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LYLE LOMAS, Research Center Head and Animal Scientist, received B.S. and M.S. degrees in Animal Husbandry from the University of Missouri and a Ph.D. in Animal Husbandry from Michigan State University. He provides leadership for research, is responsible for administration, and directs beef cattle research at the Research Center. Lyle joined the staff in 1979 as Animal Scientist and became Head in 1986. His research interests are beef cattle nutrition and forage utilization by grazing beef cattle.

KEN KELLEY, Crops and Soils Agronomist, received a B.S. degree in Agricultural Education and an M.S. degree in Agronomy from Kansas State University. He has been a staff member since 1975. His research includes evaluation of crop rotation systems, wheat management practices, and herbicides.

JIM LONG, Crop Variety Development Agronomist, received a B.S. degree from Missouri Southern State College and M.S. and Ph.D. degrees in Agronomy from the University of Arkansas. He joined the staff in 1990 and directs variety performance testing of grains, works with plant breeders in development and evaluation of new wheat and soybean cultivars, and conducts soybean production research.

JOE MOYER, Forage Agronomist, received B.S., M.S., and Ph.D. degrees in Agronomy from Kansas State University. He has been a staff member since 1978. His research evaluates cultivars and management practices with forage grasses and legumes and forage utilization by beef cattle.

DAN SWEENEY, Soil and Water Management Agronomist, received a B.S. degree in Chemistry from Kentucky Wesleyan College, an M.S. degree in Agronomy from Purdue University, and a Ph.D. in Soil Science from the University of Florida. He joined the staff in 1983. His research focuses on soil fertility, tillage and compaction, water quality, and irrigation.

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Contribution No. 05-255-S from the Kansas Agricultural Experiment Station

SCIENTIFIC NAMES OF CROPS LISTED IN THIS PUBLICATION

Common Name	Scientific Name (*Genus species*)
Alfalfa	*Medicago sativa* L.
Bermudagrass	*Cynodon dactylon* (L.) Pers.
Big bluestem	*Andropogon gerardi* Vit.
Corn	*Zea mays* L.
Cotton	*Gossypium hirsutum* L.
Crabgrass	*Digitaria sanguinalis* (L.) Scop.
Grain sorghum	*Sorghum bicolor* (L.) Moench
Indian grass	*Sorghastrum nutans* (L.) Nash
Sand bluestem	*Andropogon halii* Hack.
Soybeans	*Glycine max* (L.) Merr.
Tall fescue	*Festuca arundinacea* Schreb.
Wheat	*Triticum aestivum* L.

SOUTHEAST AGRICULTURAL RESEARCH CENTER
KANSAS STATE UNIVERSITY

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

Sixty-four crossbred steers were used to evaluate the effect of tall fescue cultivar on grazing gains, forage production, and stand persistence. Cultivars evaluated included 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 gains and more ($P<0.05$) gain per acre than did high-endophyte Kentucky 31. Steer liveweight gain and gain per acre were similar ($P>0.05$) between pastures with low-endophyte Kentucky 31, ArkPlus, and MaxQ. Stand density and average available forage for the grazing season did not differ ($P>0.05$) between varieties.

Introduction

Tall fescue, the most widely adapted cool-season perennial grass in the USA, 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, the presence of a fungal endophyte results in poor performance by grazing livestock, especially during the summer.

Until recently, producers with high-endophyte tall fescue pastures had two primary options to improve 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 does, endophyte-free fescue has proven to be less persistent under grazing and more susceptible to stand loss from drought stress. In situations in which high-endophyte tall fescue must be grown, the other option was for producers to adopt management strategies to reduce the negative effects of the endophyte on grazing animals, such as incorporation of legumes into existing pastures. Addition of legumes can improve nutritive quality of fescue pastures, increase gains of grazing livestock, and reduce N fertilizer rates.

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

Experimental Procedures

Sixty-four crossbred steers (513) were weighed on consecutive days and allotted to 16 five-acre pastures of high-endophyte Kentucky 31, low-endophyte Kentucky 31, ArkPlus, or MaxQ tall fescue (4 replications/cultivar) on March 16, 2004. All pastures were seeded in the fall of 2002 and had been harvested for hay in 2003. All pastures were fertilized on January 15, 2004, with 80 lb of N per acre and P_2O_5 and K_2O as required by soil test, and on September 3, 2004, with 40-40-30 lb of N-P_2O_5-K_2O per acre.

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. Pastures were grazed continuously until November 30, 2004 (257 days), when grazing was terminated and steers were weighed on consecutive days.

After the grazing period, cattle were moved to a feedlot facility, where they are currently being finished for slaughter.

Results and Discussion

Grazing performance is presented by cultivar in Table 1. 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/acre than those that grazed high-endophyte Kentucky 31 pastures. Gains of cattle that grazed low-endophyte Kentucky 31, ArkPlus, or MaxQ were similar ($P>0.05$). Steer daily gain from pastures with high-endophyte Kentucky 31, low-endophyte Kentucky 31, ArkPlus, and MaxQ were 0.94, 1.54, 1.55, and 1.47 lb per head daily, respectively. Gain per acre from pastures with high-endophyte Kentucky 31, low-endophyte Kentucky 31, ArkPlus, and MaxQ were 194, 317, 319, and 302 lb per acre, respectively.

Available forage and stand density of each cultivar are presented in Table 2. Although there was no difference between cultivars for average available forage for the entire grazing season, available forage between cultivars did differ on three measurement dates toward the latter part of the grazing season. On September 1, low-endophyte Kentucky 31 pastures had less ($P<0.05$) available forage than did 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 did MaxQ pastures. On November 30, high-endophyte Kentucky 31 pastures had more ($P<0.05$) available forage than low-endophyte Kentucky 31 or ArkPlus pastures had. In general, pastures with less available forage dry matter produced higher steer gains than those with greater available forage dry matter. This may indicate that reduced available dry matter may be the result of greater forage intake by grazing steers, which in turn results in higher gains and/or less vigor of the fescue cultivar. Stand density was similar between cultivars at both the beginning and end of the grazing season.

These preliminary results suggest that cattle grazing ArkPlus or MaxQ tall fescue, the new varieties with the novel endophyte, will have similar gains to those of cattle grazing low-endophyte Kentucky 31, and will have significantly higher gains than those of cattle grazing high-endophyte Kentucky 31 tall fescue. Persistence of these varieties under grazing will continue to be monitored. Cattle from this study are currently being finished for slaughter at our Mound Valley unit. This study will be continued for at least four more years.

Table 1. Effect of Cultivar on Grazing Performance of Steers Grazing Tall Fescue Pastures, Southeast Agricultural Research Center, 2004 (257 days).

	Tall Fescue Cultivar			
Item	High-Endophyte Kentucky 31	Low-Endophyte Kentucky 31	ArkPlus	MaxQ
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]

[a,b] Means within a row with the same letter are not significantly different (P<0.05).

Table 2. Effect of Cultivar on Available Forage and Stand Density of Tall Fescue Pastures, Southeast Agricultural Research Center, 2004.

