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EVALUATION OF FORAGE PRODUCTION, STAND PERSISTENCE, AND GRAZING PERFORMANCE OF STEERS GRAZING TALL FESCUE CULTIVARS WITH THE NOVEL ENDOPHYTE

Lyle W. Lomas and Joseph L. Moyer

Summary

A total of 240 mixed black steers were used to evaluate the effect of tall fescue cultivar on grazing gains, forage production, and stand persistence in 2004, 2005, 2006, and 2007. Cultivars evaluated were high-endophyte Kentucky 31, low-endophyte Kentucky 31, ArkPlus, and MaxQ. Pastures with low-endophyte Kentucky 31, ArkPlus, or MaxQ produced higher ($P < 0.05$) steer grazing gains and more ($P < 0.05$) gain per acre than high-endophyte Kentucky 31 during all 4 years. Steer live-weight gain and gain per acre were similar ($P > 0.05$) among pastures with low-endophyte Kentucky 31, ArkPlus, and MaxQ. There was no difference ($P > 0.05$) in available forage dry matter between varieties in 2004. However, in 2005, high-endophyte Kentucky 31 and MaxQ pastures had higher ($P < 0.05$) available forage than low-endophyte Kentucky 31 and ArkPlus pastures. In 2006 and 2007, high-endophyte Kentucky 31 pastures had more ($P < 0.05$) available-forage dry matter than pastures with the other varieties. Stand density did not differ ($P > 0.05$) between varieties. However, stand density of all varieties declined after the summer of 2006 but increased in 2007.

Introduction

Tall fescue, the most widely adapted cool-season perennial grass in the United States, is grown on approximately 66 million acres. Although tall fescue is well-adapted in the eastern half of the country between the temperate North and mild South, presence of a fungal endophyte results in poor performance of grazing livestock, especially during the summer.

Until recently, producers with high-endophyte tall fescue pastures had two primary options for improving grazing-livestock performance. One option was to destroy existing stands and replace them with endophyte-free fescue or other forages. Although it supports greater grazing-animal performance than endophyte-infected fescue, endophyte-free fescue is less persistent under grazing and more susceptible to stand loss from drought stress. In situations where high-endophyte tall fescue must be grown, the other option was for producers to adopt management strategies that reduce the negative effects of the endophyte on grazing animals, such as incorporating legumes into existing pastures. Adding legumes can improve nutritive quality of fescue pastures, increase gains of grazing livestock, and reduce N fertilizer rates.

During the past few years, new tall fescue cultivars have been developed that have a “novel” endophyte that provides vigor to the fescue plant but does not have the traditional negative effect on performance of grazing livestock. The objectives of this study were to evaluate grazing and subsequent finishing performance of stocker steers, forage availability, and stand persistence of two of these new cultivars and compare them with high- and low-endophyte Kentucky 31 tall fescue.

Experimental Procedures

Sixty-four mixed black steers in 2004, 2005, and 2006 and 48 mixed black steers in 2007 were weighed on two consecutive days and allotted to 16 five-acre pastures of high-endophyte Kentucky 31, low-endophyte Kentucky 31, ArkPlus, or MaxQ tall fescue (four replications per cultivar) on March 16, 2004 (513 lb), March 24, 2005 (501 lb), March 29, 2006 (568 lb), and April 10, 2007 (626 lb). All pastures were seeded in the fall of 2002 and had been harvested for hay in 2003. All pastures were fertilized with 80 lb N/a and P_2O_5 and K_2O as required by soil test on January 15, 2004; with 80 lb/a N on February 2, 2005, January 19, 2006, and March 7, 2007; and with 40-40-30 lb/a N-P_2O_5-K_2O on September 3, 2004, September 13, 2005, September 11, 2006, and September 4, 2007.

Cattle were treated for internal and external parasites before being turned out to pasture and later were vaccinated for protection from pinkeye. Steers had free access to commercial mineral blocks that contained 12% calcium, 12% phosphorus, and 12% salt.

Cattle were weighed every 28 days, and forage availability was measured approximately every 28 days with a disk meter calibrated for tall fescue. In 2006, two steers were removed from the study for reasons unrelated to experimental treatment. Pastures were grazed continuously until November 30, 2004 (257 days), December 6, 2005 (257 days), August 15, 2006 (139 days), and November 20, 2007 (224 days), when steers were weighed on two consecutive days and grazing was terminated. Pastures were stocked with four steers per pasture in 2004, 2005, and 2006 and three steers per pasture in 2007 due to stand reduction that occurred following the drought in 2006.

After the grazing period, cattle were moved to a finishing facility, implanted with SynovexS, and fed a diet of 80% ground milo, 15% corn silage, and 5% supplement (dry-matter basis). Cattle grazed in 2006 were re-implanted with Synovex S on day 84 of the finishing period. Cattle grazed during 2004, 2005, and 2007 were fed a finishing diet for 112, 112, and 100 days, respectively. Steers grazed during 2006 on low-endophyte Kentucky 31, ArkPlus, or MaxQ were fed a finishing diet for 142 days, and steers that grazed high-endophyte Kentucky 31 were fed a finishing diet for 168 days. All steers were slaughtered in a commercial facility, and carcass data were collected.

Results and Discussion

Grazing performance is presented by cultivar in Tables 1, 2, 3, and 4 for 2004, 2005, 2006, and 2007, respectively. Steers that grazed pastures of low-endophyte Kentucky 31, MaxQ, or ArkPlus gained significantly more ($P < 0.05$) and produced more ($P < 0.05$) gain per acre than those that grazed high-endophyte Kentucky 31 pastures during each of the 4 years. Gains of cattle that grazed low-endophyte Kentucky 31, ArkPlus, or MaxQ were similar ($P > 0.05$) in 2004, 2005, 2006, and 2007. Steer daily gains over four years from pastures with high-endophyte Kentucky 31, low-endophyte Kentucky 31, ArkPlus, and MaxQ were 0.94, 1.17, 0.78, and 1.24 (high-endophyte Kentucky 31); 1.54, 1.60, 1.78, and 1.85 (low-endophyte Kentucky 31); 1.55, 1.53, 1.68, and 1.87 (ArkPlus); and 1.47, 1.65, 1.87, and 1.90 (MaxQ) lb/head daily, respectively. Gains per acre over 4 years from pastures with high-endophyte Kentucky 31, low-endophyte Kentucky 31, ArkPlus, and MaxQ were 194, 241, 87 and 167 (high-endophyte Kentucky 31); 317, 329, 198, and 249 (low-endophyte Kentucky 31); 319, 314, 186, and 252 (ArkPlus); and 302, 340, 208, and 256 (MaxQ) lb/a, respectively. Drought stress reduced the length of the grazing season in 2006, which resulted in lower steer gain and gain per acre than measured in the previous two years.

Finishing performance, carcass characteristics, and overall performance (grazing + finishing) for steers grazed in 2004, 2005, 2006, and 2007 are presented in Tables 1, 2, 3, and 4, respectively. In 2004, steers that previously grazed high-endophyte Kentucky 31 had lower ($P < 0.05$) final finishing weights and lower ($P < 0.05$) hot carcass weights than those that grazed low-endophyte Kentucky 31 or ArkPlus. Final live weights and hot carcass weights were similar ($P > 0.05$) for steers that grazed high-endophyte Kentucky 31 or MaxQ. However, steers that grazed high-endophyte Kentucky 31 or ArkPlus had higher ($P < 0.05$) finishing daily gains than those that grazed low-endophyte Kentucky 31 or MaxQ.

In 2005 and 2006, steers that previously grazed high-endophyte Kentucky 31 had lower ($P < 0.05$) final finishing weights than those that grazed low-endophyte Kentucky 31 or MaxQ. Cattle that grazed high-endophyte Kentucky 31 pastures in 2006 had lower ($P < 0.05$) final finishing weights than steers that grazed the other three varieties, even though they were fed 26 days longer. Final live weights were similar ($P > 0.05$) for steers that grazed high-endophyte Kentucky 31 or ArkPlus in 2005 and 2006. In 2005, steers that grazed high-endophyte Kentucky 31 had lower ($P < 0.05$) hot carcass weights than those that grazed low-endophyte Kentucky 31, ArkPlus, or MaxQ. Final live weights and hot carcass weights were similar ($P > 0.05$) for steers that grazed low-endophyte Kentucky 31, ArkPlus, or MaxQ in 2005 and 2006. In

2007, steers that grazed high-endophyte Kentucky 31 had lower ($P < 0.05$) final live weights and hot carcass weights than those that grazed low-endophyte Kentucky 31, ArkPlus, or MaxQ. Final weights and hot carcass weights were similar ($P > 0.05$) for steers that grazed low-endophyte Kentucky 31, ArkPlus, or MaxQ. Finishing daily gains were similar ($P > 0.05$) between steers that grazed the four fescue cultivars during 2005, 2006, and 2007.

In 2004, cattle that grazed high-endophyte Kentucky 31 required less ($P < 0.05$) feed per pound of gain than those that grazed low-endophyte Kentucky 31 or MaxQ and had similar ($P > 0.05$) feed conversion to steers that grazed ArkPlus. Steers that grazed low-endophyte Kentucky 31 had similar ($P > 0.05$) feed efficiency to those that grazed ArkPlus or MaxQ. Steers that grazed ArkPlus required less ($P < 0.05$) feed per pound of gain than those that grazed MaxQ. Feed conversion was similar between treatments in 2005 and 2007. However, in 2006, steers that grazed high-endophyte Kentucky 31 had lower ($P < 0.05$) dry matter intakes and required less ($P < 0.05$) feed per pound of gain than those that grazed MaxQ. The lower dry matter intake likely was related to the lighter weights of the high-endophyte Kentucky 31 steers. Feed conversion was similar ($P > 0.05$) among steers that grazed high-endophyte Kentucky 31, low-endophyte Kentucky 31, or ArkPlus. Steers that grazed low-endophyte Kentucky 31, ArkPlus, or MaxQ had similar ($P > 0.05$) feed efficiency.

In 2004, steers that grazed ArkPlus had greater ($P < 0.05$) external fat thickness than those that grazed high-endophyte Kentucky 31, low-endophyte Kentucky 31, or MaxQ and a higher ($P < 0.05$) numerical yield grade than those that grazed MaxQ. There were no significant differences ($P > 0.05$) among treatments in the percentage of cattle grading choice or higher. In 2005, steers that grazed high-endophyte Kentucky 31 had a lower ($P < 0.05$) dressing percentage than those that grazed MaxQ and a smaller ($P < 0.05$) ribeye area than those that grazed low-endophyte Kentucky 31 or ArkPlus. The smaller ribeye area was likely due to the lower ($P < 0.05$) hot carcass weights of the high-endophyte Kentucky 31 cattle. However, steers that grazed high-endophyte Kentucky 31 yielded a higher ($P < 0.05$) percentage of choice carcasses than those that grazed ArkPlus. In 2006, steers that grazed low-endophyte Kentucky 31 had larger ($P < 0.05$) ribeye areas than those that grazed MaxQ. Steers that grazed MaxQ yielded a higher ($P < 0.05$) percentage of choice carcasses than those that grazed high-endophyte Kentucky 31, low endophyte Kentucky 31, or ArkPlus. In 2007, steers that grazed high-endophyte Kentucky 31 had a lower ($P < 0.05$) dressing percentage and less ($P < 0.05$) external fat than those that grazed low-endophyte Kentucky 31. Dressing percentage and external fat thickness were similar ($P > 0.0$) between steers that grazed low-endophyte Kentucky 31, ArkPlus, or MaxQ.

In 2004, cattle that grazed high-endophyte Kentucky 31 had lower ($P < 0.05$) overall gains (grazing + finishing) than those that grazed low-endophyte Kentucky 31 or ArkPlus and similar ($P > 0.05$) overall gains to those that grazed MaxQ. Overall gains of steers that grazed low-endophyte Kentucky 31 or ArkPlus were similar ($P > 0.05$). In 2005, cattle that grazed high-endophyte Kentucky 31 had lower ($P < 0.05$) overall gains than those that grazed low-endophyte Kentucky 31 or MaxQ and similar ($P > 0.05$) overall gains to those that grazed ArkPlus. Overall gains of steers that grazed low-endophyte Kentucky 31, ArkPlus, or MaxQ were similar ($P > 0.05$). In 2006 and 2007, cattle that grazed high-endophyte Kentucky 31 had lower ($P < 0.05$) overall daily gains than those that grazed low-endophyte Kentucky 31, ArkPlus, or MaxQ. Overall daily gains of steers that grazed low-endophyte Kentucky 31, ArkPlus, or MaxQ were similar ($P > 0.05$).

Available forage of each cultivar is presented in Table 5. Although there was no difference among cultivars for average available forage for the entire grazing season in 2004, available forage among cultivars did differ on three measurement dates toward the latter part of the grazing season. On August 30, low-endophyte Kentucky 31 pastures had less ($P < 0.05$) available forage than pastures with high-endophyte Kentucky 31, ArkPlus, or MaxQ. On September 29, low-endophyte Kentucky 31 pastures had less ($P < 0.05$) available forage than MaxQ pastures. On December 1, high-endophyte Kentucky 31 pastures had more ($P < 0.05$) available forage than low-endophyte Kentucky 31 or ArkPlus pastures.

In 2005, high-endophyte Kentucky 31 pastures had higher ($P < 0.05$) average available forage than the other three varieties. MaxQ pastures had higher ($P < 0.05$) available forage than low-endophyte Kentucky 31 or ArkPlus, and average available forage for low-endophyte Kentucky 31 and ArkPlus pastures were similar ($P > 0.05$). High-endophyte Kentucky 31 pastures had more ($P < 0.05$) available forage than the other three varieties on March 24 and September 8. On August 11, high-endophyte Kentucky 31 and MaxQ pastures had more ($P < 0.05$) available forage than low-endophyte Kentucky 31 and ArkPlus pastures. On November 2, MaxQ pastures had more ($P < 0.05$) available forage than low-endophyte Kentucky 31 pastures. On December 6, high-endophyte Kentucky 31 and low-endophyte Kentucky 31 pastures had more ($P < 0.05$) available forage than ArkPlus and MaxQ pastures.

In 2006 and 2007, high-endophyte Kentucky 31 pastures had higher ($P < 0.05$) average available forage than the other three varieties. Average available forage for low-endophyte Kentucky 31, ArkPlus, and MaxQ were similar ($P > 0.05$).

In general, steers that grazed pastures with less available-forage dry matter had higher steer gains than those with greater available-forage dry matter. This could indicate that lower available dry matter was the result of greater forage intake by grazing steers, which resulted in higher gains and/or less vigor of the fescue cultivar.

Stand density was similar among cultivars at the initiation of grazing in 2004 and at the end of each subsequent grazing season (Table 6). Stand density of all varieties gradually increased each year to a high in 2005 and then decreased dramatically in 2006 due to drought stress. The method of measuring stand density was changed in 2007 from the number of tillers per square foot to percent cover.

Cattle grazing ArkPlus or MaxQ tall fescue, new cultivars with the novel endophyte, appear to have gains similar to those of cattle grazing low-endophyte Kentucky 31 and significantly higher than cattle grazing high-endophyte Kentucky 31 tall fescue. We will continue to monitor persistence of these varieties under grazing, and this study will continue for at least one more year.

Table 1. Effect of Cultivar on Grazing and Subsequent Performance of Steers Grazing Tall Fescue Pastures, Southeast Agricultural Research Center, 2004

	Tall Fescue Cultivar			
Item	High-Endophyte Kentucky 31	Low-Endophyte Kentucky 31	ArkPlus	MaxQ
Grazing Phase (257 days)				
No. of head	16	16	16	16
Initial wt., lb	513	513	513	512
Ending wt., lb	756[a]	908[b]	911[b]	890[b]
Gain, lb	243[a]	396[b]	399[b]	377[b]
Daily gain, lb	0.94[a]	1.54[b]	1.55[b]	1.47[b]
Gain/acre, lb	194[a]	317[b]	319[b]	302[b]
Finishing Phase (112 days)				
Beginning wt., lb	756[a]	908[b]	911[b]	890[b]
Ending wt., lb	1252[a]	1341[bc]	1388[b]	1285[ac]
Gain, lb	497[a]	433[bc]	477[ac]	395[b]
Daily gain, lb	4.44[a]	3.86[b]	4.26[a]	3.53[b]
Daily DM intake, lb	27.2	28.1	28.6	27.1
Feed:Gain	6.14[a]	7.36[bc]	6.73[ac]	7.68[b]
Hot carcass wt., lb	731[a]	786[bc]	801[b]	754[ac]
Dressing percentage, %	58	59	58	59
Backfat, in.	0.38[a]	0.38[a]	0.49[b]	0.34[a]
Ribeye area, square in.	12.0	11.9	12.1	12.2
Yield grade	2.8[ab]	3.1[ab]	3.3[a]	2.7[b]
Marbling score	SM^{50}	SM^{63}	SM^{86}	SM^{24}
Percent Choice, %	69	75	94	69
Overall Performance (Grazing + Finishing) (369 days)				
Gain, lb	740[a]	828[bc]	876[b]	772[ac]
Daily gain, lb	2.00[a]	2.25[bc]	2.37[b]	2.09[ac]

Note. DM = Dry matter; SM = Small.

