Tifton 85 Bermudagrass Response to Potassium Sources and Sulfur

By V.A. Haby, W.M. Stewart, and A.T. Leonard

Yield of Tifton 85 bermudagrass grown on a Coastal Plain soil in northeast Texas was significantly increased by the lowest K rate in this study in 2002 and 2003 and by a higher K rate in 2004. The response to higher K input over time was largely attributable to depletion of soil K in the first few years at the lower rate. Potassium sources and S initially had no effect on yield, but, over time, significant yield response to K, Cl, and S developed. Yield was optimized at the moderate N rate, but yields were further increased at the high N rate with greater K input.

'Tifton 85' bermudagrass (*Cynodon dactylon* (L) Pers.) is a relatively new hybrid with improved nutritive value and yield potential compared to established hybrids such as Coastal bermudagrass. Many studies have been conducted to determine the K requirements of Coastal bermudagrass. Adams and Twersky (1960) showed that high levels of available soil K reduced Coastal bermudagrass winter injury and indicated that winter survival of this grass was favored by a high ratio of applied K to N. Kiesling et al. (1979) reported that K fertilizer dramatically increased visual stand ratings on Darco and Cuthbert soils, and that rhizome production was increased by added K. Nelson et al. (1983) indicated that K application had no significant effect on Coastal bermudagrass yield on a Darco soil, but increased 3-yr. average yields on a Cuthbert soil. Soil test K levels of both Coastal Plain soils declined at each rate of applied K, suggesting that 300 lb K_2O/A was inadequate for K fertility maintenance in Coastal bermudagrass production. Adams et al. (1967) reported no significant difference between KCl and potassium sulfate (K_2SO_4) with respect to forage yields or K content at the 200 lb or 800 lb K_2O/A rate. Miller and Dickens (1996) studied KCl vs K_2SO_4 applied twice monthly with N and reported high K rates did not increase bermudagrass rhizome cold resistance, and therefore may be of no benefit beyond K rates sufficient for optimum yield. Numerous papers reported response of Coastal bermudagrass to K applied as KCl, but none have evaluated the effect of Cl applied as KCl.

Objectives of this study were to determine the main and interactive effects of K, Cl, and S on Tifton 85 bermudagrass yield, stand decline, and disease suppression at moderate and high N rates. Additionally, treatment effects on soil and plant nutrient content were determined.

After harvesting, forage from plots was weighed and sampled for DM and chemical analysis.

Tifton 85 bermudagrass has improved nutritive value and yield potential, but more information on effects of nutrients is needed.

Darco loamy fine sand (Grossarenic Paleudult; a deep sandy soil), earlier treated with 3 tons/A ECCE 100% limestone was treated with an additional 2 tons/A ECCE 72% limestone and fertilized with 180 lb P_2O_5/A in April 2001. Treatments were incorporated by disking about 6-in. deep. Tifton 85 was sprigged on April 24, 2001, and the site was irrigated with 0.5 in. of water after applying 68 lb N/A as ammonium nitrate.

Main-plot N rates of 60 and 120 lb N/A for each regrowth of bermudagrass were strip-applied as replications. Split-plot K sources were KCl, K_2SO_4, and KCl+S at 134, 268, and 402 lb K_2O/A. The K rates were split applied after the first season, one-third prior to regrowth in spring and one-third after each of two cuttings. Rates of Cl and S applied with the various K treatments are shown in **Table 1**. The N rates were increased to 80 and 160 lb N/A for each bermudagrass regrowth in 2004. Phosphorus was reapplied at 120 lb P_2O_5/A each spring. Harvests were made with a Swift Machine forage plot harvester (**see photo**). Forage from each plot was weighed and sampled for DM and chemical analysis. Soil samples for chemical analysis were collected after the 2003 growing season.

Abbreviations and notes for this article: K = potassium; S = sulfur; N= nitrogen; Cl = chloride; KCl = muriate of potash or potassium chloride; DM = dry matter; ECCE = effective calcium carbonate equivalence; ppm = parts per million.

Table 1. Rates of Cl and S applied with K fertilizer treatments.

	Source			
	KCl	K_2SO_4	KCl+S	
K rate, lb K_2O/A	Cl rate	S rate	Cl rate	S rate
	lb/A			
134	107	46	107	46
268	214	91	214	91
402	322	137	322	137

Table 2. Tifton 85 bermudagrass dry matter yield response to K, Cl, and S at two N rates.

	Dry matter yield by year			
	2001	2002	2003	2004
Treatments	lb/A			
N[1], lb/A				
60	3,779 ns	10,258 ns	12,562 ns	11,693 b[2]
120	3,359	11,562	13,703	13,856 a
K[3], lb K_2O/A				
0	3,300 ns	9,118 b	10,831 b	9,614 c
134	3,636	11,111 a	12,983 a	12,469 b
268	3,870	11,156 a	13,338 a	13,246 a
402	3,290	11,060 a	13,844 a	13,662 a
K source				
KCl	4,126 ns	11,230 ns	13,097 ns	12,002 c
K_2SO_4	3,347	10,754	13,498	13,301 b
KCl + S	3,324	11,343	13,570	14,074 a
Coeff. of var.	49.2	17.7	7.8	8.5

[1]N rates applied at green up and after each cutting. N rates increased to 80 and 160 lb/A in 2004.