	Tall Fescue Cultivar			
Date	High-Endophyte Kentucky 31	Low-Endophyte Kentucky 31	ArkPlus	MaxQ
Available Forage	- - - - - - - - - - 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[a,b]	1879[b]	2056[a,b]	2246[a]
10/27/04	2042	1872	1764	2034
12/1/04	1653[a]	1366[b]	1342[b]	1488[a,b]
Season average	2868	2599	2676	2850
Stand Density	- - - - - - - - - - tillers/ft^2 - - - - - - - - - -			
3/17/04	66	62	70	70
12/1/04	78	85	74	75

[a,b] Means within a row with the same letter are not significantly different (P<0.05).

EFFECTS OF GRAIN SORGHUM SUPPLEMENTATION OF STEERS AND HEIFERS GRAZING SMOOTH BROMEGRASS PASTURES ON GRAZING PERFORMANCE AND SUBSEQUENT FINISHING PERFORMANCE

Lyle W. Lomas and Joseph L. Moyer

Summary

Twenty-four steer calves and 12 heifer calves in 2002 and 36 steer calves in 2003 and 2004 were used to evaluate the effect on grazing performance and subsequent finishing performance from grain sorghum supplementation of calves grazing smooth bromegrass. In all three years, cattle supplemented with 4 lb of grain sorghum per head daily had greater ($P<0.05$) grazing gain than did those that received no supplement. In 2002 and 2003, 2 lb of supplement per head daily resulted in no significant ($P>0.05$) improvement in grazing gain over the unsupplemented control. In 2004, however, steers supplemented with 2 lb of grain sorghum per head daily gained more ($P<0.05$) than did those that received no supplement. Average forage availability was not affected ($P>0.05$) by supplementation in 2002 or 2003, but was affected ($P<0.05$) on two sampling dates in 2003. Supplementation during the grazing phase had no effect ($P>0.05$) on finishing performance or overall cattle weight gain of cattle that were grazed in 2003.

Introduction

Supplementation of grazing stocker cattle is an effective way to increase gains of cattle on pasture. The decision of whether or not to provide supplement to grazing cattle may depend on several factors, including pasture conditions, supplement cost, anticipated selling price, cattle weight, and expected selling date. Although supplementation will improve grazing gains in most instances, the effect of supplementation on available forage during the grazing phase and the effects on subsequent finishing performance and carcass characteristics are not clearly documented. The purpose of this study was to evaluate the effects of grain sorghum supplementation on forage availability, grazing performance, and subsequent finishing performance.

Experimental Procedures

Twenty-four steer calves and twelve heifer calves in 2002 and thirty-six steer calves in 2003 and 2004, with initial average weights of 552, 472, 569, and 469 lb, respectively, were weighed on consecutive days, stratified by weight within sex, and allotted randomly to nine 5-acre smooth bromegrass pastures on April 25, 2002, April 29, 2003, or April 9, 2004. All animals were of predominately Angus breeding. Two pastures of steers and one pasture of heifers were randomly assigned to one of three supplementation treatments and were grazed for 188 days in 2002. Three pastures of steers were randomly assigned to one of three supplementation treatments and were grazed for 199 and 235 days in 2003 and 2004, respectively. Supplementation treatments were 0, 2, or 4 lb of ground grain sorghum/head daily. Pastures were fertilized in late spring of each year with 100-40-40 lb/a of $N\text{-}P_2O_5\text{-}K_2O$.

Cattle were weighed and forage samples were collected every 28 days, and forage availability was measured approximately every 28 days with a disk meter calibrated for smooth bromegrass. Grazing was terminated and cattle were weighed on October 29 and 30, November 12 and 13, and November 29 and 30 in 2002, 2003,and 2004, respectively.

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% phosphorus, and 12% salt.

After the grazing period, cattle were shipped to a finishing facility and fed a diet of 80% ground milo, 15% corn silage, and 5% supplement (dry-matter basis) for 120 days and 99 days in 2002 and 2003, respectively. Steers that grazed in 2004 are currently being finished for slaughter. Steers were implanted with Synovex S® and heifers were implanted with Ralgro® on days 0 and 84 of the finishing period in 2002. In 2003, steers were implanted with Synovex S® once on day 0. Cattle were slaughtered in a commercial facility at the end of the finishing period and carcass data were collected.

Results and Discussion

Forage availability and crude protein content of pastures during the grazing phase are presented in Tables 1, 2, and 3 for 2002, 2003, and 2004, respectively. In 2002, there were no significant (P>0.05) differences in pasture forage availability as a result of supplementation treatment or gender on any of the evaluation dates. In 2003, forage availability was greater (P<0.05) on May 28 in pastures with cattle supplemented with 4 lb of grain sorghum per head daily and on November 13 in pastures with cattle supplemented with 2 lb of grain sorghum per head daily. Average forage availability over the entire grazing season was not affected (P>0.05) by supplementation in 2002, 2003, or 2004. In 2002, forage availability peaked on May 29 and was least on October 29. In 2003, forage availability peaked on May 28 and was least on November 13. In 2004, forage availability peaked on May 1 and was least on November 29.

Although average forage crude protein values ranged from 11.4% in 2002 to 12.2% in both 2003 and 2004, there was considerable variation in forage protein content during the grazing season. Forage protein content tended to be the greatest in April of each year, ranging from 17.9% in 2003 to 21.1% in 2002, and tended to be the least in late June or early July, ranging from 7.2% in 2002 to 7.6% in 2004. Forage protein content tended to decline from April to late June and then gradually increase toward fall. The dramatic decrease in protein content observed from April to early July was likely caused, at least in part, by increased plant maturity and the presence of seed heads in the July samples.

Cattle performance is presented in Tables 4, 5, and 6, for 2002, 2003, and 2004, respectively. One steer was removed from the 2-lb supplementation group near the end of the grazing phase in 2003 for reasons unrelated to experimental treatment. In 2002, 2003, and 2004, respectively, cattle fed 4 lb of grain sorghum per head daily gained 0.30, 0.25, and 0.41 lb more (P<0.05) per day and produced 45, 40, and 79 lb more (P<0.05) grazing gain per acre than did those that received no supplement. Supplementation with 2 lb of grain sorghum per head daily resulted in no significant (P<0.05) improvement in grazing performance over the unsupplemented control in 2002 and 2003. In 2004, however, steers supplemented with 2 lb of grain sorghum per head daily gained 0.22 lb more (P<0.05) weight per head daily and produced 42 lb more (P<0.05) grazing gain per acre than did those that received no supplementation.

Supplementation during the grazing phase had no effect (P>0.05) on finishing gain or overall gain in either 2002 or 2003. Cattle that were grazed in 2004 are currently being finished for slaughter. Cattle supplemented with 4 lb of grain sorghum per head daily during the grazing phase in 2002 were heavier at the end of the finishing phase than were those supplemented with 0 or 2 lb per head daily, although this difference was not significant (P>0.05). Cattle that received no supplement during the grazing phase seemingly made some compensatory gain in the feedlot. Cattle supplemented with 4 lb of grain sorghum per head daily during the grazing phase had higher (P<0.05) marbling scores than those that received 0 or 2 lb of supplement. Marbling score was lower (P<0.05) for cattle fed 2 lb of supplement than for those supplemented with 0 or 4 lb per head daily.