[abc] Within rows, means without a common superscript differ ($P < 0.05$).

Table 2. Effect of Cultivar on Grazing and Subsequent Performance of Steers Grazing Tall Fescue Pastures, Southeast Agricultural Research Center, 2005

	Tall Fescue Cultivar			
Item	High-Endophyte Kentucky 31	Low-Endophyte Kentucky 31	ArkPlus	MaxQ
Grazing Phase (257 days)				
No. of head	16	16	16	16
Initial wt., lb	501	501	501	501
Ending wt., lb	802^{a}	912^{b}	893^{b}	926^{b}
Gain, lb	302^{a}	412^{b}	392^{b}	425^{b}
Daily gain, lb	1.17^{a}	1.60^{b}	1.53^{b}	1.65^{b}
Gain/acre, lb	241^{a}	329^{b}	314^{b}	340^{b}
Finishing Phase (112 days)				
Beginning wt., lb	802^{a}	912^{b}	893^{b}	926^{b}
Ending wt., lb	1298^{a}	1392^{b}	1365^{ab}	1395^{b}
Gain, lb	496	479	472	470
Daily gain, lb	4.43	4.28	4.21	4.19
Daily DM intake, lb	29.6	29.2	29.0	30.1
Feed:Gain	6.69	6.83	6.93	7.19
Hot carcass wt., lb	760^{a}	821^{b}	811^{b}	833^{b}
Dressing percentage, %	58.5^{a}	$59.0^{a,b}$	59.5^{ab}	59.7^{b}
Backfat, in.	0.44	0.44	0.49	0.48
Ribeye area, square in.	11.0^{a}	11.8^{b}	11.8^{b}	11.6^{ab}
Yield grade	3.4	3.4	3.5	3.4
Marbling score	SM^{65}	SM^{62}	SM^{04}	SM^{58}
Percent Choice, %	94^{a}	81^{ab}	56^{b}	75^{ab}
Overall Performance (Grazing + Finishing) (369 days)				
Gain, lb	797^{a}	891^{b}	864^{ab}	895^{b}
Daily gain, lb	2.16^{a}	2.41^{b}	2.34^{ab}	2.42^{b}

Note. DM = Dry matter; SM = Small.

[ab] Within rows, means without a common superscript differ ($P < 0.05$).

Table 3. Effect of Cultivar on Grazing and Subsequent Performance of Steers Grazing Tall Fescue Pastures, Southeast Agricultural Research Center, 2006

	Tall Fescue Cultivar			
Item	High-Endophyte Kentucky 31	Low-Endophyte Kentucky 31	ArkPlus	MaxQ
Grazing Phase (139 days)				
No. of head	14	16	16	16
Initial wt., lb	568	568	568	568
Ending wt., lb	676[a]	816[b]	801[b]	829[b]
Gain, lb	109[a]	248[b]	233[b]	260[b]
Daily gain, lb	0.78[a]	1.78[b]	1.68[b]	1.87[b]
Gain/acre, lb	87[a]	198[b]	186[b]	208[b]
Finishing Phase				
No. of days	168	142	142	142
Beginning wt., lb	676[a]	816[b]	801[b]	829[b]
Ending wt., lb	1299[a]	1364[b]	1343[ab]	1367[b]
Gain, lb	623[a]	547[b]	541[b]	539[b]
Daily gain, lb	3.71	3.85	3.81	3.79
Daily DM intake, lb	24.7[a]	26.4[ab]	26.0[ab]	27.7[b]
Feed:Gain	6.69[a]	6.85[ab]	6.80[ab]	7.31[b]
Hot carcass wt., lb	793	827	815	826
Dressing percentage, %	61	61	61	60
Backfat, in.	0.54	0.49	0.50	0.51
Ribeye area, square in.	12.6[ab]	13.5[a]	12.7[ab]	12.5[b]
Yield grade	3.2	3.0	3.3	3.4
Marbling score	SM[30]	SM[28]	SM[06]	SM[40]
Percent Choice, %	50[a]	69[a]	56[a]	94[b]
Overall Performance (Grazing + Finishing)				
No. of days	307	281	281	281
Gain, lb	732[a]	795[b]	774[b]	799[b]
Daily gain, lb	2.38[a]	2.83[b]	2.76[b]	2.84[b]

Note. DM = Dry matter; SM = Small.

[ab] Within rows, means without a common superscript differ ($P < 0.05$).

Table 4. Effect of Cultivar on Grazing and Subsequent Performance of Steers Grazing Tall Fescue Pastures, Southeast Agricultural Research Center, 2007

	Tall Fescue Cultivar			
Item	High-Endophyte Kentucky 31	Low-Endophyte Kentucky 31	ArkPlus	MaxQ
Grazing Phase (224 days)				
No. of head	12	12	12	12
Initial wt., lb	626	626	626	626
Ending wt., lb	904[a]	1041[b]	1046[b]	1052[b]
Gain, lb	278[a]	415[b]	420[b]	426[b]
Daily gain, lb	1.24[a]	1.85[b]	1.87[b]	1.90[b]
Gain/acre, lb	167[a]	249[b]	252[b]	256[b]
Finishing Phase (100 days)				
Beginning wt., lb	904[a]	1041[b]	1046[b]	1052[b]
Ending wt., lb	1250[a]	1367[b]	1377[b]	1355[b]
Gain, lb	346	326	331	303
Daily gain, lb	3.46	3.26	3.31	3.03
Daily DM intake, lb	27.8	28.5	27.8	27.7
Feed:Gain	8.04	8.80	8.51	9.28
Hot carcass wt., lb	718[a]	803[b]	803[b]	796[b]
Dressing percentage, %	57.5[a]	58.8[b]	58.3[ab]	58.8[b]
Backfat, in.	0.34[a]	0.47[b]	0.40[ab]	0.45[ab]
Ribeye area, square in.	11.6	11.6	12.4	11.7
Yield grade	2.2	2.8	2.7	2.7
Marbling score	MT^{10}	SM^{97}	MT^{53}	MT^{54}
Percent Choice, %	92	92	92	100
Overall Performance (Grazing + Finishing) (324 days)				
Gain, lb	624[a]	740[b]	750[b]	729[b]
Daily gain, lb	1.92[a]	2.28[b]	2.32[b]	2.25[b]

Note. DM = Dry matter; MT = Modest; SM = Small.

[ab] Within rows, means without a common superscript differ ($P < 0.05$).

Table 5. Effect of Cultivar on Available Forage of Tall Fescue Pastures, Southeast Agricultural Research Center, 2004 to 2007

	Tall Fescue Cultivar			
Date	High-Endophyte Kentucky 31	Low-Endophyte Kentucky 31	ArkPlus	MaxQ
	-------------------------lb of dry matter/acre-------------------------			
3/17/04	2611	2367	2276	2585
4/14/04	2890	2569	2576	2822
5/11/04	4652	4331	4258	4730
6/15/04	3816	3276	3632	3607
7/7/04	3179	3026	3252	3068
8/4/04	3038	2912	2975	3094
8/30/04	2610^{a}	2392^{b}	2630^{a}	2824^{a}
9/29/04	2192^{ab}	1879^{b}	2056^{ab}	2246^{a}
10/27/04	2042	1872	1764	2034
12/1/04	1653^{a}	1366^{b}	1342^{b}	1488^{ab}
2004 Season Average	2868	2599	2676	2850
3/24/05	1883^{a}	1394^{b}	1404^{b}	1498^{b}
4/20/05	2760	2526	2516	2913
5/18/05	3431	3099	3331	3389
7/14/05	2972	2811	2749	2670
8/11/05	2401^{a}	2080^{b}	2148^{b}	2472^{a}
9/8/05	2558^{a}	2262^{b}	2331^{b}	2309^{b}
10/5/05	2301	2029	2142	1996
11/2/05	1451^{ab}	1354^{b}	1568^{ab}	1791^{a}
12/6/05	1950^{a}	1643^{a}	1096^{b}	1270^{b}
2005 Season Average	2412^{a}	2133^{c}	2132^{c}	2257^{b}
3/29/06	797^{a}	706^{ab}	525^{ab}	490^{b}
4/27/06	2062	1939	1061	1070
5/24/06	2062^{a}	760^{b}	1304^{ab}	1383^{ab}
6/19/06	2094^{a}	1504^{b}	1206^{b}	1316^{b}
7/17/06	1780	1154	866	1946
8/15/06	1745^{a}	1019^{b}	950^{b}	846^{b}
2006 Season Average	1756^{a}	1180^{b}	985^{b}	1175^{b}
3/26/07	1033	836	834	832
4/9/07	1116	929	1238	1350
5/14/07	1820	1735	1796	1765
6/19/07	2085	1820	1644	1308
7/16/07	2546	2249	2041	2040
8/21/07	2107	1830	1741	1850
9/17/07	2774	2360	2326	2325
10/16/07	3082	2570	2577	2368
11/20/07	2286	1953	2006	1912
2007 Season Average	2094^{a}	1809^{b}	1801^{b}	1750^{b}

^{abc} Within rows in the same year, means without a common superscript differ ($P < 0.05$).

Table 6. Effect of Cultivar on Stand Density of Tall Fescue Pastures, Southeast Agricultural Research Center, 2004 to 2007

Date	Tall Fescue Cultivar			
	High-Endophyte Kentucky 31	Low-Endophyte Kentucky 31	ArkPlus	MaxQ
	-------------------------tillers/ft^2-------------------------			
3/17/04	66	62	70	70
12/1/04	78	85	74	75
12/12/05	130	135	118	134
12/14/06	53	43	47	37
	-------------------------% cover-------------------------			
11/29/07	95	88	88	80

SUPPLEMENTATION OF GRAZING STOCKER CATTLE WITH DISTILLER'S GRAINS

Lyle W. Lomas and Joseph L. Moyer

Summary

A total of 108 steers grazing smooth bromegrass pastures in 2005, 2006, and 2007 and 80 steers grazing bermudagrass pastures in 2006 and 2007 were used to evaluate the effects of supplementation with dried distiller's grains (DDG) at 0.5% or 1.0% of body weight on available forage, grazing gains, subsequent finishing gains, and carcass characteristics. Supplementation with DDG resulted in significantly higher (P < 0.05) grazing gains and gain per acre than feeding no supplement but had no effect (P > 0.05) on forage availability during 2005 or 2006. However, in 2007, overall forage availability was higher (P < 0.05) on bromegrass pastures where steers were supplemented with 0.5% or 1.0% DDG. Supplementation with 1.0% DDG resulted in higher (P < 0.05) grazing gains and gain per acre than supplementation with 0.5% DDG in 2005, but gains were similar (P > 0.05) for cattle fed the two supplementation rates in 2006 and 2007. Supplementation during the grazing phase had no effect (P > 0.05) on finishing gains in 2005 and 2006. However, in 2007, steers not supplemented while grazing had higher (P < 0.05) subsequent finishing gains than steers that received 0.5% or 1.0% DDG during the grazing phase. In 2005 and 2007, steers supplemented during the grazing phase had higher (P < 0.05) slaughter weights and overall gains than those that received no DDG while grazing. In 2006, steers supplemented with 0.5% DDG while grazing had higher (P < 0.05) slaughter weights and overall gains than those that received no DDG. However, steers supplemented with 1.0% DDG and those that received no DDG while grazing had similar (P > 0.05) overall gains and slaughter weights. Supplementation with DDG of steers grazing bermudagrass had no effect (P > 0.05) on grazing or finishing performance in 2006. However, in 2007, steers supplemented with 1.0% DDG had higher (P < 0.05) grazing gains and gain per acre than steers that received no supplement or 0.5% DDG. Unsupplemented steers and those that received 0.5% DDG had similar (P > 0.05) grazing gains and gain per acre.

Introduction

Distiller's grains are a by-product of the ethanol industry. Ethanol production from feed grains is a rapidly growing industry that is making a major contribution to the American agricultural economy. Total ethanol production in the United States has nearly quadrupled in the past 10 years and is expected to increase even more in the future. Currently, Kansas has ten operating dry mill ethanol plants that have a combined production capacity of more than 329 million gallons of ethanol annually, and additional plants are in various stages of planning. Current ethanol production in Kansas creates a market for more than 116 million bushels of corn and sorghum and yields more than 1 million tons of DDG annually. With further growth of the ethanol industry, availability of this co-product likely will increase, and cost likely will decrease. Therefore, efficient, cost-effective uses of this feedstuff need to be identified. The value of distiller's grains as a supplement for grazing cattle also needs to be determined.

Currently, more than 80% of distiller's grains are being fed to ruminants, but they also are used in swine and poultry diets. Distiller's grains commonly are included in diets of dairy and finishing cattle at 20% to 30% of diet dry matter. A limiting factor in feeding large amounts of distiller's grains is the environmental effect of excess nitrogen and phosphorus. A South Dakota study revealed that protein was in excess of requirements when distiller's grains were included at 30% of the diet dry matter in cows producing either 53 or 66 lb/day of milk. Care also must be taken to balance diets containing distiller's grains to avoid overfeeding phosphorus and sulfur.

Forage-based livestock production is a vital component of the Kansas economy.

Kansas has more than 18 million acres of pastureland and ranks sixth in the United States in the number of beef cows, with more than 1.5 million head. Cash receipts from cattle production in Kansas exceeded $6.25 billion in 2006. Forages account for 80% of the feed units consumed by beef cattle and, therefore, represent an extremely important resource to the industry. Increasing the proportion of feed that is harvested directly by grazing cattle and balancing their diets with low-cost supplements such as distiller's grains could improve sustainability and profitability of the beef cattle industry in Kansas and create additional demand for corn and sorghum coproducts.

Productivity of forage-livestock systems is limited by seasonality of forage growth. Energy and protein content of cool-season grasses can decline as much as 30% and 60%, respectively, from vegetative stage to maturity. Livestock growth rates and reproductive performance generally decline in response to these seasonal changes in forage availability and quality unless diets are supplemented with additional nutrients. Depending on price, use of supplemental feeds may be a cost-effective risk management strategy if amounts and/or nutritional quality of forages are inadequate. Due to the expansion of the grain processing industries, coproducts like distiller's grains or gluten feed can be purchased at a price that is competitive with corn on a net energy basis and, with further growth of the industry, likely will be less expensive in the future. Because the coproducts generally have high concentrations of protein and phosphorus, their composition complements mature forages that are typically deficient in these nutrients.

Experimental Procedures

Thirty-six steers of predominately Angus breeding were weighed on two consecutive days, stratified by weight, and randomly allotted to nine 5-acre smooth bromegrass pastures on April 5, 2005 (437 lb), April 11, 2006 (484 lb), and April 3, 2007 (497 lb). Three pastures of steers were randomly assigned to one of three supplementation treatments (three replicates per treatment) and were grazed for 196 days, 161 days, and 182 days in 2005, 2006, and 2007, respectively. Supplementation treatments were 0, 0.5%, or 1.0% of body weight of corn DDG per head daily. Pastures were assigned to the same treatment during all three years. Pastures were fertilized with 100-40-40 lb/a N-P_2O_5-K_2O_5 on March 5, 2005, March 6, 2006, and March 8, 2007. Pastures were stocked with 0.8 steers per acre and grazed continuously until October 18, 2005 (196 days), September 19, 2006 (161 days), and October 2, 2007 (182 days), when steers were weighed on two consecutive days and grazing was terminated.

Forty mixed black yearling steers were weighed on two consecutive days, stratified by weight, and randomly allotted to eight 5-acre 'Hardie' bermdagrass pastures on June 1, 2006 (749 lb) and May 22, 2007 (734 lb). Supplementation treatments were 0, 0.5%, or 1.0% of body weight of corn DDG per head daily. There were two replicates of the 0 level and three replicates each of the 0.5% and 1.0% levels. Pastures were fertilized with 100-30-30 lb/a N-P_2O_5-K_2O_5 on June 1, 2006 and June 6, 2007, 100 lb/a N on July 7, 2006, and 50 lb/a N on July 16, 2007. Pastures were stocked with one steer per acre and grazed continuously until September 6, 2006 (89 days), and September 11, 2007 (112 days), when steers were weighed on two consecutive days and grazing was terminated.

Cattle in each pasture were group fed DDG in meal form on a daily basis, and pasture was the experimental unit. No implants or feed additives were used during the grazing phase. Weight gain was the primary measurement. Cattle were weighed every 28 days; quantity of distillers grain fed was adjusted at that time. Cattle were treated for internal and external parasites before being turned out to pasture and later were vaccinated for protection from pinkeye. Cattle had free access to commercial mineral blocks that contained 12% calcium, 12% phosphorous, and 12% salt.

Forage availability was measured approximately every 28 days with a disk meter calibrated for the respective forage being grazed. In 2005, one steer was removed from the study for reasons unrelated to experimental treatment.