[2]Yields within a column and group followed by a dissimilar letter are significantly different (p = 0.05).

[3]Rates of K split-applied at initiation of regrowth and twice during the growing season in 2002, 2003, and 2004. In 2001, K rate was applied one-half at growth initiation and one-half on September 28.

Deficiency of S was visually evident in the first year of study, but DM yield was not affected until year 4.

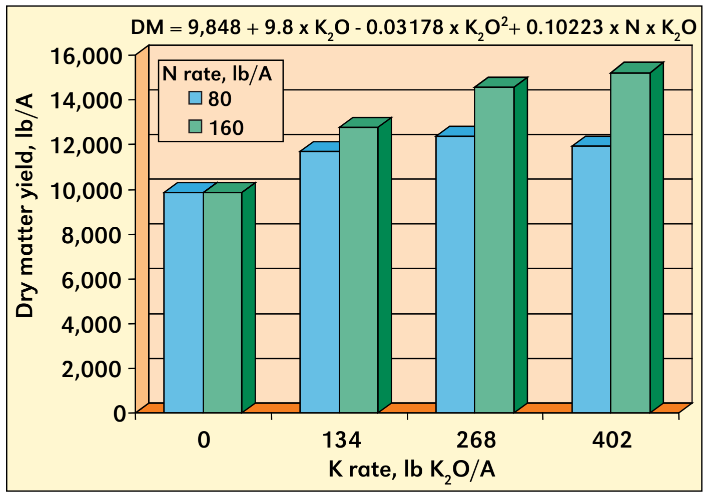

Figure 1. Effect of increased N rate on Tifton-85 bermudagrass response to K in 2004. Nitrogen rates applied for each of five cuttings. Rates of K applied at initiation of regrowth and twice during growing season.

The high coefficient of variation (cv) for the single harvest in 2001 indicates that Tifton 85 stand density was not uniform, but did improve with establishment in the ensuing years (**Table 2**). A statistically significant increase in total DM occurred at 134 lb K_2O/A in 2002 and in 2003. Source of K had no significant effect on DM production the first 3 years. In 2004, K source increased DM yield in the order KCl+S > K_2SO_4 > KCl, indicating that S and Cl had declined to deficient levels. In the first season, S deficiency was visually evident in bermudagrass that received no S, but DM yield was not affected by S deficiency until year 4 (**see photo**). In year 4, increasing the K rate to 268 lb K_2O/A increased total DM yield compared to the 134 lb K_2O rate, suggesting that soil K was being mined at the lower rate. Declining K levels were detected in soils. A significant interaction between N and K showed that greater rates of K are required to obtain the higher

Table 3. Tifton 85 bermudagrass K, Cl, S, and N concentrations and uptake, 2004 data.

	K		Cl		S		N	
Treatments	Conc., %	Uptake, lb/A	Conc., %	Uptake, lb/A	Conc., %	Uptake, lb/A	Conc., %	Uptake, lb/A
N[1], lb/A								
80	2.22 ns	258 b[2]	0.19 a	23	0.29 a	34	2.23 b	249 b
160	2.15	301 a	0.15 b	21	0.27 b	38	2.84 a	383 a
K[3], lb K_2O/A								
0	1.26 d	114 d	0.09 c	8 d	0.18 d	16 d	2.80 a	268 c
134	1.81 c	219 c	0.16 b	20 c	0.24 c	29 c	2.53 b	308 b
268	2.38 b	309 b	0.18 a	24 b	0.29 b	38 b	2.49 b	325 ab
402	2.67 a	365 a	0.19 a	27 a	0.34 a	48 a	2.49 b	332 a
K source								
KCl	2.30 ns	273 c	0.24 a	30 b	0.18 c	19 c	2.62 a	310 b
K_2SO_4	2.20	297 b	0.07 c	8 c	0.37 a	50 a	2.45 b	322 ab
KCl + S	2.33	323 a	0.22 b	33 a	0.33 b	46 b	2.44 b	333 a

[1]N rates applied at green up and after each cutting.

[2]Yields within a column and group followed by a dissimilar letter are significantly different (p = 0.05).

[3]Rates of K split applied at initiation of regrowth and twice during the growing season.

yields expected at higher N rates when water is sufficient for increased yields (**Figure 1**).