In 2003, steers supplemented with 4 lb during the grazing phase were heavier (P<0.05) at the end of the finishing phase and had heavier (P<0.05) hot-carcass weights than did those that were not supplemented while grazing. This was likely because steers supplemented with 2 lb had a higher initial starting weight, as the result of a lightweight steer being removed from the study. No other differences (P>0.05) in finishing or overall performance were observed in steers grazed in 2003.

Although the steers were heavier (P<0.05) than the heifers in 2002 at both the beginning and ending of the grazing phase, grazing gains of steers and heifers were similar (P<0.05). During the finishing phase, steers had greater (P<0.05) gains, consumed more (P<0.05) feed, had smaller (P<0.05) feed/gain, had heavier (P<0.05) carcasses, and had greater (P<0.05) overall gains than heifers. Heifers had a larger (P<0.05) dressing percentage and higher (P<0.05) marbling scores than steers did.

In summary, supplementation with 4 lb of grain sorghum/head/day improved (P<0.05) performance during the grazing phase, but had no effect (P>0.05) on finishing or overall performance. Supplementation with 2 lb of grain sorghum per head daily resulted in performance similar (P>0.05) to feeding no supplement in 2002 and 2003, but improved (P<0.05) grazing gain in 2004.

On the basis of these data, a producer planning to background cattle and sell them at the end of the grazing period might want to consider supplementation with 4 lb of grain sorghum per head daily. If the producer planned to retain ownership of the cattle through slaughter, there would be little or no advantage to supplementation during the backgrounding phase.

Table 1. Effect of Grain Sorghum Supplementation on Forage Availability for Steers and Heifers Grazing Smooth Bromegrass Pastures, Southeast Agricultural Research Center, 2002.

	Forage Availability (lb/acre)				
	Grain Sorghum (lb/head/day)				
Date	0	2	4	Average	Crude Protein (%)
April 25	3109	3546	3309	3321	21.1
May 29	4234	4266	4251	4250	8.8
June 27	2936	2798	2963	2899	8.9
July 24	2292	2307	2460	2353	7.2
August 27	1830	1699	1762	1764	8.5
September 26	1502	1497	1614	1538	16.0
October 29	1145	1055	987	1062	9.4
Average	2436	2452	2478	2455	11.4

Table 2. Effect of Grain Sorghum Supplementation on Forage Availability for Steers Grazing Smooth Bromegrass Pastures, Southeast Agricultural Research Center, 2003.

	Forage Availability (lb/acre)				
	Grain Sorghum (lb/head/day)				
Date	0	2	4	Average	Crude Protein (%)
April 30	5409	4835	5623	5289	17.9
May 28	4757[a]	5169[a]	6721[b]	5549	9.5
June 25	3581	3866	3451	3633	7.4
July 22	2751	2609	2845	2735	11.0
August 19	2162	2220	2382	2254	10.8
September 15	2048	2278	2162	2163	12.5
October 15	1562	1637	1633	1611	15.5
November 13	1202[a]	1371[b]	1151[a]	1241	13.1
Average	2934	2998	3246	3059	12.2

[a,b]Means within a row with the same letter are not significantly different ($P<0.05$).

Table 3. Effect of Grain Sorghum Supplementation on Forage Availability for Steers Grazing Smooth Bromegrass Pastures, Southeast Agricultural Research Center, 2004.

	Forage Availability (lb/acre)				
	Grain Sorghum (lb/head/day)				
Date	0	2	4	Average	Crude Protein (%)
April 8	1640	1954	1844	1813	20.2
May 11	5804	6271	6164	6080	12.9
June 11	4502	4031	4190	4241	8.5
July 7	3396	3445	3685	3509	7.6
August 4	2534	2982	2891	2802	9.8
September 2	2697	2249	2551	2499	9.3
September 30	2032	1928	1909	1956	8.7
October 28	1373	1381	1428	1394	8.4
November 29	1157	1134	1112	1134	18.3
Average	2793	2819	2864	2825	12.2

Table 4. Effect of Grain Sorghum Supplementation of Steers and Heifers Grazing Smooth Bromegrass Pastures on Grazing Performance and Subsequent Finishing Performance, Southeast Agricultural Research Center, 2002.

	Grain Sorghum (lb/head/day)			Sex	
Item	0	2	4	Steers	Heifers
Grazing Phase (188 days)					
No. of head	12	12	12	24	12
Initial wt., lb	512	512	512	552[a]	472[b]
Ending wt., lb	822[c]	844	879[d]	897[a]	800[b]
Gain, lb	310[c]	332	366[d]	345	328
Daily gain, lb	1.65[c]	1.77	1.95[d]	1.83	1.74
Gain/acre, lb	248[c]	266	293[d]	276	262
Finishing Phase (112 days)					
Initial wt., lb	822[c]	844	879[d]	897[a]	800[b]
Ending wt., lb	1214	1217	1254	1320[a]	1136[b]
Gain, lb	392	373	375	424[a]	336[b]
Daily gain, lb	3.50	3.33	3.35	3.78[a]	3.00[b]
Daily DM intake, lb	25.8	25.6	25.2	26.9[a]	24.2[b]
Feed/gain	7.46	7.76	7.57	7.12[a]	8.07[b]
Hot carcass wt., lb	720	746	749	780[a]	696[b]
Dressing %	59.4	61.4	59.8	59.0[a]	61.3[b]
Backfat, in	.39	.47	.45	.41	.46
Ribeye area, in^2	12.1	11.9	12.4	12.3	11.9
Yield grade	2.7	3.1	3.0	2.9	2.9
Marbling score	SM[51c]	SM[28d]	SM[74e]	SM[28a]	SM[74b]
% Choice	94	69	94	71	100
Overall Performance (Grazing + Finishing) (300 days)					
Gain, lb	702	705	741	768[a]	664[b]
Daily gain, lb	2.34	2.35	2.47	2.56[a]	2.21[b]

[a,b] Gender means within a row with the same letter are not significantly different (P<0.05).
[c,d,e] Supplementation-rate means within a row with the same letter are not significantly different (P<0.05).

Table 5. Effect of Grain Sorghum Supplementation of Steers Grazing Smooth Bromegrass Pastures on Grazing Performance and Subsequent Finishing Performance, Southeast Agricultural Research Center, 2003.

Item	Grain Sorghum (lb/head/day)		
	0	2	4
Grazing Phase (198 days)			
No. of head	12	11	12
Initial wt., lb	569	582	569
Ending wt., lb	919	969	968
Gain, lb	350[a]	387	400[b]
Daily gain, lb	1.77[a]	1.96	2.02[b]
Gain/acre, lb	280[a]	310	320[b]
Finishing Phase (99 days)			
Initial wt., lb	919	969	968
Ending wt., lb	1307[a]	1355[b]	1326
Gain, lb	388	385	357
Daily gain, lb	3.92	3.89	3.61
Daily DM intake, lb	29.0	28.0	28.0
Feed/gain	7.40	7.22	7.77
Hot carcass wt., lb	752[a]	795[b]	775
Dressing %	57.5	58.7	58.4
Backfat, in	.43	.47	.49
Ribeye area, in^2	12.8	13.3	13.3
Yield grade	2.7	2.8	2.8
Marbling score	SM^{04}	SM^{27}	SM^{45}
% Choice	58	75	75
Overall Performance (Grazing + Finishing) (297 days)			
Gain, lb	738	773	757
Daily gain, lb	2.48	2.60	2.55

[a,b] Means within a row with the same letter are not significantly different (P<0.05).