After the grazing period, cattle were shipped to a finishing facility, implanted with Synovex S, and fed a diet of 80% ground milo, 15% corn silage, and 5% supplement (dry-matter basis). Steers that grazed smooth bromegrass pastures in 2005, 2006, and 2007 were fed a finishing diet for 126, 126, and 119 days, respectively. Steers that grazed bermudagrass pastures in 2006 and 2007 were fed a finishing diet for 85 and 112 days, respectively. All cattle were slaughtered in a commercial facility at the end of the finishing period, and carcass data were collected.

Results and Discussion

Available forage for the smooth bromegrass pastures during the grazing phase is presented by date and supplementation level in Table 1. Supplementation with DDG had no effect (P > 0.05) on quantity of forage available for grazing on bermudagrass pastures in either 2006 or 2007 and bromegrass pastures in 2005 or 2006. However, in 2007, bromegrass pastures grazed by steers supplemented with 0.5% or 1.0% DDG had more (P < .05) available forage than pastures where steers received no supplement. Because pastures received the same supplementation treatment during each year of the study, it is possible that the effect of supplementation on forage availability was cumulative and not detected on bromegrass pastures until after the third year of grazing. An armyworm invasion in 2007 reduced the level of forage that was available in late May and might have accentuated the effect of supplementation on forage availability. Either feeding DDG caused a reduction in forage intake that our forage measurement technique was not sensitive enough to detect in the earlier years of this study or supplementation with DDG improved forage digestibility sufficiently enough to increase forage intake and offset any substitution effects.

Quantity of available forage varied by sampling date as expected. In 2005 and 2006, available forage was lowest in early April and increased with each successive sampling date to its highest level in June and gradually declined as the grazing season progressed. In 2007, available forage reached its highest level in late April, declined in May due to an armyworm invasion, increased in June and July due to timely rainfall, and then declined gradually as the grazing season progressed. Average available forage was approximately 2,400 lb/a less in 2006 than in 2005, reflecting the lower level of precipitation in 2006, and 540 lb/a less in 2006 than in 2007 despite an armyworm invasion.

Grazing and subsequent finishing performance of steers supplemented with DDG while grazing smooth bromegrass in 2005, 2006, and 2007 are presented in Tables 2, 3, and 4, respectively. In 2005, steers supplemented with 0.5% or 1.0% DDG during the grazing phase had 37% or 54% higher (P < 0.05) weight gain, daily gain, and steer gain per acre, respectively, than those that received no supplement. Steers supplemented with 0.5% or 1.0% DDG had 112 or 165 lb higher (P < 0.05) total weight gain, 0.57 or 0.84 lb higher (P < 0.05) daily gain, and 89 or 132 lb higher (P < 0.05) gain per acre, respectively, than those that received no supplementation. Supplementation of grazing steers with 1.0% DDG resulted in 13% higher (P < 0.05) weight gain (53 lb), daily gain (0.27 lb), and gain per acre (43 lb), than supplementation with 0.5% DDG. Steers supplemented with DDG at 0.5% or 1.0% body weight per head daily consumed a total of 650 or 1,308 lb of DDG, respectively, during the 196-day grazing period. Average consumption of DDG was 3.3 or 6.7 lb/head daily for steers supplemented with 0.5% or 1.0% DDG per head daily, respectively. In 2005, steers supplemented with 0.5% or 1.0% DDG per head daily consumed 5.8 or 7.9 lb of DDG for each additional pound of body weight gained during the grazing phase.

In 2006, steers supplemented with 0.5% or 1.0% DDG while grazing smooth bromegrass had 31% or 35% higher (P < 0.05) weight gain, daily gain, and steer gain per acre, respectively, than those that received no supplement. Steers supplemented with 0.5% or 1.0% DDG had 82 or 91 lb higher (P < 0.05) total weight gain, 0.51 or 0.56 lb higher (P < 0.05) daily gain, and 66 or 73 lb higher (P < 0.05) gain per acre, respectively, than those that received no supplementation. Supplementation of grazing steers with 0.5% or 1.0% DDG resulted in similar (P > 0.05) grazing performance. Steers supplemented with DDG at 0.5% or 1.0% body weight per head daily consumed a total of 539 or 1,062 lb of DDG, respectively, during the 161-day grazing period. Average consumption of DDG was 3.3 or 6.6 lb per head daily for steers supplemented with 0.5% or 1.0% DDG per head daily, respectively. In 2006, steers supplemented with 0.5% or 1.0% DDG per head daily consumed 6.6 or 11.7 lb of DDG for each additional pound of body weight gained during the grazing phase.

In 2007, steers supplemented with 0.5% or 1.0% DDG while grazing smooth bromegrass had 53% or 61% higher ($P < 0.05$) weight gain, daily gain, and steer gain per acre, respectively, than those that received no supplement. Steers supplemented with 0.5% or 1.0% DDG had 122 or 140 lb higher ($P < 0.05$) total weight gain, 0.67 or 0.77 lb higher ($P < 0.05$) daily gain, and 97 or 112 lb higher ($P < 0.05$) gain per acre, respectively, than those that received no supplementation. Supplementation of grazing steers with 0.5% or 1.0% DDG resulted in similar ($P > 0.05$) grazing performance. Steers supplemented with DDG at 0.5% or 1.0% body weight per head daily consumed a total of 631 or 1,263 lb of DDG, respectively, during the 182-day grazing period. Average consumption of DDG was 3.5 or 6.9 lb per head daily for steers supplemented with 0.5% or 1.0% DDG per head daily, respectively. In 2007, steers supplemented with 0.5% or 1.0% DDG per head daily consumed 5.2 or 10.4 lb of DDG for each additional pound of body weight gained during the grazing phase.

Supplementation with DDG during the grazing phase had no effect ($P > 0.05$) on subsequent finishing gain in 2005 and 2006. However, in 2007, steers that received no supplement during the grazing phase had higher ($P < 0.05$) finishing gains than those supplemented with 0.5% or 1.0% DDG. Steers supplemented during the grazing phase in 2005 were heavier ($P < 0.05$) at the end of the grazing phase, heavier ($P < 0.05$) at the end of the finishing phase, and had higher ($P < 0.05$) hot carcass weights than those that received no supplement while grazing. In 2006, steers that received 0.5% DDG during the grazing phase maintained their weight advantage, were heavier ($P < 0.05$) at the end of the finishing phase, and had higher ($P < 0.05$) hot carcass weights than the unsupplemented control. Final slaughter weights of steers supplemented with 1.0% DDG were similar ($P > 0.05$) to those of steers supplemented with 0 or 0.5% DDG. In 2007, steers supplemented during the grazing phase were heavier ($P < 0.05$) at the end of the finishing phase and had higher ($P < 0.05$) hot carcass weights than those that received no supplement while grazing. Supplementation during the grazing phase had no effect ($P > 0.05$) on feed intake in any of the three years. However, steers that received no supplement while grazing in 2005 required less ($P < 0.05$) feed per pound of gain than those supplemented with distillers grains at 1.0% of their body weight, and steers that received no supplement in 2007 required less ($P < 0.05$) feed per pound of gain than those that received 0.5% or 1.0% DDG. Supplementation during the grazing phase had no effect ($P > 0.05$) on fat thickness, ribeye area, yield grade, or percentage of cattle that graded choice. However, in 2007, steers supplemented with 1.0% DDG had a higher ($P < 0.05$) dressing percentage, and steers supplemented with 0.5% DDG had higher ($P < 0.05$) marbling scores than those that received no supplement while grazing.

In 2005 and 2007, overall gain (grazing + finishing) was higher ($P < 0.05$) for cattle supplemented with DDG during the grazing phase. Steers supplemented with 0.5% or 1.0% DDG in 2005 had 89 or 148 lb higher ($P < 0.05$) overall gain and 0.28 or 0.46 lb higher ($P < 0.05$) daily gain, respectively, than those that received no supplement while grazing. Steers supplemented with 0.5% or 1.0% DDG in 2007 had 65 or 62 lb higher ($P < 0.05$) overall gain and 0.22 or 0.21 lb higher ($P < 0.05$) daily gain, respectively, than those that received no supplement while grazing. Overall gains were similar in 2005 and 2007 ($P > 0.05$) between steers supplemented with 0.5% or 1.0% DDG. In 2006, overall gain for steers supplemented with 0.5% DDG during the grazing phase was higher ($P < 0.05$) than for those that received no supplement. Overall gain of steers supplemented with 1.0% DDG was similar ($P < 0.05$) to that of steers supplemented with 0 or 0.5% DDG. Steers supplemented with 0.5% DDG had 93 lb higher ($P < 0.05$) overall gain and 0.32 lb higher ($P < 0.05$) daily gain than those that received no supplement while grazing.

Available forage during the grazing phase is presented by date and supplementation level for the bermudagrass pastures in Table 5. Supplementation treatment had no effect ($P > 0.05$) on the quantity of forage available for grazing in either 2006 or 2007. Grazing and finishing performance of steers supplemented with DDG while grazing bermudagrass pastures in 2006 and 2007 are presented in Tables 6 and 7, respectively. Supplementation with DDG during the grazing phase had no effect ($P > 0.05$) on grazing, finishing, or overall performance in 2006. In 2006, unsupplemented cattle gained more than anticipated during the grazing phase (2.25 lb/head daily), which resulted in supplementation not being beneficial. The only difference noted in the bermudagrass study in 2006 was that steers not supplemented during the grazing phase had less ($P < 0.05$) external fat at slaughter than those supplemented with DDG. In 2007, steers supplemented with 1.0% DDG had higher ($P < 0.05$) grazing gains than those that received no supplement or 0.5% DDG. Steers supplemented with 1.0% DDG had higher ($P < 0.05$) final weights at the end of the finishing phase and higher ($P < 0.05$) overall gains than those that received no supplement during the grazing phase. However, hot carcass weights were similar ($P > 0.05$) among supplementation treatments. Steers supplemented with 1.0% DDG during the grazing phase yielded a lower ($P < 0.05$) percentage of choice carcasses than those supplemented with 0.5% DDG. Supplement conversion was more favorable in 2007 than in 2006; steers supplemented with 0.5% or 1.0% consumed 16.4 or 10.0 lb of DDG, respectively, for each additional pound of live-weight gain.

Under the conditions of this study, supplementation of stocker cattle grazing smooth bromegrass pasture with DDG at 0.5% of their body weight resulted in more efficient supplement conversion and, therefore, a greater potential return on dollars invested in DDG than supplementation at the 1.0% level. Supplementation of stocker cattle grazing bermudagrass pastures with DDG appeared to be less beneficial than supplementation of cattle grazing smooth bromegrass pastures.

Table 1. Effect of Supplementation with Distiller's Dried Grains on Available Smooth Bromegrass Forage, Southeast Agricultural Research Center, 2005 to 2007

	Level of Distiller's Grains (% body weight/head per day)			
Date	0	0.5	1.0	Average
	------------------------lb of dry matter/acre------------------------			
4/6/05	1602	1595	1480	1559[a]
5/3/05	4205	4040	4099	4114[b]
6/2/05	4241	4470	4470	4394[b]
6/28/05	9954	10107	10753	10271[c]
7/26/05	9680	9522	10349	9851[c]
8/23/05	7285	7378	7229	7297[d]
9/22/05	6844	6872	6983	6900[de]
10/17/05	6189	6315	6231	6245[e]
2005 Season Average	6250	6287	6449	6329
4/14/06	2015	2100	2192	2102[a]
5/11/06	4996	5065	4847	4969[b]
6/6/06	5468	5454	5658	5526[c]
7/5/06	4197	4160	4578	4312[d]
8/1/06	3982	3693	3894	3856[e]
8/29/06	3567	3519	4025	3704[e]
9/20/06	2923	3364	2585	2958[f]
2006 Season Average	3878	3908	3968	3918
3/28/07	2038	1902	2104	2015[a]
4/2/07	4297	4014	4245	4185[bc]
4/30/07	5631	5725	5598	5651[d]
5/29/07	3376	3737	3621	3578[e]
6/26/07	4304	4908	4670	4628[bf]
7/24/07	4625	5109	4762	4832[f]
8/21/07	4189	4699	4694	4528[bf]
9/17/07	3855	4451	4702	4336[b]
10/1/07	3452	3861	4151	3821[ce]
2007 Season Average	3974[g]	4267[h]	4283[h]	4175

[abcdef] Within columns in the same year, means without a common superscript differ ($P < 0.05$).
[gh] Within rows, means without a common superscript differ ($P < 0.05$).

Table 2. Effect of Supplementing Steers Grazing Smooth Bromegrass Pastures with Distiller's Dried Grains on Grazing and Subsequent Finishing Performance, Southeast Agricultural Research Center, 2005

	Level of Distiller's Grains (% body weight/head per day)		
Item	0	0.5	1.0
Grazing Phase (196 days)			
No. of head	11	12	12
Initial wt., lb	435	438	437
Final wt., lb	739[a]	853[b]	907[c]
Gain, lb	304[a]	416[b]	469[c]
Daily gain, lb	1.55[a]	2.12[b]	2.39[c]
Gain/acre, lb	243[a]	332[b]	375[c]
Total DDG consumption, lb/head	0	650	1308
Average DDG consumption, lb/head/day	0	3.3	6.7
DDG, lb/additional gain	-	5.8	7.9
Finishing Phase (126 days)			
Beginning wt., lb	739[a]	853[b]	907[c]
Ending wt., lb	1225[a]	1317[b]	1375[b]
Gain, lb	486	464	468
Daily gain, lb	3.85	3.68	3.72
Daily DM intake, lb	26.1	26.6	28.0
Feed:Gain	6.78[a]	7.23[ab]	7.52[b]
Hot carcass wt., lb	747[a]	805[b]	848[c]
Dressing percentage, %	61	61	62
Backfat, in.	0.52	0.62	0.68
Ribeye area, square in.	13.2	13.4	13.5
Yield grade	2.8	3.2	3.5
Marbling score	SM^{38}	SM^{35}	SM^{69}
Percent Choice, %	83	83	83
Overall Performance (Grazing + Finishing) (322 days)			
Gain, lb	790[a]	879[b]	938[b]
Daily gain, lb	2.45[a]	2.73[b]	2.91[b]

Note. DDG = Distiller's dried grains; DM = Dry matter; SM = Small.
[abc] Within rows, means without a common superscript differ ($P < 0.05$).

Table 3. Effect of Supplementing Steers Grazing Smooth Bromegrass Pastures with Distiller's Dried Grains on Grazing and Subsequent Finishing Performance, Southeast Agricultural Research Center, 2006

	Level of Distiller's Grains (% body weight/head per day)		
Item	0	0.5	1.0
Grazing Phase (161 days)			
No. of head	12	12	12
Initial wt., lb	484	484	484
Final wt., lb	746[a]	828[b]	837[b]
Gain, lb	262[a]	344[b]	353[b]
Daily gain, lb	1.63[a]	2.14[b]	2.19[b]
Gain/acre, lb	209[a]	275[b]	282[b]
Total DDG consumption, lb/head	0	539	1062
Average DDG consumption, lb/head/day	0	3.3	6.6
DDG, lb/additional gain	-	6.6	11.7
Finishing Phase (126 days)			
Beginning wt., lb	746[a]	828[b]	837[b]
Ending wt., lb	1215[a]	1308[b]	1277[ab]
Gain, lb	469	480	440
Daily gain, lb	3.72	3.81	3.50
Daily DM intake, lb	26.2	27.2	27.7
Feed:Gain	7.09	7.14	7.93
Hot carcass wt., lb	730[a]	791[b]	771[ab]
Dressing percentage, %	60	61	60
Backfat, in.	0.51	0.52	0.52
Ribeye area, square in.	12.0	12.3	12.6
Yield grade	3.1	3.3	3.1
Marbling score	SM^{33}	SM^{36}	SM^{69}
Percent Choice, %	58	50	58
Overall Performance (Grazing + Finishing) (278 days)			
Gain, lb	731[a]	824[b]	793[ab]
Daily gain, lb	2.55[a]	2.87[b]	2.76[ab]

Note. DDG = Distiller's dried grains; DM = Dry matter; SM = Small.
[abc] Within rows, means without a common superscript differ ($P < 0.05$).

