the first and second years of the trial.

Potassium was applied at the rate of 240 lbs/acre of K_2O (0-0-60) to all plots on both soil types. Phosphorus was applied at the rate of 200 lbs/acre of P_2O_5 (0-46-0) to all plots on both soil types with the exception of Treatment 8 which received 100 lbs/ac P_2O_5 and Treatment 9 which received 0 lbs/ac P_2O_5. Gypsum was applied at the rate of 40 lbs/acre sulfur to all plots on both soils with the exception of Treatments 6 and 7 which received 0 lbs/acre gypsum.

All plots were harvested with a sickle-type mower and monitored for dry matter yield and forage nitrogen content. Nitrogen determinations were via micro-Kjeldahl.

Results and Discussion

Cuthbert soil

Dry matter (DM) yields and percent nitrogen (N) of bermudagrass during a two-year period are shown in Tables 3-7. More than twice (12" vs 28") the rainfall occurred during the second year's growing season as compared to the first year of the trial (Table 2). And, as a result, DM yields during the second year were nearly double the yields from the first year. This second-year yield response also held for the check plots. Dry matter production differences were greater between rate of N rather than between sources of N. The first 150 lbs N/ac resulted in DM production which ranged from 4360 lbs/ac for urea and ammonium nitrate sulfate to 4700 lbs/ac for ammonium nitrate and urea ammonium phosphate (Table 7). The efficiency of applying the second 150 lbs N/ac (300 lbs N/ac total) in terms of DM yields, were 71.2, 62.0, 61.7, and 56.0% for ammonium nitrate, urea, ammonium nitrate sulfate and urea ammonium phosphate, respectively (Table 15).

Darco soil

Production of forage DM and percent N of bermudagrass during a three-year period are shown in Tables 8-14. Rainfall was responsible for approximately doubling DM during the second year as compared with the first year's trial. Three-year average DM yields from the 1X rate of N ranged from 7,049 lbs/ac for urea ammonium phosphate to 7,516 lbs/ac for urea (Table 14). The 2X rate of N was responsible for three-year DM productions which ranged from 8,784 lbs/ac for urea to 10,240 lbs/ac for calcium-protected urea. The efficiency of applying the second rate of N (double rate), in terms of DM yields, were 16.9, 29.1, 34.4, and 40.6% for urea, ammonium nitrate, ammonium nitrate sulfate, and urea ammonium phosphate, respectively (Table 15). Thus, when the two soil types are compared on the basis of efficiency of DM production as related to the 2X rate, the various sources of N fertilizer occupy nearly reverse rankings. The calcium protected urea was only applied at the 2X rate; therefore, no efficiency comparisons could be made between rates.

General

From the data shown in this trial, there were considerable DM and efficiency of N utilization due to rates, sources, and soil type. The most dramatic differences in efficiency of N utilization occurred with the 2X rate of urea when applied to a Cuthbert (62%) and a Darco (16.9%) soil. Overall the Cuthbert soil, which is a sandy clay loam with gravel outcrops, was more efficient in using N than was the deep, sandy Darco soil. Before any economic comparisons are made, adjustments need to be made for both the sulfur-containing source and the phosphate containing sources.

Table 1. Nitrogen rate and source treatments applied to Coastal bermudagrass.

Treatment No.	N Rate (lbs/ac)	N Source
1	0	Check
2	200	ammonium nitrate (33.5-0-0)
3	400	ammonium nitrate (33.5-0-0)
4	200	urea (46-0-0)
5	400	urea (46-0-0)
6	200	Ortho ammonium nitrate sulfate (30-0-0-6)
7	400	Ortho ammonium nitrate sulfate (30-0-0-6)
8	200	Nipak urea ammonium phosphate (30-15-0)
9	400	Nipak urea ammonium phosphate (30-15-0)
10	400	Ca-protected urea (band) (28-0-0)
11	400	Ca-protected urea (broadcast) (28-0-0)

Table 2. Monthly and total rainfall during study period.

Month	Year 1	Year 2	Year 3
	inches		
January	4.21	9.35	3.62
February	2.69	3.45	2.69
March	3.49	5.70	2.67
April	1.16	4.95	4.35
May	4.20	7.06	6.15
June	0.39	2.04	2.11
July	2.14	4.03	1.38
August	1.55	0.57	0.95
September	0.95	6.64	3.26
October	1.65	2.47	1.96
November	5.90	4.31	3.58
December	2.57	5.12	1.53
TOTALS			
1. April - October	12.04	27.76	20.16
2. Year	30.90	55.69	34.25

Table 3. First year total dry matter production of Coastal bermudagrass on a Cuthbert soil.

Treatment[1]	Harvest Date 5-24	7-25	10-16	Total
	(lbs/ac)			
1	1046	1083	1524	3653 d[2]
2	2261	2975	1698	6934 abc
3	3411	3599	1911	8921 a
4	1750	2676	1784	6210 c
5	2581	3543	1878	8002 abc
6	2313	2942	1771	7026 abc
7	3179	3605	1878	8662 ab
8	1921	2559	2176	6656 bc
9	2670	3629	1980	8279 abc
10	3162	3340	2104	8606 ab
11	3200	3207	1939	8346 abc

Table 4. First year percent nitrogen of Coastal bermudagrass forage grown on a Cuthbert soil.