Table 6. Effect of Grain Sorghum Supplementation on Performance of Steers Grazing Smooth Bromegrass Pastures, Southeast Agricultural Research Center, 2004 (235 days).

Item	Grain Sorghum (lb/head/day)		
	0	2	4
No. of head	12	12	12
Initial wt., lb	469	468	469
Ending wt., lb	806[a]	859[b]	904[b]
Gain, lb	338[a]	390[b]	436[b]
Daily gain, lb	1.44[a]	1.66[b]	1.85[b]
Gain/acre, lb	270[a]	312[b]	349[b]

[a,b] Means within a row with the same letter are not significantly different (P<0.05).

INTERSEEDING LESPEDEZA INTO CRABGRASS PASTURE VERSUS ADDITIONAL NITROGEN FERTILIZATION ON FORAGE PRODUCTION AND CATTLE PERFORMANCE

Lyle W. Lomas, Joseph L. Moyer, Frank K. Brazle[1] and Gary L. Kilgore[1]

Summary

Fifty steers grazed wheat-'Red River' crabgrass pastures fertilized with additional nitrogen (N) or interseeded with lespedeza in a double-crop grazing system during 2002, 2003, and 2004. These pastures had been grazed in a wheat-crabgrass double-crop grazing system and broadcast with 2 lb/a of crabgrass during each of the four previous years. In 2002, 2003, and 2004, additional crabgrass seed was not planted to determine whether crabgrass would voluntarily reseed itself sufficiently to sustain the system. Legume cover, forage dry-matter production, grazing steer performance, and subsequent feedlot performance were measured. Forage availability, grazing, finishing, and overall performance were similar ($P>0.05$) in all three years between steers that grazed pastures fertilized with additional N or pastures interseeded with lespedeza. Steers that grazed pastures interseeded with lespedeza in 2003 had more ($P<0.05$) efficient feed conversion during the finishing phase than those that grazed pastures fertilized with additional N had.

Introduction

Cattlemen in southeastern Kansas, eastern Oklahoma, and western Arkansas need high-quality forages to complement grazing of tall fescue. Complementary forages are especially needed during the summer months, when fescue forage production declines and animal performance is reduced by the endophyte that typically is found in most fescue grown in this region. Crabgrass could fill this niche by providing high-quality forage for summer grazing. A considerable amount of nitrogen (N) fertilization is required for crabgrass. Adding a legume could reduce the amount of N fertilizer required, enhance the utilization of crabgrass, and extend grazing of high-quality forage in late summer. Crabgrass is an annual, and must sufficiently reseed itself on a volunteer basis to provide grazing the following year if it is to be a viable forage in southeastern Kansas. The purpose of this study was to evaluate the effect of interseeding lespedeza into crabgrass pastures on forage availability, grazing stocker-steer performance, and subsequent feedlot performance, and to determine if crabgrass can sufficiently reseed itself on a volunteer basis to sustain the system.

Experimental Procedures

Pastures

Korean lespedeza was no-till seeded on March 1, 2002, March 17, 2003, and March 23, 2004 at the rate of 18.5 lb/a, 23 lb/a, and 23 lb/a, respectively, on five of 10 4-acre pastures that had previously been interseeded with lespedeza during each year since 1998. All pastures had originally been seeded with 'Red River' crabgrass during the summer of 1997 and no-till seeded with 'Jagger' wheat at 121 lb/a, 126 lb/a, and 142 lb/a on September 25, 2001; October 25, 2002; and October 21, 2003, respectively. All pastures were broadcast with 2 lb/a of crabgrass seed during the

[1] KSU Southeast Area Extension Office, Chanute.

spring in 1998, 1999, 2000, and 2001 and were grazed in a wheat-crabgrass double-crop system. Additional crabgrass was not seeded in 2002, 2003, and 2004 to determine if it could voluntarily reseed itself in a manner sufficient to sustain the system. All pastures were fertilized with 60-55-40 lb/a of N-P_2O_5-K_2O on November 13, 2001; 46 lb/a of N on February 14, 2002; 48 lb/a of N on May 15, 2002; 81-40-53 lb/a of N-P_2O_5-K_2O on January 31, 2003; 49 lb/a of N on May 28, 2003; and 75-37-37 lb/a of N-P_2O_5-K_2O on February 26, 2004. An additional 48 lb/a, 53 lb/a, and 51 lb/a of N were applied to the five pastures without lespedeza on July 1, 2002, July 21, 2003, and July 9, 2004, respectively.

Available forage was determined at the initiation of grazing and during the season with a disk meter calibrated for crabgrass and for wheat. One exclosure (15-20 ft^2) was placed in each pasture. Total production was estimated from three readings per exclosure, and available forage was determined from three readings near each cage. Lespedeza canopy coverage was estimated from the percentage of the disk circumference that contacted a portion of the canopy.

Cattle

In 2002, 2003, and 2004, fifty yearling steers of predominately Angus breeding with initial weights of 665 lb, 633 lb, and 582 lb, respectively, were weighed on consecutive days, stratified by weight, and allotted randomly to the 10 pastures on March 7, 2002, April 2, 2003, and March 18, 2004, to graze out wheat and then graze crabgrass. In 2002, cattle grazed wheat from March 7 until May 7 (61 days) and then grazed crabgrass until September 4 (120 days). In 2003, cattle grazed wheat from April 2 until May 29 (57 days) and then grazed crabgrass until September 10 (104 days). In 2004, cattle grazed wheat from March 18 until May 20 (63 days) and then grazed crabgrass until September 9 (112 days). Pastures were stocked initially with 1.2 head/a until the end of the wheat phase, when a steer closest to the pen average weight was removed from each pasture. Pastures were then stocked at 1 head/a until grazing was terminated, and steers were weighed on September 3 and 4, 2002, September 9 and 10, 2003, and September 8 and 9, 2004.

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.

After the grazing period, cattle were shipped to a finishing facility and fed a diet of 80% ground milo, 15% corn silage, and 5% supplement (dry-matter basis). Cattle grazed in 2002, 2003, and 2004 were fed for 120, 93, and 112 days, respectively. All steers were implanted with Synovex S® on day 0 of the finishing period. Cattle were slaughtered in a commercial facility at the end of the finishing period, and carcass data were collected.

Results and Discussion

Pastures

Available forage dry matter (DM) is presented in Figure 1 for 2002, 2003, and 2004. Available forage was similar between pastures that received additional N fertilizer and those that were interseeded with lespedeza during all three years. Available forage in 2003 was greater than in 2002. This may have been partly because less precipitation fell during the grazing phase in 2002 and the stocking rate closely matched available forage. Lespedeza canopy coverage peaked at 13% on June 24 in 2002, 7% on August 20 in 2003, and 12.5% on September 8, 2004.