Table 4. Effect of Supplementing Steers Grazing Smooth Bromegrass Pastures with Distiller's Dried Grains on Grazing and Subsequent Finishing Performance, Southeast Agricultural Research Center, 2007

	Level of Distiller's Grains (% body weight/head per day)		
Item	0	0.5	1.0
Grazing Phase (182 days)			
No. of head	12	12	12
Initial wt., lb	497	497	497
Final wt., lb	728[a]	850[b]	868[b]
Gain, lb	231[a]	353[b]	371[b]
Daily gain, lb	1.27[a]	1.94[b]	2.04[b]
Gain/acre, lb	185[a]	282[b]	297[b]
Total DDG consumption, lb/head	0	631	1263
Average DDG consumption, lb/head/day	0	3.5	6.9
DDG, lb/additional gain	-	5.2	10.4
Finishing Phase (126 days)			
Beginning wt., lb	728[a]	850[b]	868[b]
Ending wt., lb	1202[a]	1267[b]	1264[b]
Gain, lb	474[a]	417[b]	396[b]
Daily gain, lb	3.98[a]	3.51[b]	3.33[b]
Daily DM intake, lb	25.1	25.6	24.8
Feed:Gain	6.31[a]	7.31[b]	7.44[b]
Hot carcass wt., lb	705[a]	753[b]	765[b]
Dressing percentage, %	59[a]	59[ab]	61[b]
Backfat, in.	0.44	0.43	0.41
Ribeye area, square in.	14.0	13.3	13.2
Yield grade	2.2	2.6	2.6
Marbling score	SM[06a]	SM[48b]	SM[22ab]
Percent Choice, %	67	75	75
Overall Performance (Grazing + Finishing) (301 days)			
Gain, lb	705[a]	770[b]	767[b]
Daily gain, lb	2.34[a]	2.56[b]	2.55[b]

Note. DDG = Distiller's dried grains; DM = Dry matter; SM = Small.

[abc] Within rows, means without a common superscript differ ($P < 0.05$).

Table 5. Effect of Supplementation with Distiller's Dried Grains on Available Bermudagrass Forage, Southeast Agricultural Research Center, 2006 and 2007

	Level of Distiller's Grains (% body weight/head per day)			
Date	0	0.5	1.0	Average
	--------------------------lb of dry matter/acre--------------------------			
6/14/06	2659	2516	2478	2551
7/7/06	2250	3486	1130	2289
8/4/06	3761	3034	4327	3707
9/5/06	2777	2190	3377	2781
2006 Season Average	2862	2806	2828	2832
6/19/07	1346	1172	1293	1270
7/16/07	5004	3610	5181	4598
8/9/07	9617	8384	12527	10176
9/12/07	998	1397	986	1127
2007 Season Average	4241	3641	4997	4293

Table 6. Effect of Supplementing Steers Grazing Bermudagrass Pastures with Distiller's Dried Grains on Grazing and Subsequent Finishing Performance, Southeast Agricultural Research Center, 2006

	Level of Distiller's Grains (% body weight/head per day)		
Item	0	0.5	1.0
Grazing Phase (89 days)			
No. of head	10	15	15
Initial wt., lb	749	749	749
Final wt., lb	950	954	988
Gain, lb	200	205	239
Daily gain, lb	2.25	2.30	2.68
Gain/acre, lb	200	205	239
Total DDG consumption, lb/head	0	382	756
Average DDG consumption, lb/head/day	0	4.3	8.5
DDG, lb/additional gain	-	76.4	19.4
Finishing Phase (85 days)			
Beginning wt., lb	950	954	988
Ending wt., lb	1283	1282	1290
Gain, lb	333	328	302
Daily gain, lb	3.92	3.86	3.55
Daily DM intake, lb	25.5	25.1	25.2
Feed:Gain	6.52	6.53	7.15
Hot carcass wt., lb	756	775	786
Dressing percentage, %	59	60	61
Backfat, in.	0.34^{a}	0.46^{b}	0.45^{b}
Ribeye area, square in.	11.8	12.6	12.2
Yield grade	2.8	3.0	3.1
Marbling score	SL^{99}	SM^{26}	SM^{61}
Percent Choice, %	50	47	53
Overall Performance (Grazing + Finishing) (174 days)			
Gain, lb	533	533	541
Daily gain, lb	3.06	3.06	3.11

Note. DDG = Distiller's dried grains; DM = Dry matter; SL = Slight; SM = Small.

^{abc} Within rows, means without a common superscript differ ($P < 0.05$).

Table 7. Effect of Supplementing Steers Grazing Bermudagrass Pastures with Distiller's Dried Grains on Grazing and Subsequent Finishing Performance, Southeast Agricultural Research Center, 2007

	Level of Distiller's Grains (% body weight/head per day)		
Item	0	0.5	1.0
Grazing Phase (112 days)			
No. of head	10	15	15
Initial wt., lb	734	734	734
Final wt., lb	884[a]	912[a]	980[b]
Gain, lb	150[a]	178[a]	246[b]
Daily gain, lb	1.34[a]	1.59[a]	2.20[b]
Gain/acre, lb	150[a]	178[a]	246[b]
Total DDG consumption, lb/head	0	459	963
Average DDG consumption, lb/head/day	0	4.1	8.6
DDG, lb/additional gain	-	16.4	10.0
Finishing Phase (112 days)			
Beginning wt., lb	884[a]	912[a]	980[b]
Ending wt., lb	1336[a]	1364[ab]	1428[b]
Gain, lb	451	451	448
Daily gain, lb	4.03	4.03	4.00
Daily DM intake, lb	26.2	26.6	26.3
Feed:Gain	6.50	6.62	6.61
Hot carcass wt., lb	801	814	823
Dressing percentage, %	60	60	58
Backfat, in.	0.36	0.32	0.37
Ribeye area, square in.	13.3	13.4	13.8
Yield grade	2.6	2.6	2.6
Marbling score	SM^{33}	SM^{36}	SM^{69}
Percent Choice, %	70[ab]	80[a]	53[b]
Overall Performance (Grazing + Finishing) (174 days)			
Gain, lb	601[a]	629[ab]	694[b]
Daily gain, lb	2.68[a]	2.81[ab]	3.10[b]

Note. DDG = Distiller's dried grains; DM = Dry matter; SM = Small.
[abc] Within rows, means without a common superscript differ ($P < 0.05$).

EVALUATION OF TALL FESCUE CULTIVARS

Joseph L. Moyer

Summary

Spring 2007 yields of the 2003 trial were higher for FA 2846 than for 16 other entries. Summer yields of Ky 31 LE were higher than yields from any other entry. Fall production of FTF-24 was higher than 16 other entries. Total 2007 production was higher for Ky 31 LE and FTF-24 than for 13 other entries. Four-year production for FTF-24 was greater than 13 other cultivars.

Introduction

Tall fescue (*Festuca arundinacea* Schreb.) is the most widely grown forage grass in southeastern Kansas. Its tolerance to extremes in climate and soils of the region is partly attributable to its association with a fungal endophyte, *Neotyphodium coenophialum*. However, most ubiquitous endophytes also are responsible for production of substances toxic to some herbivores, including cattle, sheep, and horses.

Endophytes that purportedly lack toxins but augment plant vigor have been identified and inserted into tall fescue cultivars adapted to the United States. These cultivars, and others that are fungus-free or contain a ubiquitous endophyte are included in this test.

Experimental Procedures

All trials were seeded at the Mound Valley Unit of the Southeast Agricultural Research Center in 10-in. rows on Parsons silt loam soil. Plots were 30 ft by 5 ft and arranged in four randomized complete blocks. Tests were seeded with 19 lb/a of pure, live seed on September 17, 2003.

Fertilizer to supply 140-50-60 lb/a N-P_2O_5-K_2O was applied to all plots on March 8, 2007. Harvest was performed on a 3-ft-wide and 15- to 20-ft long strip from each plot cut to a 3-in. height with a flail-type harvester after all plots were headed (May 23, 2007). Regrowth occurred due to June moisture, so plots were harvested in August for summer production and in December for fall production. A forage subsample was collected and dried at 140°F for moisture determination, and forage was removed from the rest of the plot at the same height.

Results and Discussion

Spring 2007 forage yield of entries in the 2003 trial was greater ($P < 0.05$) for FA 2846 than for 16 other entries (Table 1). FA 111 and AU Triumph had lower yields than 17 higher-producing entries. Summer yields were higher for Ky 31 LE than for any other entry, and FTF-24 yielded more than FA 2845 and Montendre. Fall production of FTF-24 was higher than 16 other entries, and FTF-25 yielded more than FA 2845, FA 2846, and FA 2848. Total 2007 production was higher for Ky 31 LE and FTF-24 than for 13 other entries. FA 2845 had lower yield than eight higher-producing entries.

Total 4-year production from 2004 to 2007 for FTF-24 was greater than for 13 other cultivars. FA 2845 and FA 111 had lower yield than seven higher-producing entries.

Table 1. Forage Yield of Tall Fescue Cultivars in 2007 and 4-year Total, Mound Valley Unit

Cultivar	5/23	8/28	12/5	2007	4-Yr
	- - - - - - - - - - - - - - - - -	tons/a at 12% moisture	- - - - - - - - - - - - - - - - -		
FTF-24	2.21	1.55	2.05	5.80	16.90
FTF-25	2.20	1.28	1.73	5.20	15.87
AU Triumph	2.09	1.53	1.33	4.95	14.60
Stockman	2.38	1.32	1.62	5.32	15.69
Tuscany II	2.53	1.41	1.51	5.45	15.65
Montendre	2.33	1.18	1.55	5.06	14.54
ArkPlus[1]	2.55	1.44	1.42	5.40	15.66
Jesup MaxQ[1]	2.40	1.28	1.43	5.11	15.23
Select	2.43	1.39	1.35	5.18	14.42
Enhance	2.30	1.33	1.47	5.09	14.40
FA 111	1.89	1.46	1.50	4.84	14.21
FA 117	2.23	1.38	1.65	5.25	15.88
FA 120	2.19	1.47	1.37	5.03	15.05
FA 121	2.29	1.35	1.52	5.16	15.66
FA 2845	2.53	2.20	1.16	4.78	14.16
FA 2846	2.65	1.54	1.19	5.38	14.84
FA 2847	2.38	1.36	1.54	5.27	15.55
FA 2848	2.51	1.42	1.20	5.13	15.06
FA 2849	2.47	1.28	1.38	5.12	14.63
FA 2850	2.42	1.39	1.60	5.41	15.51
FA 2860	2.39	1.31	1.65	5.35	15.06
FA 2861	2.27	1.32	1.50	5.09	15.23
Ky 31 HE[2]	2.47	1.32	1.68	5.47	15.58
Ky 31 LE[2]	2.53	1.87	1.66	6.06	15.58
Average	2.36	1.39	1.50	5.25	15.21
LSD (0.05)	0.19	0.29	0.49	0.55	1.42

[1] Contains proprietary novel endophyte.
[2] LE = Low-endophyte seed (0-2% infected); HE = High-endophyte seed (80% infected).

PERFORMANCE OF LEGUMES INTERSEEDED INTO TALL FESCUE

Joseph L. Moyer

Summary

Twenty-three legumes interseeded in the spring of 2003 were monitored for stand persistence in grazed and clipped plots. Grazed stands of Regal and K 6022B white clover and Dawn birdsfoot trefoil exceeded stands of 13 other entries. Other plots were harvested for forage production. In 2004, production from plots with the four red clovers exceeded that of all other entries except Dawn birdsfoot trefoil. In 2005, Dawn plots produced more than plots of 15 other legumes, including Kenland red clover.

Introduction

Interseeding improved varieties of legume species could help fill the summer production gap that occurs in forage systems based on cool-season grasses. Legumes such as red and white (ladino) clover are used in certain sites in southeastern Kansas. Clovers, particularly Regal ladino clover, have been successfully interseeded to supplement tall fescue pastures. This study was implemented to test other legumes that might be useful in tall fescue pasture.

Experimental Procedures

Eight blocks of plots (30 ft by 5 ft) were sprayed on April 10, 2003, with Select herbicide (clethodim) at 1.5 pint/a (26 g/ha) then seeded with a cone planter in 10-in. rows on April 15, 2003 at the Mound Valley Unit of the Southeast Agricultural Research Center. Seeding rates of 4, 6, 8, 8, 15, and 15 lb/a pure, live seed were used for white clover, subclover, kura clover, birdsfoot trefoil, red clover, and alfalfa entries, respectively. Stands were evaluated visually beginning the first summer and continuing for three years. Four blocks were designated for continuous grazing beginning in the fall of 2003, and the other four blocks were clipped from 2003 to 2006. A 20-ft by 3-ft area was harvested in 2004 and 2005 with a Carter flail harvester at a height of 2 to 3 in. The remainder of the area was clipped to the same height.

Results and Discussion

Stand assessments for legumes in the interseeded plots are shown in Table 1. Red clover entries had the best stands in the first summer after seeding; all four entries had higher ($P < 0.05$) stand ratings than all other legumes except five white clovers. Alfagraze alfalfa and the three birdsfoot trefoil cultivars were intermediate, with first-year stand ratings less than the red clovers and most of the white clovers. After about 18 months of grazing the four designated blocks, stands of Dawn birdfoot trefoil exceeded those of 13 other legumes. In harvested plots, Empire birdsfoot trefoil had better legume stands after three years than 19 other entries.

In 2004, production from plots with the four red clovers exceeded ($P < 0.05$) that of all other entries except Dawn birdsfoot trefoil (Table 2). In 2005, Dawn plots produced more than plots of 15 other legumes, including Kenland red clover (Table 3). The only plots that produced more forage in 2005 than the fescue-only plots were those containing the three birdsfoot trefoil cultivars.

Forage crude protein concentration (Table 4) could indicate the amount of legume in the forage. At the first harvest, forage from Kenland and Narn red clover plots had higher ($P < 0.05$) crude protein concentrations than 12 other entries. By that fall, however, forage from ARS-2620 birdsfoot trefoil plots had a higher crude protein concentration than 13 other entries, including those of two red clovers but not including either of the other two birdsfoot trefoil cultivars.

In the spring of 2005, forage crude protein concentration from plots with Dawn birdsfoot trefoil had a higher ($P < 0.05$) crude protein concentration than 10 other entries, including Kenland red clover (Table 4). In the fall of 2005, forage from plots with Empire birdsfoot trefoil had higher crude protein concentration than all other entries except for plots with Alfagraze alfalfa, Endura kura clover, Renegade red clover, and ARS-2620 birdsfoot trefoil.

Table 1. Stand Ratings of Legumes Interseeded into Endophyte-Infected Tall Fescue[1]

Entry	7/24/2003[2]	4/27/2005[3]	9/29/2005[4]	4/11/2006[4]
	- - - - - - - - - - - - - - - - Rating (0 to 5)	- - - - - - - - - - - - - - - -		
Alfagraze Alfalfa	1.6	1.3	2.3	1.5
K 4822L Subclover	0.5	1.0	1.8	0.4
KTA9723E Kura Clover	0.4	1.3	1.8	1.0
Endura Kura Clover	1.1	1.3	2.5	1.3
NF 93 Kura Clover	0.1	1.3	1.3	0.8
KTA 202 Kura clover	0.3	1.0	1.3	1.0
K 6043G Red Clover	3.9	2.0	0.8	0.5
Renegade Red Clover	3.5	1.8	1.0	1.0
Kenland Red Clover	4.0	1.3	1.5	0.8
Narn Red Clover	3.9	1.0	2.0	1.3
Regal White Clover	3.1	2.5	1.3	0.8
Ivory White Clover	2.3	2.0	1.5	0.3
K 6069 White Clover	2.9	1.3	1.0	0.5
K 6070 White Clover	2.0	1.0	0.8	0
K 6071 White Clover	2.4	2.0	1.0	0
Tripoli White Clover	2.5	1.8	1.3	0.5
K 2889T White Clover	1.1	1.3	1.3	1.0
K 6072 White Clover	3.3	2.3	1.3	0
K 6022B White Clover	2.9	2.5	1.3	0.3
Kopu II R White Clover	3.1	2.3	1.5	0.5
Dawn Birdsfoot Trefoil	1.8	2.5	2.3	1.8
Empire Birdsfoot Trefoil	1.4	2.0	3.0	2.5
ARS-2620 Birdsfoot Trefoil	1.3	2.0	1.5	1.5
Fescue Alone	0	1.0	1.3	0.5
LSD(0.05)	0.9	1.0	1.3	1.1

[1] Rating scale: 0 to 5, where 0 = no legume and 5 = solid stand in seeded rows.
[2] Mean of eight replications.
[3] Mean of four replications grazed for 2 years.
[4] Mean of four replications clipped for 2 years.