Treatment[1]	Harvest Date 5-24	7-25	10-16
	% N		
1	1.90 e	1.34 cde	1.29 cd[2]
2	2.22 bcde	1.18 e	1.25 cd
3	2.56 a	1.73 ab	1.83 ab
4	2.29 abcd	1.55 bcd	1.35 cd
5	2.19 cde	1.62 b	1.91 a
6	2.40 abc	1.27 de	1.47 bcd
7	2.55 ab	1.74 ab	1.63 abc
8	1.95 de	1.57 bc	1.31 cd
9	2.26 abcde	1.63 ab	1.50 bcd
10	2.32 abc	1.76 ab	1.62 abc
11	2.51 abc	1.87 a	1.18 d

[1]Because of drought-like conditions, nitrogen rate applied was either 150 or 300 lbs/ac.

[2]Numbers within a column and followed by the same letter are not significantly different at the 0.05 level using Duncan's Multiple Range Test.

Table 5. Second-year dry matter production of Coastal bermudagrass grown on a Cuthbert soil.

Treatment[1]	Harvest Date 6-14	8-11	11-1	TOTAL
	lbs/ac			
1	3054	1401	1616	6,071 e[2]
2	4286	3263	4649	12,198 d
3	6546	4267	6096	16,909 a
4	4678	3163	4398	12,239 d
5	6559	3813	5484	15,856 bc
6	3747	3101	4569	11,417 d
7	5421	4026	5710	15,157 c
8	5017	3206	4339	12,562 d
9	5901	4196	6161	16,258 ab
10	6490	4176	5946	16,612 ab
11	6581	3854	5412	15,847 bc

Table 6. Second-year percent nitrogen of Coastal bermudagrass forage grown on a Cuthbert soil.

Treatment[1]	Harvest Date 6-14	8-11	11-1
	% N		
1	1.36 a	1.37 c	1.00 bc[2]
2	1.47 a	1.91 b	1.01 bc
3	1.53 a	2.28 a	1.15 abc
4	1.55 a	1.85 b	1.07 bc
5	1.44 a	2.36 a	1.18 ab
6	1.46 a	1.91 b	1.04 bc
7	1.33 a	2.08 ab	1.35 a
8	1.39 a	1.92 b	.93 c
9	1.70 a	2.25 a	1.21 ab
10	1.60 a	2.07 ab	1.04 bc
11	1.45 a	2.12 ab	1.15 abc

[1]Total N rate applied was either 150 or 300 lbs/ac

[2]Numbers within a column and followed by the same letter are not significantly different at the 0.05 level using Duncan's Multiple Range Test.

Table 7. Two-year average of dry matter production of Coastal bermudagrass grown on a Cuthbert soil.

Treatment	Year 1	Year 2	AVERAGES		
	lbs/ac				
			Total Yield	Fertilizer N Yield	2X N Yield
1	3,653	6,071	4,862	0	0
2	6,934	12,198	9,566	4,704	-
3	8,921	16,909	12,915	8,053	3,349
4	6,210	12,239	9,225	4,363	-
5	8,002	15,856	11,929	7,067	2,704
6	7,026	11,417	9,222	4,360	-
7	8,662	15,157	11,910	7,048	2,688
8	6,656	12,562	9,609	4,747	-
9	8,279	16,258	12,269	7,407	2,660
10	8,606	16,612	12,609	7,747	-
11	8,346	15,847	12,097	7,235	-

Table 8. First year dry matter production of Coastal bermudagrass on a Darco soil.

Treatment[1]	Harvest Date 5-25	7-26	10-12	TOTAL
	lbs/ac			
1	556	954	1213	2723 g[2]
2	2259	2064	2277	6600 de
3	3283	2327	2258	7868 ab
4	1732	2004	2188	5924 f
5	2825	2223	2293	7341 bc
6	2427	1913	2413	6753 cd
7	3611	2504	2291	8406 a
8	1759	2038	2193	5990 ef
9	2721	2140	2455	7316 bc
10	3425	2183	2422	8030 a
11	3250	2234	2658	8142 a

Table 9. First year percent nitrogen of Coastal bermudagrass forage grown on a Darco soil.

Treatment[1]	Harvest Date 5-25	7-26	10-12
	% N		
1	1.57 bc	1.09 c	1.76 b[2]
2	1.48 c	1.32 bc	1.52 b
3	2.09 a	1.74 a	1.41 b
4	1.59 bc	1.33 bc	1.52 b
5	1.91 abc	1.57 ab	1.70 b
6	2.05 a	1.30 bc	1.55 b
7	1.77 abc	1.71 a	1.70 b
8	1.92 abc	1.37 bc	1.71 b
9	1.91 abc	1.73 a	1.81 b
10	1.99 ab	1.57 ab	2.23 a
11	1.97 ab	1.51 ab	1.47 b

[1]Because of drought-like conditions nitrogen rate applied was either 150 or 300 lbs/ac.