Cattle Performance

Performance of steers that grazed crabgrass pastures either fertilized with additional N or interseeded with lespedeza are shown in Table 1. Cattle that grazed pastures fertilized with additional N and those interseeded with lespedeza had similar ($P>0.05$) grazing weight gains during the wheat phase, crabgrass phase, and overall during both years.

In 2002, gains during the wheat phase averaged 3.05 and 2.94 lb/head/day, gains during the crabgrass phase averaged 1.72 and 1.58 lb/head/day, and overall grazing gains averaged 2.17 and 2.03 lb/head/day for pastures fertilized with additional N and pastures interseeded with lespedeza, respectively. Gain per acre averaged 233 and 224 lb during the wheat phase, 207 and 189 lb during the crabgrass phase, and 440 and 413 lb overall for pastures fertilized with additional N and pastures interseeded with lespedeza, respectively. Crabgrass gains were likely limited by forage availability due to below-normal precipitation during the summer months.

In 2003, gains during the wheat phase averaged 2.85 and 2.77 lb/head/day, gains during the crabgrass phase averaged 1.64 and 1.55 lb/head/day, and overall grazing gains averaged 2.07 and 1.98 lb/head/day for pastures fertilized with additional N and pastures interseeded with lespedeza, respectively. Gain per acre averaged 203 and 197 lb during the wheat phase, 171 and 161 lb during the crabgrass phase, and 374 and 358 lb overall for pastures fertilized with additional N and pastures interseeded with lespedeza, respectively.

In 2004, gains during the wheat phase averaged 3.35 and 3.17 lb/head/day, gains during the crabgrass phase averaged 2.11 and 2.05 lb/head/day, and overall grazing gains averaged 2.55 and 2.45 lb/head/day for pastures fertilized with additional N and pastures interseeded with lespedeza, respectively. Gain per acre averaged 264 and 250 lb during the wheat phase, 236 and 229 lb during the crabgrass phase, and 499 and 479 lb overall for pastures fertilized with additional N and pastures interseeded with lespedeza, respectively.

Finishing gains, carcass characteristics, and overall gains were similar ($P>0.05$) between treatments during both years. Finishing gains averaged 3.67 and 3.62 lb/head/day and overall gains (grazing + finishing) averaged 2.75 and 2.64 lb/head/day for steers that had previously grazed pastures fertilized with additional N and pastures interseeded with lespedeza, respectively, in 2002. Two steers that had previously grazed the lespedeza treatment in 2002 were removed from the study during the finishing phase for reasons unrelated to experimental treatment. Finishing gains averaged 3.59 and 3.83 lb/head/day and overall gains (grazing + finishing) averaged 2.63 and 2.65 lb/head/day for steers that had previously grazed pastures fertilized with additional N and pastures interseeded with lespedeza, respectively, in 2003. Finishing gains averaged 3.35 and 3.26 lb/head/day and overall gains (grazing + finishing) averaged 2.86 and 2.76 lb/head/day for steers that had previously grazed pastures fertilized with additional N and pastures interseeded with lespedeza, respectively, in 2004. Previous grazing treatment had no effect ($P>0.05$) on finishing performance or carcass characteristics except that steers that had previously grazed pastures interseeded with lespedeza in 2003 were 8.3% more ($P<0.05$) efficient in feed conversion during the finishing phase than were steers that had grazed pastures fertilized with additional N.

Grazing and finishing performance were similar ($P>0.05$) between steers that grazed pastures fertilized with additional N or pastures interseeded with lespedeza. Cattle performance and gain per acre were similar to those measured during the previous three years when crabgrass was seeded each year.

Although visual decline in crabgrass stands were observed, grazing steer performance and available forage measurements would indicate that sufficient volunteer crabgrass was present to sustain the wheat-crabgrass grazing system for 3 years after planting of crabgrass seed.

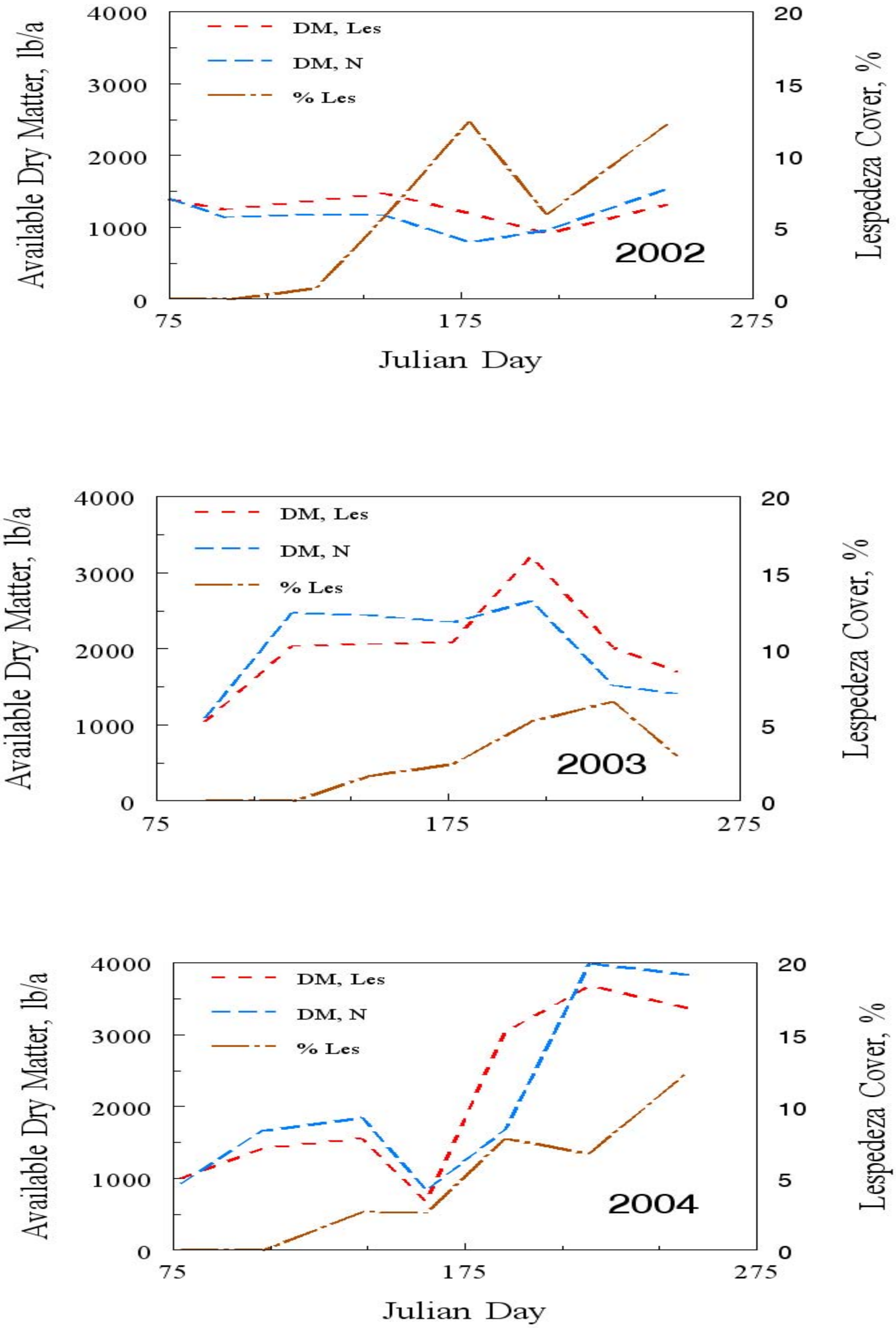

Figure 1. Available Forage and Lespedeza Canopy Cover in Wheat and Crabgrass Pastures, Southeast Agricultural Research Center, 2002-2004.