Table 2. 2004 Forage Yield of Endophyte-Infected Tall Fescue Interseeded with Legumes in 2003

Entry	6/30/2004	9/2/2004	Total
	- - - - - - - - tons/a at 12% moisture- - - - - - - -		
Alfagraze Alfalfa	3.48	1.64	5.11
K 4822L Subclover	3.52	1.62	5.14
KTA9723E Kura Clover	3.24	1.23	4.46
Endura Kura Clover	3.45	1.40	4.85
NF 93 Kura Clover	3.36	1.78	4.83
KTA 202 Kura clover	3.02	1.10	4.12
K 6043G Red Clover	4.50	1.67	6.17
Renegade Red Clover	4.08	1.89	5.97
Kenland Red Clover	4.29	1.91	6.40
Narn Red Clover	4.83	2.19	7.02
Regal White Clover	3.11	1.56	4.67
Ivory White Clover	3.31	1.44	4.75
K 6069 White Clover	3.96	1.80	5.76
K 6070 White Clover	3.08	1.26	4.27
K 6071 White Clover	3.90	1.60	5.51
Tripoli White Clover	3.62	1.56	5.18
K 2889T White Clover	3.41	1.60	5.01
K 6072 White Clover	3.35	1.88	5.23
K 6022B White Clover	3.42	1.24	4.66
Kopu II R White Clover	3.72	1.51	5.23
Dawn Birdsfoot Trefoil	4.17	1.97	6.14
Empire Birdsfoot Trefoil	4.07	1.56	5.64
ARS-2620 Birdsfoot Trefoil	4.05	1.58	5.62
None (tall fescue only)	3.15	1.15	4.30
LSD(0.05)	0.84	0.51	1.19

Table 3. 2005 Forage Yield of Endophyte-Infected Tall Fescue Interseeded with Legumes in 2003

Entry	6/29/2005	9/29/2005	Total
	- - - - - - - - tons/a at 12% moisture- - - - - - - -		
Alfagraze Alfalfa	4.46	2.01	6.47
K 4822L Subclover	4.10	2.30	6.40
KTA9723E Kura Clover	3.20	1.73	4.93
Endura Kura Clover	3.82	1.75	5.58
NF 93 Kura Clover	3.91	1.89	5.80
KTA 202 Kura clover	3.13	1.63	4.75
K 6043G Red Clover	4.35	2.09	6.44
Renegade Red Clover	4.29	2.25	6.54
Kenland Red Clover	4.16	1.98	6.15
Narn Red Clover	4.63	2.07	6.70
Regal White Clover	3.79	1.85	5.64
Ivory White Clover	3.72	1.98	5.70
K 6069 White Clover	3.98	2.13	6.10
K 6070 White Clover	3.23	1.70	4.93
K 6071 White Clover	3.95	1.36	5.31
Tripoli White Clover	3.76	1.80	5.55
K 2889T White Clover	3.76	1.95	5.71
K 6072 White Clover	3.83	1.88	5.71
K 6022B White Clover	3.56	1.51	5.06
Kopu II R White Clover	3.83	2.19	6.02
Dawn Birdsfoot Trefoil	5.02	2.68	7.70
Empire Birdsfoot Trefoil	4.58	2.27	6.85
ARS-2620 Birdsfoot Trefoil	4.71	2.20	6.91
None (tall fescue only)	3.47	1.68	5.15
LSD(0.05)	0.95	0.77	1.47

Table 4. Forage Crude Protein Concentration of Endophyte-Infected Tall Fescue Interseeded with Legumes in 2003

	2004		2005	
Entry	6/30	9/2	6/29	9/29
	- - - - - - - - - - - - - - - - -	%	- - - - - - - - - - - - - - - - - - -	
Alfagraze Alfalfa	8.6	11.7	9.0	11.1
K 4822L Subclover	8.4	10.1	9.2	7.9
KTA9723E Kura Clover	7.0	10.0	9.0	9.8
Endura Kura Clover	8.7	11.5	10.3	10.1
NF 93 Kura Clover	9.2	10.8	9.1	9.2
KTA 202 Kura clover	7.1	9.9	8.5	8.4
K 6043G Red Clover	9.6	11.4	9.4	9.0
Renegade Red Clover	10.8	10.6	10.8	9.9
Kenland Red Clover	11.4	10.9	8.7	8.9
Narn Red Clover	11.5	11.7	9.5	9.4
Regal White Clover	8.2	11.2	8.6	8.7
Ivory White Clover	10.2	11.3	9.3	8.3
K 6069 White Clover	8.0	11.2	8.8	8.0
K 6070 White Clover	8.1	10.8	8.7	9.0
K 6071 White Clover	7.7	10.3	7.9	8.1
Tripoli White Clover	8.6	10.7	7.7	9.7
K 2889T White Clover	8.3	10.8	8.3	8.8
K 6072 White Clover	9.2	10.5	10.3	9.2
K 6022B White Clover	8.8	12.0	9.4	8.0
Kopu II R White Clover	9.3	11.5	9.3	8.1
Dawn Birdsfoot Trefoil	10.9	12.4	11.0	9.4
Empire Birdsfoot Trefoil	9.5	12.1	9.9	11.8
ARS-2620 Birdsfoot Trefoil	9.4	12.9	10.4	9.9
None (tall fescue only)	6.7	10.6	8.0	9.7
LSD(0.05)	2.4	1.7	1.9	2.0

GROWING ANNUAL CROPS FOR SUMMER FORAGE

Joseph L. Moyer and Kenneth J. Moore[1]

Summary

Forage yields of sudangrass, pearl millet, and crabgrass were similar at the vegetative stage. At the reproductive stage, yields of the five species were highest for corn and sudangrass, with millet and soybean intermediate. Crabgrass production at the reproductive stage was lowest of the five species grown in 2007.

Introduction

Pastures in eastern Kansas consist mainly of cool-season grasses that produce mostly in spring and early summer, but nutritional needs of stockers and cow-calf pairs generally increase throughout the season. Typical management undergrazes early growth of cool-season pastures in preparation for when production declines and demand increases. The problem with this approach is that as ungrazed forage matures, its quality declines. A complementary system that uses annuals for summer grazing would provide high-quality forage when quality of cool-season grasses is lowest. Designing such a system requires gathering basic information about growth and development of annual species in each area. The objective of this research is to evaluate the adaptability, yield, and quality of summer annual forages at specific sites on a regional basis for use in complementary forage systems.

Experimental Procedures

Sudangrass, pearl millet, soybean, and crabgrass were planted in blocks with four replications at designated rates. Soil temperature was ≈65°F on May 21, 2007, when soil dried sufficiently. Fertilizer (100-50-60 lb/a N-P_2O_5-K_2O) was applied preplant. Oat, Italian ryegrass, berseem clover, and forage rape were not planted in 2007 because soil was wet throughout their optimum planting period. Separate portions of plots were harvested initially at one of two growth stages—mid-vegetative and early reproductive—except for corn and soybean, where wet soil prevented harvest at the vegetative stage (Table 1). Regrowth was harvested from previously harvested strips if sufficient forage was produced. Subsamples were used for moisture determination then ground for analysis.

Results and Discussion

When cut at the mid-vegetative stage before reproductive growth began, pearl millet, sudangrass, and crabgrass produced similar ($P > 0.05$) amounts of growth, regrowth, and total forage in 2007 (Table 2).

At the reproductive stage, corn produced more ($P < 0.05$) at the initial cut than other species except sudangrass. Because only sudangrass was able to produce a harvestable amount of reproductive regrowth, its total production at that stage was greater than other species except corn. Millet and soybean produced similar amounts of forage, and yields of both at the reproductive stage were greater than crabgrass yield (Table 2).

Throughout the three years of this study, forage production at this location was greatest for corn, millet, and sudangrass (data not shown). Among earlier-spring-seeded species planted in previous years, oat appeared more productive than berseem clover, rape, and ryegrass. However, when forage quality is considered, crops such as soybean, ryegrass, and clover can provide additional value.

[1] Iowa State University Department of Agronomy

Table 1. 2007 Harvest Dates for Crops at Vegetative and Reproductive Stages

Species	Vegetative	Reproductive
Sudangrass	7/11, 8/8	7/31, 9/21
Millet	7/11, 8/28	8/8
Soybean	-	8/4
Corn	-	8/8
Crabgrass	7/11, 8/8, 9/21	7/31

Table 2. Summer 2007 Forage Yield from Five Annual Species, Mound Valley Unit

		Cut at Vegetative Stage			Cut at Reproductive Stage		
Species	Cultivar	First Growth	Re-growth	Total	First Growth	Re-growth	Total
		- - - - - - - - - tons/a at 12% moisture - - - - - - - - -					
Sudangrass	Trudan 8	2.80	1.54	4.34	4.90	2.03	6.93
Pearl millet	Tifleaf III	2.48	1.09	3.57	4.60	- -	4.60
Soybean	Derry	- -	- -	- -	4.07	- -	4.07
Corn	Garst 8315IT	- -	- -	- -	6.28	- -	6.28
Crabgrass	Red River	2.16	1.34	3.49	2.29	- -	2.29
Average		2.48	1.60	3.80	4.43	- -	4.83
LSD (0.05)		NS	NS	NS	1.43	- -	1.75

FORAGE PRODUCTION OF SEEDED BERMUDAGRASS CULTIVARS

Joseph L. Moyer and Charles M. Taliaferro[1]

Summary

Stands of Wrangler and Riata were better than those of most other entries throughout 2007. Their second-cut (July 20) yield was greater than yield of 10 other entries. However, their subsequent production was less than that of nine other entries, particularly Midland 99 and KF 194.

Introduction

Bermudagrass can be a high-producing, warm-season perennial forage for eastern Kansas when not affected by winterkill. Producers in southeastern Kansas profit from using winter-hardy varieties that produce more than common bermudas. Seeded types offer cost savings or other advantages in marginal areas. Further developments in bermudagrass breeding should be monitored to speed adoption of improved, cold-hardy types.

Experimental Procedures

Thirteen bermudagrass entries were seeded at 8 lb/a of pure, live seed for hulled seed or 5 lb/a for hulless seed at the Mound Valley Unit of the Southeast Agricultural Research Center on June 21, 2005, and Midland 99 plugs were planted two weeks later. In 2007, plots were fertilized on May 22 with 125-50-60 lb/a N-P_2O_5-K_2O and on July 17 with 50 lb/a of N as ammonium nitrate.

Plots were cut June 21 and July 20, but some plots had excessive weed growth in the first cutting. Thus, only visual estimates of percentage grass in the forage were made during the first cutting. In the second cutting, sub-samples were collected from 20-ft by 3-ft strips harvested to determine forage moisture content. Stand notes were taken at the second cutting and at season's end on October 31, and grass growth was assessed at season's end.

Results and Discussion

Warm spring temperatures followed by subfreezing temperatures in early April, reaching 20°F on April 8, severely impeded spring development. The freeze damage, preceded by drought conditions in 2006 and followed by excessively wet conditions in May and June, promoted weed competition. This made it impractical to determine forage yield, so estimates of the percentage of bermudagrass in the plot were made before removal (Table 1). Estimates were higher (100%) for Riata and Wrangler than for any other entries.

Second-cut (July 20) yields of Wrangler, Riata, and Midland 99 were greater than yields of eight other cultivars (Table 1), and stand percentages for Wrangler and Riata were greater than those of seven other cultivars. Stand of SG 19 was better than stands of Cherokee and KF 194, but yield of SG 19 was similar to that of KF 194 and less than that of Cherokee.

Final stands of Wrangler and Riata were greater than those of Cherokee, Midland 99, and Sungrazer Plus (Table 1). However, late-summer growth of Riata and Wrangler was less than that of nine other cultivars. Growth of Midland 99 and KF 194 was greater than that of five other cultivars.

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[1] Retired, Oklahoma State University Department of Plant and Soil Sciences

Table 1. Grass Percentage, Stand Density, Cut Two Forage Yield, and Fall Growth in 2007 for Bermudagrass Seeded in 2005, Mound Valley Unit

		Grass	Stand		Yield	Growth
Source	Entry	6/21	7/20	10/31	7/20	10/31
		- - - - - - % - - - - - -			tons/a[1]	0 to 5[2]
K-F Seeds	KF 888	25	45	70	0.67	2.8
K-F Seeds	KF 194	28	35	75	0.82	4.3
K-F Seeds	KF 111	56	65	80	1.21	3.5
K-F Seeds	KF 222	45	40	75	0.72	3.5
K-F Seeds	SG 19	51	70	80	0.60	3.8
Genetic Seed & Chemical	Sungrazer	49	60	80	0.78	3.8
Genetic Seed & Chemical	Sungrazer I	32	50	70	0.78	3.8
Genetic Seed & Chemical	Sungrazer Plus	33	50	65	0.82	4.0
Nixa Hardware & Seed	Cherokee	31	35	55	1.02	3.8
Genetic Seed & Chemical	Jackpot	32	65	70	1.25	3.3
Oklahoma State University	Wrangler	100	95	90	1.80	2.5
Oklahoma State University	Midland 99[3]	56	60	60	1.49	5.0
Johnston Seed	Riata	100	90	85	1.54	2.3
DLF International Seeds	CIS-CD 4	32	50	70	1.18	3.3
Average		48	60	70	1.05	3.5
LSD 0.05		30	30	15	0.31	0.8

[1] At 12% moisture.
[2] Rating scale: 0 to 5, where 0 = no bermudagrass and 5 = maximum growth.
[3] Sprigged cultivar.

ALFALFA VARIETY PERFORMANCE IN SOUTHEASTERN KANSAS[1]

Joseph L. Moyer

Summary

A 13-line alfalfa test seeded in 2005 was cut five times in 2007. Yields from AA112E, 6530, and FSG505 were greater ($P < 0.05$) than from six other cultivars. Three-year production from FSG505 was greater than from seven other entries.

Introduction

Alfalfa can be an important feed and cash crop on some soils in southeastern Kansas. The worth of a particular variety is determined by many factors including pest resistance, adaptability, longevity under specific conditions, and productivity.

Experimental Procedures

A 13-line alfalfa test with four replications was seeded (15 lb/a) on April 14, 2005, at the Mound Valley Unit of the Southeast Agricultural Research Center (Parsons silt loam). In 2007, plots were fertilized with 20-50-200 lb/a $N\text{-}P_2O_5\text{-}K_2O$ on March 8 and sprayed for grass control with 1 qt/a of Poast Plus on June 25. Harvests were taken on April 12, June 6, July 16, August 27, and November 1. No treatment for insects or disease was necessary.

Results and Discussion

Wet conditions during much of the 2007 growing season (see Weather Summary) resulted in five cuttings. We decided to take the first cutting early because warm spring temperatures caused unusual early growth, and lows in the low 20s (April 7-9) killed some top growth. Wet June conditions further diminished stands, and one replication was abandoned. Normal patterns with periods of drier and warmer than average conditions returned for the rest of July and August.

Early-spring (cut one) yields were significantly greater ($P < 0.05$) for Cimarron VL400 and 6420 than for Kanza, CW 15030, and Good as Gold II (Table 1). Second-cut yields were greater for 6530 than for Kanza and WL 357HQ. Third-cut yields were greater for AA108E and AA112E than for Good as Gold II, Perry, and 6420. Fourth-cut yields were greater for AA112E and FSG4080DP than for CW 15030, AA108E, 6420, and Perry.

Total 2007 yield from AA112E was greater than from seven other entries (Table 2). Six entries had higher 2007 yield than Good as Gold II, Perry, and Kanza. Three-year total yield for FSG505 was greater than for seven other entries, and FSG50 and Cimarron VL400 yielded more than Integrity and 6420.

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[1] Statewide alfalfa performance test results can be found at http://kscroptests.agron.ksu.edu/

Table 1. 2007 Forage Yields (tons/a at 12% moisture) for the 2005 Alfalfa Variety Test, Mound Valley Unit

		Date				
Source	Entry	4/12	6/6	7/16	8/27	11/1
AgriPro Biosciences, Inc.	AA112E	1.25 [abc]	1.85 [abc]	1.67[a]	0.83[a]	0.86[a]
AgriPro Biosciences, Inc.	AA108E	1.27[c]	1.87 [abc]	1.67[a]	0.60[c]	0.78[a]
AgriPro Biosciences, Inc.	Integrity	1.23 [abc]	1.85 [abc]	1.40 [abc]	0.68 [abc]	0.83[a]
Allied	FSG505	1.26[ab]	1.87 [abc]	1.59[ab]	0.69 [abc]	0.93[a]
Allied	FSG408DP	1.25 [abc]	1.90[ab]	1.46 [abc]	0.77[ab]	0.94[a]
Cal/West	CW 1503	1.21[bc]	1.90[ab]	1.37 [abc]	0.57[c]	0.77[a]
Cimarron USA	Cimarron VL400	1.34[a]	1.84 [abc]	1.54[ab]	0.67 [abc]	0.95[a]
Garst Seed	6420	1.32[a]	1.93[ab]	1.17[c]	0.61[c]	0.89[a]
Garst Seed	6530	1.25 [abc]	2.00[a]	1.63[ab]	0.68 [abc]	0.86[a]
Johnston Seed Co.	Good as Gold II	1.21[bc]	1.75 [abc]	1.16[c]	0.63[bc]	0.86[a]
W-L Research	WL 357 HQ	1.25 [abc]	1.69[bc]	1.32[bc]	0.68 [abc]	0.96[a]
Kansas Ag. Exp. Stat. and USDA	Kanza	1.16[c]	1.64[c]	1.36 [abc]	0.68 [abc]	0.84[a]
Nebraska Ag. Exp. Stat. and USDA	Perry	1.25 [abc]	1.77 [abc]	1.17[c]	0.61[c]	0.86[a]
Average		1.25	1.83	1.42	0.67	0.87

[abc] Within columns, means without a common superscript differ ($P < 0.05$) according to Duncan's test.