Increasing the K rate increased plant K concentration (**Table 3**). At low application rates, KCl increased plant K compared to K_2SO_4 and KCl+S, and at the high application rate, plant K was highest (2.8%) with application of KCl+S and was lowest (2.6%) in plants treated with KCl (data not shown). However, when averaged over N and K rates there was no K-source difference in plant K levels. Higher DM yields increased K uptake by the bermudagrass. Plant Cl concentration was highest in the order KCl > KCl+S > K_2SO_4 and declined with increasing N rate. As the K rate was raised to 402 lb K_2O/A, Cl levels in plants increased to 0.19%. However, at similar K rate increases applied as K_2SO_4, plant Cl concentration declined from 0.09 to 0.06% (data not shown). Plant Cl content and uptake increased with higher K rates. Plant S levels from all K sources declined with increasing N rates, and were elevated from 0.18 to 0.34% with increasing rates of K_2O. However, plant S remained constant at 0.18% as the rate of K as KCl was raised (data not shown). Plant N concentration was increased by the higher N rate and declined as yield was increased with applied K. The seasonal average main effect N:S ratio declined from 17.3 to 9.4 as the K rate was increased from zero to 402 lb K_2O/A and increased from 9.3 to 13.2 as the N rate was raised from 80 to 160 lb/A. Seasonal average main effect N:S ratios by K source were 16.3 for KCl, 7.5 for K_2SO_4, and 8.1 for KCl+S.

Table 4. Extractable plant nutrient levels and pH in 0 to 6-in. depth of Darco soil after the 2003 growing season[1].

Treatments	Soil pH and nutrient levels after 4 years of treatments						
	pH[1]	K	SO_4-S	Cl	P	Ca	Mg
	ppm						
N[2], lb/A							
60	6.8 a[3]	34 a	12 ns	4 ns	84 ns	976 ns	40 ns
120	6.2 b	22 b	14	4	77	717	38
K[4], K_2O, lb/A							
0	6.4 ns	17 c	11 b	4 ns	89 ns	768 ns	34 ns
134	6.5	19 c	11 b	3	83	842	40
268	6.6	30 b	12 b	4	77	891	40
402	6.5	39 a	17 a	5	80	833	39
K source							
KCl	6.6 a	33 a	11 b	4 a	77 ns	871 ns	39 ns
K_2SO_4	6.7 a	30 a	12 b	2 b	81	882	40
KCl + S	6.3 b	24 b	17 a	5 a	81	813	

[1]pH in 1:2 soil: water; P by ammonium acetate-EDTA (Hons et al.) extraction and colorimetric analysis; K, Ca, and Mg by ammonium acetate-EDTA extraction and atomic absorption analysis; S by extraction with ammonium acetate-acetic acid and turbidometric analysis; and Cl by extraction with 0.01 M $Ca(NO_3)_2 \cdot H_2O$ using thiocyanate-ferric nitrate color development.
[2]N rates applied at green up and after each cutting.
[3]Yields within a column and group followed by a dissimilar letter are significantly different (p = 0.05).
[4]Rates of K split applied at initiation of regrowth and twice during the growing season.

In general, increasing K rates from zero to 402 lb K_2O/A significantly increased soil K in the 0 to 6-in. depth (**Table 4**) and at depths to 24-in. after 3 years of treatment (data for depths below 6-in. not shown). However, regardless of this increase, all surface-depth K levels remained in the very low soil test rating category. At depths deeper than 24-in., higher K rates were needed to increase extractable soil K. Higher yields at constant rates of K_2O decreased surface depth levels of plant-available soil K. Extractable S levels were increased where KCl+S was applied and at the highest K rate. Soil Cl levels declined to 2 ppm when Cl was not included in the K treatment. Soil pH significantly declined at the high N rate and with the KCl+S treatments. Extractable levels of P, Ca, and Mg were unaffected by treatment. At the zero K rate, bermudagrass stand decline was visually detected in the initial spring regrowth, but only a minor incidence of the disease *Helminthosporium* leaf spot was observed in one season. The low level of disease incidence could not be correlated with a particular treatment.

Conclusion

Tifton 85 bermudagrass DM yields were increased by K sources in the order KCl+S > K_2SO_4 > KCl. The main effect DM yields were significantly increased at 268 lb K_2O/A. The yield curve peaked near 268 lb K_2O/A at the 80 lb N/A treatment, while DM yield continued to increase at 402 lb K_2O/A when the N rate was increased to 160 lb N/A for each cutting of grass. Regardless of the significant increases in soil K level with addition of K, these soil K levels were all in the very low category and the bermudagrass depended on applied K for adequate growth. In addition to applied K and N, S and Cl were needed for increased yields of bermudagrass. BC

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Dr. Haby is Texas A&M University System Regents Fellow and Professor and Mr. Leonard is Research Associate-Soils, both with the Texas Agricultural Experiment Station at Overton; e-mail: v-haby@tamu.edu. Dr. Stewart, IPNI Southern and Central Great Plains Director, is located at San Antonio, Texas; e-mail: mstewart@ipni.net.

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