Table 1. Effect of Interseeding Lespedeza vs. Nitrogen Fertilization on Performance of Steers Grazing Crabgrass Pastures, Southeast Agricultural Research Center, 2002-2004.

	2002		2003		2004	
Item	Nitrogen	Lespedeza	Nitrogen	Lespedeza	Nitrogen	Lespedeza
Grazing Phase - Wheat						
No. of days	61	61	57	57	63	63
No. of head	15	20	15	20	15	20
Initial wt., lb	665	665	632	633	582	582
Ending wt., lb	851	844	795	790	793	782
Gain, lb	186	179	163	158	211	200
Daily gain, lb	3.05	2.94	2.85	2.77	3.35	3.17
Gain/a, lb	233	224	203	197	264	250
Grazing Phase - Crabgrass						
No. of days	120	120	104	104	112	112
No. of head	12	16	12	16	12	16
Initial wt., lb	849	842	796	789	791	780
Ending wt., lb	1056	1031	966	950	1027	1009
Gain, lb	207	189	171	161	236	229
Daily gain, lb	1.72	1.58	1.64	1.55	2.11	2.05
Gain/a, lb	207	189	171	161	236	229
Overall Grazing Performance (Wheat + Crabgrass)						
No. of days	181	181	161	161	175	175
Gain, lb	393	368	333	319	447	429
Daily gain, lb	2.17	2.03	2.07	1.98	2.55	2.45
Gain/a, lb	440	413	374	358	499	479
Finishing Phase						
No. of days	118	118	93	93	112	112
No. of head	12	14	12	16	12	16
Initial wt., lb	1056	1030	966	950	1027	1009
Ending wt., lb	1490	1456	1300	1306	1402	1374
Gain, lb	434	427	334	356	375	365
Daily gain, lb	3.67	3.62	3.59	3.83	3.35	3.26
Daily DM intake, lb	28.5	27.6	26.6	26.3	26.7	26.3
Feed/gain	7.76	7.63	7.44[a]	6.87[b]	7.98	8.13
Hot carcass wt., lb	895	871	765	772	849	828
Dressing %	60.1	59.8	58.9	59.1	60.6	60.3
Backfat, in	0.60	0.56	0.45	0.48	0.49	0.50
Ribeye area, in^2	12.4	12.8	11.8	11.8	13.7	13.7
Yield grade	3.7	3.5	3.2	3.3	3.1	3.1
Marbling score	SM^{45}	SM^{34}	SM^{22}	SM^{55}	SM^{74}	SM^{47}
% Choice	92	86	67	75	83	75
Overall Performance (Grazing + Finishing Phase)						
No. of days	299	299	254	254	287	287
Gain, lb	825	791	668	674	820	791
Daily gain, lb	2.75	2.64	2.63	2.65	2.86	2.76

[a,b]Means within a row within the same year with the same letter are not significantly different (P<0.05).

ALFALFA VARIETY PERFORMANCE IN SOUTHEASTERN KANSAS

Joseph L. Moyer

Summary

A 13-line alfalfa test seeded in 2001 was cut four times in 2004. Yields were greater ($P<0.05$) from '6420', 'Perry', and 'Hybriforce-400' than from four other cultivars. Four-year total production was greater from 6420, 'WL 327', and Hybriforce-400 than from 'Kanza'.

Introduction

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

Experimental Procedures

A 13-line alfalfa test was seeded (15 lb/a) on May 9, 2001, at the Mound Valley Unit (Parsons silt loam) after preplant fertilization with 20-50-200 lb/a of N-P_2O_5-K_2O. Plots were treated for weed control with 1 pt/a of Poast® on June 19 and 2 qt/a of Butyrac® on July 2, and for webworm infestation on August 9 with malathion.

In 2004, plots were fertilized on March 10 with 20-50-200 lb/a of N-P_2O_5-K_2O. Alfalfa was cut on May 10, June 8, July 12, and August 8. Cuttings were taken at about 1/10 bloom, except that the third cut was taken at the bud stage because of a blister beetle infestation. Because of dry weather beginning in July, regrowth was insufficient for further cutting. (see weather summary).

Results and Discussion

Yields of the first cutting in 2004 were significantly ($P<0.05$) greater for 6420 and Perry than for 'WL 342', Kanza, 'Pawnee', and '350' (Table 1). Yield of Hybriforce-400 was greater than yields of the three lowest-yielding cultivars. Second-cut yields were greater from '5-Star', 6420, and Hybriforce-400 than from 350 and '400SCL'. Third-cut yields did not differ among cultivars, but fourth-cut yields were greater for Hybriforce-400 and 5-Star than for Pawnee, 400SCL, and 'Dagger+EV' (Table 1).

For 2004, total yields of the 13 entries were significantly ($P<0.05$) greater for 6420 and Perry than for five other cultivars (Table 2). Yields of the two highest-yielding cultivars and Hybriforce-400 were greater than yields of Pawnee, 350, Dagger+EV, and Kanza. Total 4-year yields of 6420 were greater than yields of four other cultivars. 6420, WL 327, and Hybriforce-400 yielded significantly ($P<0.05$) more than Kanza did over the 4-year period. Statewide alfalfa performance test results can be found at http://www.ksu.edu/kscpt/.

Table 1. Forage Yields (tons/a @ 12% moisture) for Four Cuttings for the 2001 Alfalfa Variety Test, Mound Valley Unit, Southeast Agricultural Research Center, 2004.

Source	Entry	5/10	6/8	7/12	8/8
AgriPro Biosciences, Inc	Dagger + EV	2.24[a,b,c,d]	1.22[a,b,c,d]	1.37[a]	1.03[b,c]
Allied	350	2.10[b,c,d]	1.10[d]	1.50[a]	1.11[a,b,c]
Allied	400SCL	2.32[a,b,c]	1.11[c,d]	1.43[a]	1.02[b,c]
Croplan Genetics	5-Star	2.24[a,b,c,d]	1.30[a]	1.42[a]	1.19[a]
Croplan Genetics	Rebound 4.2	2.38[a,b,c]	1.24[a,b,c,d]	1.46[a]	1.04[a,b,c]
Dairyland	HybriForce-400	2.44[a,b]	1.27[a,b]	1.59[a]	1.20[a]
Garst Seed	6420	2.64[a]	1.28[a,b]	1.54[a]	1.18[a,b]
Midwest Seed	Pawnee	2.00[c,d]	1.18[a,b,c,d]	1.43[a]	0.98[c]
Pioneer	54V54	2.32[a,b,c,d]	1.18[a,b,c,d]	1.39[a]	1.12[a,b,c]
W-L Research	WL 327	2.30[a,b,c,d]	1.27[a,b,c]	1.41[a]	1.11[a,b,c]
W-L Research	WL 342	1.88[d]	1.14[b,c,d]	1.45[a]	1.09[a,b,c]
Kansas AES & USDA	Kanza	2.00[c,d]	1.21[a,b,c,d]	1.41[a]	1.16[a,b]
Nebraska AES & USDA	Perry	2.60[a]	1.16[a,b,c,d]	1.54[a.]	1.13[a,b,c]
Average		2.27	1.21	1.46	1.11

[a,b,c,d] Means within a column followed by the same letter are not significantly ($P<0.05$) different, according to Duncan's test.