Table 2. Forage Yields (tons/a at 12% moisture) for Three Years and the 3-Year Total for the 2005 Alfalfa Variety Test, Mound Valley Unit

Source	Entry	2005	2006	2007	Total
AgriPro Biosciences, Inc.	AA112E	4.74^{ab}	3.82^{ab}	6.49^{a}	15.13^{abc}
AgriPro Biosciences, Inc.	AA108E	4.35^{b}	3.20^{b}	6.23^{abcd}	14.00^{bc}
AgriPro Biosciences, Inc.	Integrity	4.08^{b}	3.28^{b}	6.00^{bcde}	13.49^{c}
Allied	FSG505	5.42^{a}	4.25^{a}	6.44^{abc}	16.17^{a}
Allied	FSG408DP	4.66^{ab}	3.52^{b}	6.34^{abcd}	14.69^{abc}
Cal/West	CW 1503	4.54^{ab}	3.84^{ab}	5.88^{de}	14.04^{bc}
Cimarron USA	Cimarron VL400	4.82^{ab}	3.62^{ab}	6.37^{abc}	15.32^{ab}
Garst Seed	6420	4.37^{b}	3.64^{ab}	5.93^{cde}	13.57^{c}
Garst Seed	6530	4.81^{ab}	3.68^{ab}	6.45^{ab}	14.82^{abc}
Johnston Seed Co.	Good as Gold II	4.79^{ab}	3.82^{ab}	5.68^{e}	13.75^{bc}
W-L Research	WL 357 HQ	5.01^{ab}	3.61^{ab}	5.95^{cde}	14.79^{abc}
Kansas Ag. Exp. Stat. and USDA	Kanza	4.87^{ab}	3.57^{ab}	5.73^{e}	14.40^{bc}
Nebraska Ag. Exp. Stat. and USDA	Perry	4.90^{ab}	3.78^{ab}	5.70^{e}	14.02^{bc}
Average		4.72	3.66	6.09	14.48

^{abcde} Within columns, means without a common superscript differ ($P < 0.05$) according to Duncan's test. Total yield represents only three replications and might not equal the sum of the three years.

TILLAGE AND NITROGEN PLACEMENT EFFECTS ON YIELDS IN A SHORT-SEASON CORN/WHEAT/DOUBLE-CROP SOYBEAN ROTATION

Daniel W. Sweeney and Kenneth W. Kelley

Summary

In 2007, corn yields were greater with conventional tillage than with reduced or no tillage. Overall, adding N fertilizer greatly increased yields, especially when knifed.

Introduction

Many crop rotation systems are used in southeastern Kansas. This experiment was designed to determine the long-term effect of selected tillage and N fertilizer placement options on yields of short-season corn, wheat, and double-crop soybean in rotation.

Experimental Procedures

A split-plot design with four replications was initiated in 1983 with tillage system as the whole plot and N treatment as the subplot. In 2005, the rotation was changed to begin a short-season corn/wheat/double-crop soybean sequence. Use of three tillage systems (conventional, reduced, and no-till) continued in the same areas as during the previous 22 years. The conventional system consists of chiseling, disking, and field cultivation. Chiseling occurred in the fall preceding corn or wheat crops. The reduced-tillage system consists of disking and field cultivation prior to planting. Glyphosate (Roundup) was applied to the no-till areas. The four N treatments for the crop were: no N (control), broadcast urea-ammonium nitrate (UAN; 28% N) solution, dribble UAN solution, and knife UAN solution at 4 in. deep. The N rate for the corn crop grown in odd years was 125 lb/a.

Results and Discussion

In 2007, adding fertilizer N, in general, greatly increased corn yields compared with the no-N controls (Figure 1). Overall yield was greater with knifed application than with broadcast or dribble. Although this trend did not appear as prevalent in conventional tillage as in reduced and no-till, there was no significant interaction between tillage and N fertilization treatment. Additionally, overall corn yields were greatest with conventional tillage compared with reduced or no tillage.

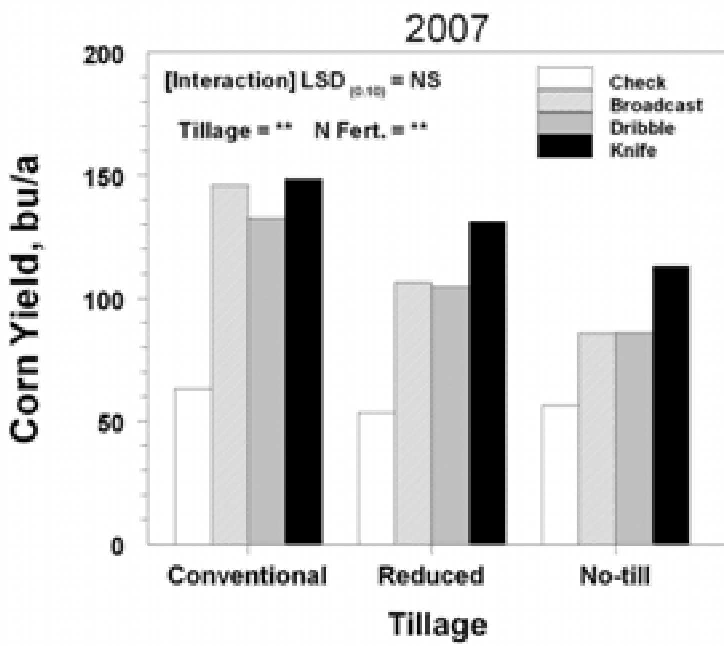


Figure 1. Effect of Tillage and N Placement on Short-Season Corn Yield in 2007

SURFACE RUNOFF NUTRIENT LOSSES FROM CROPLAND RECEIVING FERTILIZER AND TURKEY LITTER

Daniel W. Sweeney and Gary M. Pierzynski[1]

Summary

Phosphorus losses were greater when turkey litter was applied based on crop N needs. Applying turkey litter based on crop P needs reduced P losses. Nitrogen losses appeared to follow a similar trend. Incorporating turkey litter by conventional tillage did not result in greater sediment loss; however, losses were small on this soil, which is typical of southeastern Kansas.

Introduction

Nutrient and sediment losses due to surface runoff are significant threats to surface water quality. Little information is available on relative losses of nutrients from animal wastes compared with losses from commercial fertilizers, especially in southeastern Kansas. Current nutrient management guidelines in Kansas require P-based, rather than N-based, applications of animal wastes when risk of offsite P movement is high, but the water quality benefits from this strategy are not known. Objectives of this study were to: 1) compare surface runoff losses of nutrients and sediment from fertilizer and turkey litter manure nutrient sources and 2) determine the influence of tillage on nutrient and sediment losses in surface runoff from use of fertilizer and turkey litter.

Experimental Procedures

The experiment was initiated in 2005 near Girard on the Greenbush educational facility grounds. Soil was a Parsons silt loam overlying a claypan B horizon. Five treatments were replicated twice:

1) Control—no fertilizer or turkey litter applied
2) Fertilizer—only commercial fertilizer to supply N and P with no turkey litter
3) Turkey litter (N-based)—turkey litter applications to supply all N (that also provides excess P)
4) Turkey litter (P-based)—turkey litter applications to supply all P with supplemental fertilizer N
5) Turkey litter (P-based)—same as treatment 4 but with incorporation of litter and fertilizer

Treatments 1 through 4 were planted with no tillage, but Treatment 5 was planted after chisel and disk incorporation of the litter and fertilizer. Individual plot size was one acre. In 2007, fertilizer was applied on June 22, turkey litter was applied on June 25, and Treatment 5 was chiseled on June 25 and disked the next day. Yield was collected from a 5-ft by 50-ft area within each plot. ISCO-brand samplers were used to determine runoff volume and sample runoff water. Water samples were analyzed for NH_4-N, NO_3-N, ortho-P, bio-available P, total N, total P, and total suspended solids (TSS) by standard methods.

Runoff was measured, and samples were obtained for several events before fertilizer and litter application and three events after application in 2007. Three events prior to application were selected to represent expected nutrient and sediment losses from measured runoff; these collection dates were March 30, May 7, and June 12. The three events after fertilizer and turkey litter application were June 29, July 1, and July 30. Rainfall amounts were: 1.38 in. (March 30), 2.04 in. (May 7), 5.23 in. (June 10-12), 1.69 in. (June 29), 5.17 in. (June 30-July 1), and 1.62 in. (July 30).

Results and Discussion

With a few exceptions, average runoff volume and concentrations as well as total volume and loadings of three runoff events that occurred in spring 2007 prior to fertilizer and turkey litter applications in late June were not statistically affected by previous treatments (Table 1). Only ortho-P concentrations were affected by previous

[1] Kansas State University Department of Agronomy

treatments. Where litter was applied based on N needs of the crop (which overapplies P), the concentration of ortho-P was nearly threefold greater than the next highest concentration from the fertilizer-only treatment. Other concentrations and average flow were not statistically affected by previous treatments. The litter N-based treatment also resulted in greater NO_3-N loadings than the other treatments and greater bio-available P loadings than the other treatments except for the litter P-based treatment.

For the three runoff events in 2007 after turkey litter and fertilizer application, average concentrations of most measured N and P parameters were affected by amendment treatment (Table 2). Ammonium-N concentration was greatest in runoff from the N-based treatment. Also, NH_4-N concentration was greater in runoff from the fertilizer treatment than from the control or the litter P-based treatment when incorporated. Nitrate-N concentration was unaffected by amendment. Phosphorus concentrations generally were greatest in runoff from the N-based turkey litter treatment followed by the fertilizer treatment. Incorporating turkey litter did not significantly reduce the various P concentrations in runoff compared with runoff from the no-till, P-based treatment. Phosphorus loadings, however, were greater from the N-based turkey litter treatment with no differences in loadings from the other treatments. Total suspended solids (i.e., sediment) and runoff water flow were unaffected by amendments

In its third year, this field study demonstrates the P losses that can occur if a producer applies turkey litter based on crop N needs. Applying turkey litter based on crop P needs reduced P losses. Nitrogen losses appeared to follow a similar trend. In this third year, incorporation by conventional tillage did not result in significantly greater sediment loss; however, losses were small on this soil, which is typical of southeastern Kansas.

Table 1. Average Concentrations and Total Loadings of Selected Chemical Parameters in Runoff Water of Three Events in 2007 Prior to Application of Turkey Litter and Fertilizer

	Concentrations							
Amendment	NH_4-N	NO_3-N	Total N	Ortho-P	Bio-Avail P	Total P	TSS	Avg. Flow
	ppm						mg/L	ft^3/a
Control	0.3	1.2	3.2	0.42	0.44	0.71	143	2180
Fertilizer	2.6	0.7	6.6	1.16	1.19	1.70	78	3940
Litter–N based	0.6	0.4	3.6	3.15	2.56	3.36	69	7140
Litter–P based	6.3	0.2	12.5	0.83	1.65	2.06	420	8290
Litter–P based–CT	1.1	0.4	3.7	0.59	0.78	0.97	121	3090
LSD (0.20)	NS	NS	NS	0.62	NS	NS	NS	NS

	Loadings							
Amendment	NH_4-N	NO_3-N	Total N	Ortho-P	Bio-Avail P	Total P	TSS	Total Flow
	lb/a							ft^3/a
Control	0.1	0.1	0.7	0.14	0.12	0.22	30	6500
Fertilizer	0.4	0.1	1.6	0.45	0.38	0.60	22	10500
Litter–N based	0.4	0.6	4.3	3.48	2.62	3.86	74	21400
Litter–P based	11.3	0.2	22.1	1.30	1.49	3.46	788	24900
Litter–P based–CT	0.6	0.1	2.2	0.44	0.48	0.74	49	9000
LSD (0.20)	NS	0.3	NS	NS	1.22	NS	NS	NS

Note. NS = nonsignificant.

Table 2. Average Concentrations and Total Loadings of Selected Chemical Parameters in Runoff Water of the First Three Events in 2007 After Application of Turkey Litter and Fertilizer

Amendment	Concentrations							
	NH_4-N	NO_3-N	Total N	Ortho-P	Bio-Avail P	Total P	TSS	Avg. Flow
	---------------------------------- ppm					----------------------------------	mg/L	ft^3/a
Control	0.1	0.1	3.1	0.24	0.23	0.61	140	1670
Fertilizer	5.0	7.2	14.2	5.19	4.35	5.72	41	2200
Litter–N based	13.6	2.4	29.6	9.45	7.52	9.92	75	6300
Litter–P based	2.9	6.8	12.3	1.87	1.50	2.23	388	7500
Litter–P based–CT	0.2	7.1	11.8	1.29	1.18	1.99	326	2720
LSD (0.20)	4.1	NS	5.6	2.00	1.68	2.21	NS	NS

Amendment	Loadings							
	NH_4-N	NO_3-N	Total N	Ortho-P	Bio-Avail P	Total P	TSS	Total Flow
	--lb/a						-------------------------------------	ft^3/a
Control	0.1	0.2	0.8	0.05	0.05	0.17	55	5000
Fertilizer	3.8	9.2	20.3	5.10	4.27	5.63	109	23400
Litter–N based	17.3	2.2	35.5	12.54	10.19	13.51	107	18900
Litter–P based	3.0	6.0	11.2	2.09	1.72	2.42	218	22500
Litter–P based–CT	0.1	5.0	8.1	0.68	0.62	1.22	264	7700
LSD (0.20)	NS	NS	21.8	6.80	5.62	7.66	NS	NS

Note. NS = nonsignificant.

NITROGEN MANAGEMENT FOR SEED AND RESIDUAL FORAGE PRODUCTION OF ENDOPHYTE-FREE AND ENDOPHYTE-INFECTED TALL FESCUE

Daniel W. Sweeney and Joseph L. Moyer

Summary

In 2007, greater clean seed yields were obtained with 100 to 150 lb/a N from endophyte-free fescue; lower yields were obtained with endophyte-infected fescue, even at N rates up to 200 lb/a. Forage aftermath yield tended to maximize at about 100 lb/a N for endophyte-free fescue. Forage yields of endophyte-infected fescue continued to increase with greater N rates. Nitrogen fertilizer timing had little effect on clean seed or aftermath forage yield in 2007.

Introduction

Nitrogen fertilization is important for fescue and other cool-season grasses, but N management for seed production is less defined. Endophyte-free tall fescue might need better management than infected stands. Nitrogen fertilization has been shown to affect forage yields, but data on yield and quality of the aftermath remaining after seed harvest are lacking. The objective of this study was to determine the effects of timing and rate of N applied to endophyte-free and endophyte-infected tall fescue for seed and aftermath forage production.

Experimental Procedures

The experiment was established as a split-plot arrangement of a completely randomized block design with three replications. Whole plots were endophyte-free and endophyte-infected tall fescue. Subplots were a 3 × 5 factorial arrangement of fertilizer N timing and N rate. The three N timings were 100% in late fall (Dec. 1, 2003, Dec. 17, 2004, Dec. 13, 2005, and Dec. 14, 2006), 100% in late winter (Feb. 26, 2004, Mar. 7, 2005, Feb. 28, 2006, and March 6, 2007), and 50% in late fall and 50% in late winter. The five N rates were 0, 50, 100, 150, and 200 lb/a. In all treatments, N fertilizer was broadcast applied as urea ammonium-nitrate (UAN) solution. Each fall, all plots received broadcast applications of 40 lb/a P_2O_5 and 70 lb/a K_2O. Seed harvest was on June 7, 2004, June 15, 2005, June 16, 2006, and June 20, 2007, and forage aftermath was harvested on June 14, 2004, June 20, 2005, June 20, 2006, and June 22, 2007.

Results and Discussion

In 2007, fescue clean seed yield and aftermath forage yields were affected by an interaction between N rate and endophyte infection, with little effect due to fertilizer timing. Clean seed yields were moderate, but exceeded 100 lb/a for endophyte-free fescue fertilized with 100 or 150 lb/a N (Fig. 1). However, endophyte-infected fescue seed yields were lower and never exceed 75 lb/a, even at the highest N rate. Aftermath forage yields of endophyte-free tall fescue tended to maximize at about 100 lb/a. N Forage yields of endophyte-infected fescue continued to increase with N rates up to 200 lb/a.

