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Fluid Fertilization for Forages

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Summary

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

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

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

Introduction

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

Procedure

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

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

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

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

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

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

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

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

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

Results and Discussion

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

TABLE 3. (CONTINUED)

	Interaction of Source of N by Rate on Total Yield, lb/A Rate of Nitrogen, lb/A		
Source of N	40	80	120
1	6,887	9,091	9,657
2	7,155	10,170	10,030
3	6,081	8,849	9,640
4	6,441	9,250	9,387
5	6,773	8,455	9,909
6	9,405	8,769	10,840
7	6,982	8,773	9,847
8	7,917	9,590	10,300
9	7,236	9,415	10,400

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

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

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

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

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

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

L.S.D. (0.05) = 2,191

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

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

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

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

Interaction of Method of Application with Fertilizer Grade, Total Yield

Fertilizer Grade[2]	Method of Application		
	Spray Broadcast	Surface Banded	Subsurface Banded
80 - 0 - 0 - 0	7,444	7,908	7,911
80 - 22 - 0 - 0	7,696	8,126	7,279
80 - 0 - 60 - 0	6,854	6,478	7,170
80 - 22 - 60 - 0	7,587	7,564	7,776
80 - 22 - 60 - 12	7,565	8,408	7,680
L.S.D. (0.05) = Not Significant			

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

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

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

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

Interaction of Method of Application with Fertilizer Grade, Total Yield

Fertilizer Grade[2]	Method of Application		
	Spray Broadcast	Surface Banded	Subsurface Banded
80 - 0 - 0 - 0	12,030	12,850	12,990
80 - 22 - 0 - 0	11,760	12,790	11,930
80 - 0 - 60 - 0	10,370	10,490	10,880
80 - 22 - 60 - 0	9,596	11,210	13,530
80 - 22 - 60 - 12	11,070	12,610	13,040
L.S.D. (0.05) = Not significant			

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

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