Table 2. Forage Yields (tons/a @ 12% moisture) in the 2001 Alfalfa Variety Test, Mound Valley Unit, Southeast Agricultural Research Center, 2001-2004 .

Source	Entry	2001	2002	2003	2004	4-Yr Total
AgriPro Biosciences, Inc	Dagger + EV	1.44[a]	5.86[a,b]	5.97[a]	5.91[c,d]	19.39[ab,c]
Allied	350	1.30[a,b,c]	5.44[b]	5.51[a]	5.91[c,d]	18.39[b,c]
Allied	400SCL	1.16[b,c]	5.64[a,b]	5.70[a]	6.06[b,c,d]	18.75[b,c]
Croplan Genetics	5-Star	1.36[a,b,c]	5.58[a,b]	5.72[a]	6.20[a,b,c,d]	19.38[a,b,c]
Croplan Genetics	Rebound 4.2	1.14[c]	5.43[b]	5.77[a]	6.32[a,b,c]	18.95[b,c]
Dairyland	HybriForce-400	1.40[a,b]	6.13[a]	5.60[a]	6.57[a,b]	19.80[a,b]
Garst Seed	6420	1.39[a,b,c]	6.11[a]	5.92[a]	6.76[a]	20.56[a]
Midwest Seed	Pawnee	1.40[a,b]	5.37[b]	5.89[a]	5.70[d]	18.55[b,c]
Pioneer	54V54	1.34[a,b,c]	5.51[a,b]	5.74[a]	6.21[a,b,c,d]	19.08[a,b,c]
W-L Research	WL 327	1.26[a,b,c]	5.75[a,b]	6.00[a]	6.27[a,b,c,d]	19.81[a,b]
W-L Research	WL 342	1.25[a,b,c]	5.80[a,b]	5.74[a]	6.20[a,b,c,d]	19.39[a,b,c]
Kansas AES & USDA	Kanza	1.15[c]	5.33[b]	5.44[a]	5.93[c,d]	18.18[c]
Nebraska AES & USDA	Perry	1.29[a,b,c]	5.35[b]	5.57[a]	6.69[a]	19.11[a,b,c]
Average		1.31	0.80	5.74	6.21	19.18

[a,b,c,d] Means within a column followed by the same letter are not significantly ($P<0.05$) different, according to Duncan's test.

SOUTHEAST AGRICULTURAL RESEARCH CENTER
KANSAS STATE UNIVERSITY

EVALUATION OF TALL FESCUE CULTIVARS

Joseph L. Moyer

Summary

Tall fescue trials seeded in fall 1999, 2001, and 2003 were harvested in May, September, and December, 2004. In the 1999 trial, 'AU Triumph' and 'FA 102' produced more forage in 2004 than 'Ky 31' HE and 'Jesup' NETF did. In the 2001 trial, production of AU Triumph was more than that of 'CIS-FTF-1' and 'CIS-FTF-2'. In the 2003 trial, 'CIS-FTF-24' produced more in 2004 than 'Montendre' and 'Enhance' did.

Introduction

Tall fescue (*Festuca arundinacea* Schreb.) is the most widely grown forage grass in southeastern Kansas. The abundance of this cool-season perennial grass is due largely to its vigor and tolerance to the extremes in climate and soils of the region. Tolerance of the grass to stresses and heavy use is partly attributable to its association with a fungal endophyte, *Neotyphodium coenophialum* (Morgan-Jones and Gams) Glenn, Bacon, and Hanlin, but most ubiquitous endophytes are also responsible for the production of substances toxic to some herbivores, including cattle, sheep, and horses.

Recent research efforts have identified endophytes that purportedly lack toxins but augment plant vigor. Such endophytes have been inserted into tall fescue cultivars adapted to the United States and are represented in this test. Other cultivars are either fungus-free or contain a ubiquitous form of the endophyte. Such combinations need to be tested in this western fringe of the United States' tall fescue belt.

Experimental Procedures

All trials were seeded at the Mound Valley Unit, Southeast Agricultural Research Center, with a cone planter in 10-inch rows on Parsons silt loam soil (Mollic albaqualf). Plots were 30 ft x 5 ft arranged in four randomized complete blocks. The tests were seeded with 19 lb/a of pure, live seed in September each year, on the 9th in 1999, the 25th in 2001, and the 17th in 2003.

Fertilizer to supply 150-50-60 lb/a of N-P_2O_5-K_2O was applied to all plots on March 10, 2004, and another 50 lb/a of N as ammonium nitrate was added on July 26. A 3-ft x 20-ft area was harvested from each plot to a 3-in. height with a flail-type harvester, and grass was weighed on May 10, 2004, after all plots were headed. A forage subsample was collected and dried at 140F for moisture determination, and forage was removed from the rest of the plot at the same height. Summer growth was harvested with the same procedure on September 1, and fall regrowth was harvested on December 14.

Results and Discussion

Heading date in the 1999 trial was earlier ($P<0.05$) for AU Triumph than for all other cultivars (Table 1). FA 102 was also earlier than the remaining cultivars, whereas 'Fuego' and 'Seine' headed later than all except 'Ky 31 EF'. Spring forage yield of entries in the 1999 trial was less for Ky 31 HE than for 'MV 99' and any of four other cultivars. Summer production was greater for FA 102 and Fuego than for 'Select' and Seine. Fall production of Seine, Fuego, and AU

Triumph was greater than that of any of five other entries, including Ky 31 HE.

Total 2004 yield of the 1999 trial was greater (P<0.05) for AU Triumph and FA 102 than for Ky 31 HE and Jesup (Table 2). Total yield for the past 4 years was greater (P<0.10) for Fuego than for Ky 31 HE (data not shown).

Heading date in the 2001 trial was earlier (P<0.05) for AU Triumph than for any other cultivar, and that of 'Q4508' was earlier than that of the remaining cultivars (Table 3). Heading date of CIS-FTF-1 and 2 was later than that of any of seven other cultivars. Heading date of 'ArkPlus' was later than that of any of five other cultivars.

Spring forage yield in the 2001 trial in spring 2004 was greater (P< 0.05) for AU Triumph and 'Cajun 2' than for 'R 4663' and CIS-FTF-2 (Table 3). Summer production was greater for R 4663 than for any of the other cultivars, and yield of Q 4508 was greater than that of any of four other cultivars. Fall production of 'CIS-FTF-2' was greater than that of any of seven other entries, and fall production of 'Martin 2 ' was greater than that of any of four other cultivars (Table 3).