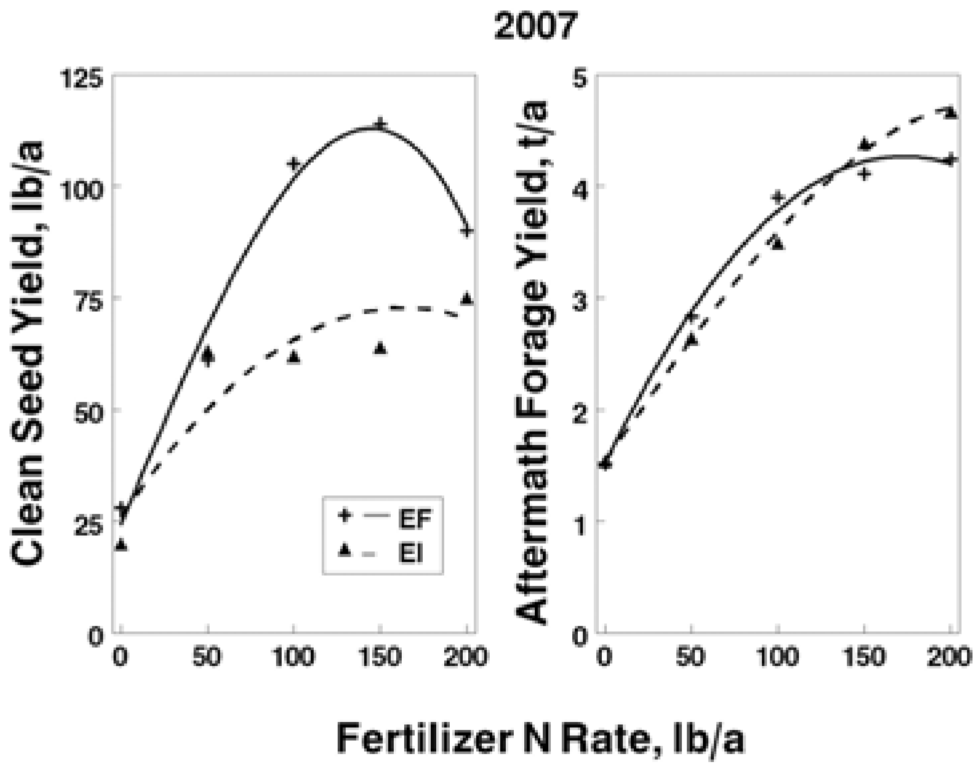


Figure 1. Effects of Nitrogen Fertilizer Rate on Clean-Seed Yield and Aftermath-Forage Yield of Endophyte-Infected (EI) and Endophyte-Free (EF) Tall Fescue During 2007

EFFECTS OF TILLAGE ON FULL-SEASON SOYBEAN YIELD

Kenneth W. Kelley and Daniel W. Sweeney

Summary

Long-term effects of tillage method (conventional and no-till) on full-season soybean yields have been evaluated at the Parsons and Columbus Units of the Southeast Agricultural Research Center. Effects varied with year and location. However, soybean yields with no-till have been greater than yields with conventional tillage at both locations during the last 3 years of the study.

Introduction

In southeastern Kansas, full-season soybean often is rotated with other crops, such as corn and grain sorghum, to diversify cropping systems. Previously, soybean has been planted with conventional tillage (chisel–disk–field cultivate), but improved equipment technology has made no-till planting more feasible. This research evaluates the long-term effects of tillage method on full-season soybean yield when soybean is grown in rotation with corn or grain sorghum.

Experimental Procedures

A 3-year crop rotation was evaluated from 1995 through 2002. The rotation consisted of (corn and grain sorghum)/soybean/(wheat and double-crop soybean). Tillage effects on full-season soybean yields were evaluated every 3 years. Tillage treatments were: 1) plant all crops with conventional tillage, 2) plant all crops with no-tillage, and 3) alternate conventional and no-till systems. Beginning in 2003, the 3-year rotation was changed to a 2-year rotation that consisted of soybean following grain sorghum. Tillage effects on soybean yield were evaluated each year at both the Columbus and Parsons Units.

Results and Discussion

Effects of tillage method on full-season soybean yields are shown in Table 1. At the Columbus Unit, soybean yields with conventional tillage were greater than with no-till during the first two cropping cycles. In recent years, however, soybean yields with continuous no-till have been equal to or greater than yields with conventional tillage. Soybean yields for no-till following conventional tillage have been significantly lower than those for continuous no-till or continuous conventional tillage. Tillage had less effect on soybean yield at the Parsons Unit, except during the last two cropping years.

In 2006 and 2007, a Kansas State University graduate student monitored soil water movement in the claypan subsoil of conventional tillage and no-till plots. Data is being summarized and will be reported in future years.

Table 1. Effects of Tillage Systems on Full-Season Soybean Yield, Southeast Agricultural Research Center, 1996 to 2007

	Full-Season Soybean Yield								
Tillage System[1]	1996[2]	1999[2]	2002[2]	2003	2004	2005	2006[3]	2007	8-yr avg.
Columbus Unit	----------------------------------- bu/a -----------------------------------								
NT only	48.4	18.1	27.0	35.7	46.1	30.8	35.8	47.9	36.2
NT following CT	46.0	14.2	26.0	29.3	38.4	23.7	29.8	45.4	31.6
CT only	53.9	20.3	23.4	35.8	43.2	29.3	27.9	43.2	34.6
CT following NT	54.4	20.0	26.5	36.9	40.3	25.9	28.3	44.3	34.6
LSD (0.05)	4.9	1.3	1.4	2.0	3.7	1.7	2.3	NS	
Parsons Unit									
NT only	45.3	15.8	32.4	34.9	42.4	30.8	---	35.0	33.8
NT following CT	43.7	14.9	32.1	33.5	42.2	27.1	---	32.0	32.2
CT only	45.2	15.5	27.9	30.8	45.1	29.4	---	32.2	32.3
CT following NT	45.8	16.0	29.6	35.1	43.8	29.4	---	33.6	33.3
LSD (0.05)	NS	NS	3.9	2.8	NS	1.9	---	2.1	

[1] NT = no tillage; CT = conventional tillage (disk–chisel–disk–field cultivate).
[2] Effects of previous crop (corn and grain sorghum) on soybean yield were non-significant (NS) for the first phase of the study from 1996 through 2002; thus, yields were averaged over both previous crops. From 2003 to 2006, previous crop before soybean was grain sorghum.
[3] Drought conditions in 2006 prevented any meaningful yield data at the Parsons Unit.

EFFECT OF SOIL pH ON CROP YIELD

Kenneth W. Kelley

Summary

Grain yields of grain sorghum, soybean, and wheat increased as soil acidity decreased with lime application. In 2007, however, soybean yield response to lime was small.

Introduction

In southeastern Kansas, nearly all topsoils are naturally acidic (pH less than 7.0). Agricultural limestone is applied to correct soil acidity and improve nutrient availability. But, applying too much lime can result in alkaline soil conditions (pH greater than 7.0), which also reduces nutrient availability and increases persistence of some herbicides. This research evaluated crop yield responses to different soil pH levels.

Experimental Procedures

Beginning in 1989, five soil pH levels, ranging from 5.5 to 7.5, were established on a native grass site at the Parsons Unit of the Southeast Agricultural Research Center in a 3-year crop rotation: (wheat/double-cropped soybean)/grain sorghum/soybean. Crops are grown with conventional tillage.

Results and Discussion

Grain yield responses for the various soil pH treatments over several years are shown in Table 1. Yields of all crops increased as soil acidity decreased. Generally, yields were greatest when soil pH was near the neutral range of 7.0, but in 2007, (data not shown) soybean yield response to soil pH was small.

Table 1. Effects of Soil pH on Crop Yields, Parsons Unit

	Grain Yield[1]			
Soil pH[2]	Grain Sorghum	Full-season Soybean	Double-crop Soybean	Winter Wheat
	---------- bu/a ----------			
5.4	82.3	30.7	18.9	43.0
6.0	87.8	32.4	21.8	44.0
6.3	92.8	35.2	23.3	45.1
7.0	95.7	35.7	25.0	46.6
7.3	95.3	36.4	24.0	45.8
LSD (0.05)	4.0	1.5	1.3	2.3

[1] Grain yields represent 5-year averages for grain sorghum and full-season soybean and 4-year averages for double-crop soybean and wheat.

[2] Average soil pH from 2005 through 2007 (0- to 6-in. depth).

EFFECTS OF PHOSPHORUS AND POTASSIUM FERTILIZER RATE AND TIME OF APPLICATION IN A WHEAT DOUBLE-CROPPING SYSTEM

Kenneth W. Kelley

Summary

Grain yields of grain sorghum, wheat, and double-crop soybean were not significantly affected by P and K fertilizer rates or time of application during the initial stages of this long-term study.

Introduction

Timing and rate of fertilizer P and K application are important crop production management decisions. In southeastern Kansas, producers often plant wheat following harvest of a feed-grain crop, such as grain sorghum or corn, and then plant double-crop soybean after wheat, giving three crops in two years. In these multiple-crop systems, producers typically apply fertilizer P and K only to the feed-grain and wheat crops. Because fertilizer costs are increasing, this research seeks to determine the direct and residual effects of rate and timing of P and K fertilizer application on grain yields in a double-cropping system.

Experimental Procedures

This study was established in 2004 at the Columbus Unit of the Southeast Agricultural Research Center. Crop rotation consists of grain sorghum/wheat/double-crop soybean, giving three crops in a 2-year period. Grain sorghum is planted with conventional tillage, and wheat and double-crop soybean are planted with no-till. Different P and K fertilizer rates are applied preplant to the grain sorghum crop only or to both the grain sorghum and wheat crops. Initial soil test values before study establishment were 23 ppm Bray-1 P and 160 ppm exchangeable K for the 0- to 6-in. soil depth.

Results and Discussion

Effects of the various P and K fertilizer treatments on grain sorghum, wheat, and double-crop soybean yields are shown in Table 1. Grain yields have been affected very little by fertilizer treatments during the initial years of study establishment. The non-significant yield response was not unexpected because initial soil test values indicated that soil P and K values were sufficient for the expected yield goals.

The amount of nutrient removal in harvested grain for 100 bu/a grain sorghum, 50 bu/a wheat, and 25 bu/a double-crop soybean is 87 lb/a P_20_5 and 72 lb/a K_20. Thus, this study will continue for several cropping cycles to monitor the residual effects of P and K fertilizer treatments on grain yields and soil nutrient concentrations of P and K. Additional treatments, such as starter fertilizer effects, likely will be imposed in the study as soil test values change with time.

Table 1. Effects of Phosphorus and Potassium Fertilizer Rate and Time of Application on Grain Yield in a Double-Cropping System, Columbus Unit

Fertilizer Rate						Grain Yield[1]		
Grain Sorghum			Wheat					
N	P_2O_5	K_2O	N	P_2O_5	K_2O	Grain Sorghum	Wheat	Soy
------------------------- lbs/a -------------------------						-------------- bu/a --------------		
120	0	0	120	0	0	86	51	30
120	40	40	120	40	40	89	52	31
120	80	80	120	0	0	91	52	30
120	60	60	120	60	60	90	52	30
120	120	120	120	0	0	92	54	30
120	80	80	120	80	80	93	51	31
LSD (0.05)						NS	NS	NS

Note. Initial soil test values before study establishment were 23 ppm Bray-1 P and 160 ppm exchangeable K for the 0- to 6-in. soil depth.

[1]Values represent average grain yields from 2005 to 2007, except no grain yields were reported for wheat in 2007 due to early April freeze damage.

EFFECTS OF NITROGEN FERTILIZER RATE AND TIME OF APPLICATION ON CORN AND GRAIN SORGHUM YIELDS

Kenneth W. Kelley and Daniel W. Sweeney

Summary

Corn and grain sorghum yield responses to N fertilizer rate and time of application varied with environmental conditions. However, for the initial 2 years of data, yield differences between preplant N and side-dress N have been small. Fertilizer N rate has influenced grain yields more than time of N application.

Introduction

Due to recent increases in N fertilizer prices, producers are looking for ways to reduce production costs for feed-grain crops, such as corn and grain sorghum. One method that has gained renewed interest is applying some of the fertilizer N requirement after the crop has emerged, referred to as side-dressing. Some research has shown that a subsurface application of banded N after the crop has emerged results in more efficient N use and often increases net return. In southeastern Kansas, excessive spring rainfall also increases the potential for greater N loss where fertilizer N is applied preplant.

Experimental Procedures

Studies were established at the Columbus Unit of the Southeast Agricultural Research Center in 2006 and 2007 to evaluate the effects of time and rate of N fertilizer application on both corn and grain sorghum. Fertilizer (28% liquid N) treatments consisted of different N rates applied preplant or side-dressed. Preplant N fertilizer was subsurface applied in mid-March on 15-in. centers at a depth of 4 to 6 in. Side-dress N also was subsurface applied between 30-in. rows. All plots received 30 lb/a N preplant as 18-46-0. The previous crop was double-crop soybean.

Results and Discussion

Corn and grain sorghum yield responses to N fertilizer rate and time of application varied with year and environmental conditions (Table 1). Grain yields were higher in 2007 than in 2006 due to timely rainfall during the growing season. In 2007, corn yield increased linearly with increasing rates of N fertilizer, but time of application did not have a significant effect. In 2007, grain sorghum yields were slightly greater when N fertilizer was side-dressed compared with preplant N treatments, although differences were not large. Grain sorghum yields in 2007 showed little response above the 120 lb/a N rate.

This study will continue for several more cycles to investigate N fertilizer responses under varying environmental conditions.

Table 1. Effects of Nitrogen Fertilizer Rate and Time of Application on Corn and Grain Sorghum Yields, Columbus Unit

Rate of Fertilizer N[1]		Grain Yield			
		Corn		Grain Sorghum	
Preplant	Side-dress	2006	2007	2006	2007
---------- lb N/a ----------		------------------------------ bu/a ------------------------------			
30	0	81.6	74.5	69.8	93.9
60	0	94.6	91.8	70.7	109.4
90	0	103.9	117.7	72.3	109.9
120	0	106.7	129.8	70.3	125.2
150	0	105.4	149.8	68.2	122.0
30	30	92.4	90.6	73.2	112.2
30	60	99.4	119.3	73.4	123.6
30	90	106.2	133.1	68.8	134.3
30	120	112.4	154.0	65.6	131.3
LSD (0.05)		10.6	11.3	NS	6.8

[1] 30 lb/a N applied preplant as 18-46-0 to all treatments.

EFFECTS OF NITROGEN FERTILIZER AND PREVIOUS DOUBLE-CROPPING SYSTEMS ON SUBSEQUENT CORN YIELD

Kenneth W. Kelley and Joseph L. Moyer

Summary

Corn yields were greatest following wheat/double-crop soybean and least following wheat/double-crop grain sorghum. Corn yield response to N fertilizer differed among previous wheat/double-crop systems.

Introduction

In southeastern Kansas, producers typically double-crop soybean after wheat, but other double-crop options are suitable for the growing conditions of this region. Grain sorghum can be grown successfully as a double-crop option if planted by early July. If wet conditions follow wheat harvest, double-crop sunflower can be planted as late as mid- to late July. Small-seeded legumes, such as lespedeza or sweet clover, typically are seeded into wheat in late winter. Lespedeza commonly is grown for seed or cut for hay, and sweet clover is planted primarily for soil amendment purposes. Other producers summer fallow land after wheat harvest. Previous wheat and double-crop systems likely affect growth of subsequent crops, such as corn. In addition, N fertilizer requirements for corn might need to be adjusted depending on the previous wheat double-crop system used.

Experimental Procedure

The study was conducted at the Parsons Unit of the Southeast Agricultural Research Center. The experimental design was a split-plot arrangement with three replications.

Main plots consisted of six different systems:

1. wheat/double-crop soybean
2. wheat/double-crop grain sorghum
3. wheat/double-crop sunflower
4. wheat/sweet clover
5. wheat/lespedeza
6. wheat/chemical fallow

Double-crop grain sorghum and sunflower plots each received 75 lb/a N. Subplots consisted of six preplant fertilizer N rates (0, 30, 60, 90, 120, and 150 lb/a) for corn following wheat/double-crop options. Nitrogen source was 28% N solution preplant applied with a coulter-knife applicator. Because residual soil test values were relatively high, neither phosphorus nor potassium fertilizer was applied. Corn was planted with conventional tillage.

Results and Discussion

Corn yields in 2005 and 2007 were greatest following wheat/double-crop soybean and lowest following wheat/double-crop grain sorghum (Table 1). Differences in corn yield among previous double-crop options were less pronounced at higher N rates than at lower N rates. In 2004 and 2006, sweet clover growth was reduced due to dry soil conditions during mid-summer, which likely affected subsequent corn yield responses. The higher N fertilizer requirement following wheat/double-crop grain sorghum likely is the result of greater immobilization of N fertilizer following the high-residue sorghum crop.