[2]Numbers within a column and followed by the same letter are not significantly different at the 0.05 level using Duncan's Multiple Range Test.

Table 10. Second year dry matter production of Coastal bermudagrass grown on a Darco soil.

Treatment	Harvest Date 6-12	7-16	8-13	11-5	TOTAL
	lbs/ac				
1	1532	1188	1296	509	4,524 f[1]
2	4101	2740	4571	3731	15,142 e
3	5557	4113	4047	4923	18,640 bc
4	4499	2651	4414	3054	14,618 e
5	5188	3829	4859	3845	17,721 d
6	4521	2495	4405	3293	14,714 e
7	6213	4109	4121	3871	18,313 cd
8	4431	2684	3899	3520	14,534 e
9	6142	3891	4800	4329	19,162 ab
10	5628	3815	4578	4867	18,888 abc
11	5213	3827	5120	5238	19,398 a

Table 11. Second year percent nitrogen of Coastal bermudagrass forage grown on a Darco soil.

Treatment	Harvest Date 7-16	8-13	11-5
	% N		
1	1.42 c	1.41 e	1.12 c[1]
2	1.66 bc	1.54 de	1.21 bc
3	1.82 ab	1.96 ab	1.43 abc
4	1.73 bc	1.59 de	1.28 abc
5	1.98 ab	1.92 abc	1.49 ab
6	1.77 ab	1.69 bcde	1.22 bc
7	1.73 bc	2.12 a	1.53 ab
8	1.68 bc	1.61 cde	1.13 c
9	1.94 ab	1.85 abcd	1.57 a
10	1.93 ab	1.86 abcd	1.44 abc
11	2.08 a	1.71 bcde	1.37 abc

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

Table 12. Third year dry matter production of Coastal bermudagrass grown on a Darco soil.

Treatment	Harvest Date 6-10	7-19	8-19	10-29	TOTAL
	lbs/ac				
1	836	276	181	697	1,990 d[1]
2	6611	586	454	2037	9,688 c
3	7385	1235	446	2314	11,380 ab
4	6722	1871	458	2192	11,243 ab
5	5745	2242	464	2077	10,528 bc
6	4997	1907	515	2255	9,674 c
7	6959	2299	453	2244	11,955 a
8	5010	1879	673	2299	9,861 c
9	6440	2909	586	2566	12,501 a
10	7354	2207	546	2256	12,363 a
11	7036	2221	653	2507	12,417 a

Table 13. Third year percent nitrogen of Coastal bermudagrass forage grown on a Darco soil.

Treatment	Harvest Date 6-10	7-19	8-19	10-29
	% N			
1	1.41 e	1.14 e	1.64 c	1.18 e[1]
2	2.31 ab	1.69 cd	2.51 ab	1.69 cd
3	2.18 abc	1.53 d	2.59 ab	2.04 ab
4	1.97 bcd	2.01 abc	2.49 ab	1.85 bcd
5	2.18 abc	2.21 ab	2.75 a	2.14 ab
6	1.99 bcd	1.90 bcd	2.33 b	1.63 d
7	2.23 ab	2.38 a	2.52 ab	2.16 ab
8	2.08 abcd	2.07 abc	2.25 b	1.58 d
9	2.54 a	2.32 a	2.53 ab	2.32 a
10	1.69 cde	2.41 a	2.63 ab	2.16 ab
11	1.62 de	2.31 a	2.59 ab	1.98 bc

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

Table 14. Three year average dry matter production of Coastal bermudagrass grown on a Darco soil.

Treatment	Year 1	Year 2	Year 3	AVERAGES		
	lbs/ac					
				Total Yield	Fertilizer N Yield	2X N Yield
1	2,723	4,524	1,990	3,079	0	0
2	6,600	15,142	9,689	10,477	7,398	-
3	7,868	18,640	11,380	12,629	9,550	2,152
4	5,924	14,618	11,244	10,595	7,516	-
5	7,341	17,721	10,528	11,863	8,784	1,268
6	6,753	14,714	9,675	10,381	7,302	-
7	8,406	18,313	11,954	12,891	9,812	2,510
8	5,990	14,534	9,861	10,128	7,049	-
9	7,316	19,162	12,501	12,993	9,914	2,865
10	8,030	18,888	12,363	13,094	10,015	-
11	8,142	19,398	12,417	13,319	10,240	-

Table 15. Comparison of soil types and nitrogen source for efficiency of dry matter production from doubling the rate of nitrogen fertilizer.

Nitrogen Source	Efficiency of 1X N vs 2X N	
	Cuthbert	Darco
	%	
Ammonium nitrate	71.2	29.1
Urea	62.0	16.9
Ammonium nitrate sulfate	61.7	34.4
Urea ammonium phosphate	56.0	40.6