Table 1. Effects of Nitrogen and Previous Wheat/Double-Crop Systems on Subsequent Corn Production, Parsons Unit

		Corn Yield	
Previous Wheat/ Double-Crop System	N Rate	2005	2007
	lb/a	---------------bu/a ---------------	
Chemical fallow	0	50.6	65.9
	30	75.5	100.2
	60	117.6	139.8
	90	137.9	146.9
	120	149.9	169.2
	150	158.7	178.7
Soybean	0	69.1	105.2
	30	90.3	137.4
	60	108.4	151.9
	90	135.6	156.4
	120	154.7	158.3
	150	157.2	168.3
Grain sorghum	0	28.8	43.6
	30	58.7	75.3
	60	78.7	96.1
	90	101.4	123.2
	120	128.0	149.3
	150	139.3	159.9
Sunflower	0	44.0	80.4
	30	70.8	100.2
	60	117.6	150.5
	90	129.7	159.2
	120	144.5	169.9
	150	158.0	178.3
Sweet clover	0	59.6	67.0
	30	86.3	71.9
	60	119.6	124.4
	90	134.5	138.3
	120	148.1	161.6
	150	152.5	163.0
Lespedeza	0	49.2	84.7
	30	68.7	99.0
	60	103.8	125.6
	90	127.6	147.9
	120	142.5	155.9
	150	142.1	168.3

(Continued)

Table 1. Effects of Nitrogen and Previous Wheat-Double-Crop Systems on Subsequent Corn Production, Parsons Unit

		Corn Yield	
Previous Wheat/ Double-Crop System	N Rate	2005	2007
		---------------bu/a ---------------	
LSD (0.05)		7.8	11.5
Same cropping system		8.8	14.0
Different system			
Mean Values			
Chemical fallow		115.0	133.5
Soybean		119.2	146.3
Grain sorghum		89.2	107.9
Sunflower		110.8	139.8
Sweet clover		116.8	121.0
Lespedeza		105.6	130.3
LSD (0.05)		5.7	10.3

SOYBEAN FOLIAR FUNGICIDE TRIAL

James H. Long, Doug Jardine[1], and Eric De Wolf[1]

Summary

Eight fungicide treatments were applied to full-season soybean to evaluate control of soybean rust (*Phakopsora pachyrhizi*). Plots were evaluated for grain yield and other agronomic characteristics throughout the summer of 2007. Due to its late arrival, soybean rust did not affect yields. Grain yields ranged from 33 to 36 bu/a for all treatments, and the untreated check averaged 35 bu/a.

Introduction

Soybean rust is a new disease capable of causing severe grain yield loss; it can completely defoliate a soybean plant in just a few weeks. This disease spread from South America to the United States in 2004 and has infected most major U.S. soybean-producing areas. There are no known resistant varieties, so disease management through fungicide application is the only reliable remedy for this disease. Many fungicide treatments are available to manage soybean rust, but little is known about their effectiveness in Kansas. Treatments were determined by contacting retail outlets that sell soybean fungicides and determining treatments available to producers. This study established best management practices for control of this quick-acting disease and determined if fungicides should be applied at pre-determined growth stages to protect the crop.

Experimental Procedures

Soybean variety NK S52U3 was planted into good moisture at the Parsons Unit of the Southeast Agricultural Research Center. The soil is a Parsons silt loam. Soil was conventionally tilled, and soybeans were planted with John Deere 7000 planter units on June 7, 2007, at 10 seeds/ft of row. Dual II Magnum herbicide was applied pre-emergent at the rate of 1 pint/a. Roundup Weathermax was sprayed at 22 oz/a after planting to control weeds. Fungicide applications were applied at three growth stages with a 10-ft-wide boom sprayer using a 20 gal/a mixture. Harvest occurred November 6, 2007.

Results and Discussion

Most foliar fungicide treatments were applied at the R3 growth stage (beginning to pod), which is early in the reproductive stages of the soybean plant. One treatment was applied very early at R1 (first bloom), and another was applied late at R5 (pod fill). Soybean rust was present in these plots from mid-R5 growth stage on. However, because rust infection occurred late in the season, grain yield of the untreated check was equal to yields of plots treated with fungicide (Table 1). Grain yields ranged from 33 to 36 bu/a. Fungicide treatment also had little effect on grain yield components.

[1] Kansas State University Department of Plant Pathology

Table 1. Foliar Fungicide Effects on Soybean Grain Yields and Yield Components During 2007, Parsons Unit

Treatment	Rate[1] (oz/a)	Growth Stage at Application	Grain Yield (bu/a)	Yield Components	
				Pods (no./ft.)	Seeds/Pod
Folicure	4	R3	34	209	2.14
Domark	5.5	R3	33	192	2.16
Headline+Caramba	4.4 + 7.7	R3	36	194	2.16
Quadris	12.3	R3	36	195	2.20
Quilt	14	R1	34	199	2.12
Quilt	14	R3	36	198	2.26
Quilt	14	R5	33	200	2.19
Check – None	-	-	35	211	2.17
0.05 level of significance			NS	NS	NS

[1] All treatments had NIS at 0.25% v/v.

Figure 1. Headline fungicide at 8 oz/a (left) and no fungicide treatment (right).

FOLIAR FUNGICIDE APPLICATION ON FULL-SEASON AND DOUBLE-CROP SOYBEAN

James H. Long, Doug Jardine[1], and Eric De Wolf[1]

Summary

Six fungicide timing treatments were applied to full-season and double-crop soybean to evaluate control of soybean rust (*Phakopsora pachyrhizi*). Plots were evaluated for grain yield and other agronomic characteristics throughout the summer of 2007. Due to its late arrival, soybean rust did not affect yields. Grain yields ranged from 25.2 to 43.2 bu/a.

Introduction

Fungicide application timing depends on two factors. First, it is important to determine when the disease arrives from the southern region of the United States via wind-borne spores. Second, the growth stage of soybeans in surrounding fields determines how vulnerable the crop is to the disease. Growth stages are influenced by the maturity grouping of the variety and planting time. In southeastern Kansas, many soybean fields are planted late in the growing season and might be more susceptible to disease development. This study helped determine the effect of soybean maturity group and planting date on disease development and its affect on soybean grain yield in 2007.

Experimental Procedures

Three soybean varieties were planted over the course of the summer at the Parsons Unit of the Southeast Agricultural Research Center. Two varieties, Asgrow 3802 and Asgrow 5605, were planted on June 17, and NK 52U3 was planted on June 29 at 10 seeds/ft of row. Conventional tillage was used for early planted soybean, and double-crop soybean was planted without tillage. Dual II Magnum herbicide was applied pre-emergent at 1 pint/a. Plants emerged to form an excellent stand. All varieties were glyphosate tolerant, and Roundup Weathermax herbicide was applied postemergent at 22 oz/a. Harvest occurred November 8, 2007.

Results and Discussion

Fungicide had little effect on soybean grain yield or yield components in 2007 (Table 1). Early-planted Asgrow 5605 outyielded Asgrow 3802 by producing more pods. Yields ranged from 25.2 to 43.2 bu/a.

[1] Kansas State University Department of Plant Pathology

Table 1. Foliar Fungicide Effects on Grain Yields and Yield Components of Full-Season and Double-Crop Soybean During 2007, Parsons Unit

		Growth Stage		Grain	Yield Components	
Variety	Fungicide[1]	Infection	Application	Yield	Pods	Seeds/Pod
				(bu/a)	(no./ft)	
Early planted following corn in 2006						
Asgrow 3802	Yes	R7	R5	34.9	219	2.14
Asgrow 3802	No	R7	R5	34.3	203	2.26
Asgrow 5605	Yes	R6	R5	42.2	266	2.29
Asgrow 5605	No	R6	R5	43.2	268	2.26
0.05 level of significance				5.5	40	NS
Late planted following wheat in 2007						
NK S52U3	Yes	R5	R5	25.2	177	2.01
NK S52U3	No	R5	R5	26.2	187	1.91
0.05 level of significance				NS	NS	NS

[1] Headline fungicide applied at 8 oz/a + NIS at 0.25% v/v at the R5 growth stage.

EFFECT OF PLANT POPULATION ON CORN GRAIN YIELD IN SOUTHEASTERN KANSAS

James H. Long

Summary

Corn hybrid Pioneer 35P12 was planted at Parsons, Pittsburg, and Erie, Kansas in plant population studies over a 4-year period. Increasing plant populations increased grain yield by increasing the number of ears produced with adequate kernels on each ear. Higher plant populations did best under favorable weather conditions in 2004 and 2005 at Parsons and Pittsburg. Under less favorable conditions, lower plant populations yielded as well as high populations. Grain yields ranged from 80 to 191 bu/a during the study.

Introduction

Short-season corn has rapidly become a major crop in southeastern Kansas. Crop acreage grew from less than 50,000 acres to nearly 350,000 acres during the last 25 years; most of the acreage increase occurred during the last 10 years. This increase has been influenced by the release of well-adapted, high-yielding corn hybrids. However, little is known about the effects of higher seeding rates on grain yield capacity of these improved hybrids.

Experimental Procedures

Pioneer corn hybrid 35P12 (a top yielding hybrid in southeastern Kansas) was planted at three locations, Parsons, Erie, and Pittsburg, over a 4-year period at 40,000 seeds per acre. Plots at Erie were lost to hail in 2005, and plots were not planted at Parsons in 2006. All plots were lost in 2007. Original stands were thinned to five different final stands. Final stands were 12,000, 18,000, 24,000, 30,000, and 36,000 plants/a. During the 4-year study, corn was planted during late March and early April. At all locations, corn followed a previous soybean crop. Prior to planting, fields were field cultivated. Following planting, Dual II Magnum herbicide was applied pre-emergent to help control weeds. Fertilizer was applied following soil test recommendations for corn. Grain was harvested in August and September at all locations. Yield was determined at 15.5% moisture.

Results and Discussion

Summers of 2004 and 2005 at Parsons and Pittsburg were favorable for corn, and grain yields were very high. Both locations saw grain yields near 180 bu/a. The Erie location had too much water early, and grain yields were near 120 bu/a. At all locations, 2006 started and ended hotter and drier than normal. There was very little substantial rain from planting until July. Lack of rainfall severely reduced yield but allowed a timely harvest. Due to the wide range in weather conditions over locations and years, the corn population most effective at achieving optimum grain yields varied. However, observations can be made based on expected grain yields for a location (Figure 1). Under low-yielding conditions (100 bu/a or less), 18,000 to 24,000 plants/a gave optimum grain yields, with higher populations decreasing yields. Under higher yielding conditions (130 bu/a), 24,000 plants/a gave optimum grain yields with higher populations equal to 24,000 plants/a. Under the best conditions or on deep river-bottom soils with more than 160 bu/a potential, 30,000 or more plants/a gave optimum yields. National Agricultural Statistics Service 5-year estimates of average non-irrigated corn yields for southeastern Kansas range from 80 to 116 bu/a.

Figure 1. Effects of Corn Population on Grain Yield in Southeastern Kansas 2004 to 2006

Annual Summary of Weather Data for Parsons, Kansas

Mary Knapp[1]

2007 Data

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Avg. Max	39.0	40.7	66.3	63.2	77.0	81.9	87.3	94.0	82.9	72.1	59.4	42.6	67.2
Avg. Min	21.0	21.3	43.7	41.4	59.7	65.3	68.8	71.0	60.7	48.6	33.13	23.3	46.5
Avg. Mean	30.0	31.0	55.0	52.3	68.4	73.6	78.1	82.5	71.8	60.4	46.3	33.0	56.8
Precipitation	2.18	0.77	5.35	3.4	9.84	13.54	3.97	1.42	2.37	5.05	0.27	2.12	50.30
Snow	6.0	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	2.5	12.0
Heat DD*	1086	953	320	385	23	0	0	0	17	204	564.5	994	4545
Cool DD*	0	0	11	3	127	258	405	544	221	60	3	0	1631
Rain Days	8	5	9	9	17	14	10	4	7	9	2	11	105
Min < 10	3	5	0	0	0	0	0	0	0	0	0	0	8
Min < 32	29	23	7	6	0	0	0	0	0	0	13	29	107
Max > 90	0	0	0	0	0	0	5	23	3	0	0	0	31

NORMAL VALUES (1971-2000)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Avg. Max	40.2	47.2	57.2	67.1	76.0	85.0	91.1	90.0	81.0	70.5	55.5	44.4	67.1
Avg. Min	20.2	25.6	34.8	44.1	54.4	63.4	68.3	66.0	58.0	46.3	34.9	24.8	45.1
Avg. Mean	30.2	36.4	46.0	55.6	65.2	74.2	79.7	78.0	69.5	58.4	45.2	34.6	56.1
Precipitation	1.37	1.78	3.37	3.82	5.39	4.82	3.83	3.42	4.93	4.04	3.29	2.03	42.09
Snow	2.0	3.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2	0.0	8.5
Heat DD	1079	800	590	295	95	6	0	3	51	229	594	942	4684
Cool DD	0	0	0	13	101	283	456	406	187	24	0	0	1470

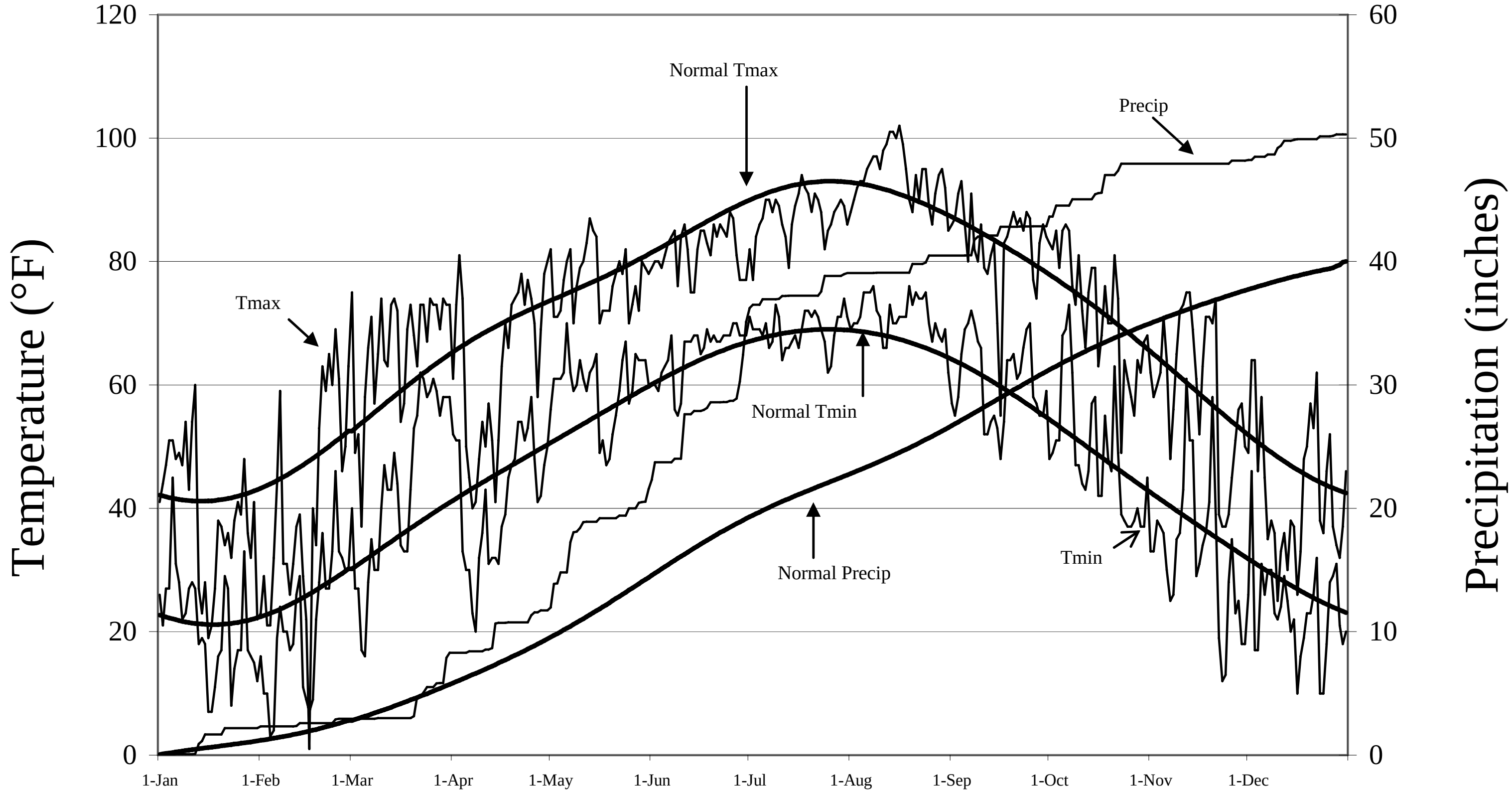
DEPARTURE FROM NORMAL

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Avg. Max	-1.2	-6.5	9.1	-3.9	1.0	-3.1	-3.8	4.0	1.9	1.6	3.9	-1.8	0.1
Avg. Min	0.8	-4.3	8.9	-2.7	5.3	1.9	0.5	5.0	2.7	2.3	-1.77	-1.5	1.4
Avg. Mean	-0.2	-5.4	9.0	-3.3	3.2	-0.6	-1.6	4.5	2.3	2.0	1.1	-1.6	0.8
Precipitation	0.81	-1.01	1.98	-0.4	4.45	8.72	0.14	-2	-2.56	1.01	-3.02	0.09	8.21
Snow	4.0	0.5	-1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-2	2.5	3.5
Heat DD	7	153	-270	90	-73	-6	0	-3	-34	-25	-29.5	52	-139
Cool DD	0	0	11	-10	26	-26	-51	138	34	36	3	0	161

* Daily values were computed from mean temperatures. Each degree that a day's mean is below (or above) 65°F is counted for one heating (or cooling) degree day.

[1] State Climatologist

2007 Weather Summary for Parsons



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