Total 2004 yield of the 2001 trial was greater (P<0.05) for AU Triumph than for CIS-FTF-1 and 2 (Table 3). Total yield for the past 2 years was greater (P<0.10) for Q 4508 and 'Ky 31 LE' than for CIS-FTF-1 and 'HiMag'.

Heading date in the 2003 trial for 2004 was earlier (P<0.05) for AU Triumph than for any other cultivar (Table 4). 'FA 111' did not head by May 10, and Enhance was later than 20 of the other 22 cultivars.

Spring, 2004 forage yield of entries in the 2003 trial was greater (P<0.05) for 'Jesup Max Q' than for any of four other cultivars (Table 4). Summer production was greater for FA 111 than for yield of any of 17 other cultivars. On the other hand, summer yield of Montendre was less than yield of any of seven other cultivars. Fall production of ArkPlus and 'CIS-FTF-24' was greater than that of any of 19 other entries. Total 2004 yield of the 2003 trial was greater for CIS-FTF-24 than for any of three other cultivars (Table 4).

Table 1. Forage Yield and Heading Date of Tall Fescue Cultivars Seeded in 1999, Mound Valley Unit, Southeast Agricultural Research Center, 2004.

Cultivar	Heading Date[1]	Forage Yield 5/10	Forage Yield 9/1	Forage Yield 12/14
	Julian Day	- - - - - - tons/a@12% moisture - - - - -		
FA 102 EF[2]	119	2.94	1.35	0.32
Jesup NETF[3]	123	2.71	0.98	0.28
Ga-5 NETF[3]	122	3.12	1.04	0.31
AU Triumph	110	3.10	1.12	0.39
Fuego LE[4]	129	2.84	1.21	0.40
Seine EF	128	2.68	0.94	0.42
Select EF	124	3.09	0.92	0.28
Ky 31 EF	126	2.92	0.98	0.28
Ky 31 HE[4]	123	2.35	1.08	0.26
MV 99 EF	124	3.18	0.98	0.28
Average	123	2.89	1.06	0.32
LSD(0.05)	3	0.59	0.26	0.10

[1]Day when 50% of plants were headed; Day 122=May 1.
[2]EF=Endophyte-free.
[3]Contains proprietary novel endophyte.
[4]LE= Low-endophyte seed (0-2% infected); HE=High-endophyte seed (80% infected).

Table 2. Forage Yield By Year and 4-Year Total of Tall Fescue Cultivars Seeded in 1999, Mound Valley Unit, Southeast Agricultural Research Center, 2001-2004.

	Forage Yield				
Cultivar	2001	2002	2003	2004	4-Yr Total
	- - - - - - - - - - - - tons/a@12% moisture - - - - - - - - - - - -				
FA 102 EF[1]	3.65	2.62	4.49	4.60	15.37
Jesup NETF[2]	4.21	2.92	4.50	3.96	15.60
Ga-5 NETF[2]	4.00	2.77	4.74	4.47	15.98
AU Triumph	3.98	2.42	4.62	4.62	15.66
Fuego LE[3]	4.12	2.91	4.67	4.45	16.15
Seine EF	3.98	3.02	4.44	4.04	15.48
Select EF	4.26	2.73	4.44	4.29	15.73
Ky 31 EF	4.42	2.81	4.12	4.17	15.52
Ky 31 HE[3]	4.30	2.87	4.29	3.69	15.15
MV 99 EF	4.11	2.98	4.48	4.44	16.01
Average	4.10	2.81	4.47	4.27	15.67
LSD(0.05)	0.19	0.32	0.50	0.60	NS

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

Table 3. Forage Yield and Heading Date in 2004 and 2-Year Total Yield of Tall Fescue Cultivars that were Seeded in 2001, Mound Valley Unit, Southeast Agricultural Research Center.

Cultivar	Heading Date[1]	Forage Yield 5/10	9/1	12/14	2004 Total	2-Yr Total
	Julian Day	- - - - - - - - - - tons/a@12% moisture - - - - - - - - - -				
CIS-FTF-1	125	2.29	0.94	0.32	3.55	8.47[b]
CIS-FTF-2	126	2.19	1.03	0.39	3.61	8.96[ab]
AU Triumph	111	2.85	1.15	0.30	4.30	9.35[ab]
Martin 2	120	2.62	1.01	0.38	4.01	9.35[ab]
Cajun 2	122	2.84	0.94	0.29	4.07	9.18[ab]
HiMag EF [2]	122	2.48	0.95	0.30	3.73	8.56[b]
ArkPlus [3]	124	2.46	1.02	0.29	3.77	8.99[ab]
Q 4508	113	2.48	1.21	0.34	4.03	9.70[a]
R 4663	123	2.04	1.46	0.24	3.74	9.02[ab]
Ky 31 HE [4]	124	2.66	0.94	0.28	3.87	9.00[ab]
Ky 31 LE [4]	123	2.58	1.09	0.28	3.95	9.59[a]
Average	121	2.50	1.07	0.31	3.88	9.09
LSD(0.05)	2	0.59	0.23	0.09	0.59	NS

[1]Day when 50% of plants were headed; Day 122=May 1.
[2]EF=Endophyte-free.
[3]Contains proprietary novel endophyte.
[4]LE= Low-endophyte seed (0-2% infected); HE=High-endophyte seed (80% infected).
[a,b] Least-square means within the column followed by different letters are significantly (P<0.10) different, according to individual t-tests.

Table 4. Forage Yield and Heading Date of Tall Fescue Cultivars that were Seeded in 2003, Mound Valley Unit, Southeast Agricultural Research Center, 2004.

Cultivar	Heading Date[1]	Forage Yield 5/10	9/1	12/14	2004 Total
	Julian Day	- - - - - - - - tons/a@12% moisture - - - - - - - -			
CIS-FTF-24	120	2.58	1.81	0.72	5.11
CIS-FTF-25	122	2.63	1.65	0.52	4.80
AU Triumph	111	1.91	1.69	0.56	4.15
Stockman	124	2.55	1.77	0.53	4.85
Tuscany II	125	2.52	1.55	0.50	4.57
Montendre	128	2.24	1.34	0.54	4.13
ArkPlus [2]	124	2.67	1.43	0.72	4.83
Jesup MaxQ [2]	122	2.97	1.42	0.41	4.80
Select	124	2.35	1.58	0.41	4.34
Enhance	130	2.14	1.64	0.40	4.19
FA 111	- - [4]	1.96	1.84	0.57	4.37
FA 117	120	2.92	1.46	0.56	4.94
FA 120	118	2.60	1.43	0.46	4.48
FA 121	120	2.86	1.54	0.44	4.85
FA 2845	122	2.38	1.53	0.39	4.30
FA 2846	123	2.57	1.42	0.46	4.44
FA 2847	122	2.74	1.54	0.46	4.75
FA 2848	123	2.56	1.42	0.46	4.46
FA 2849	123	2.49	1.56	0.41	4.46
FA 2850	123	2.61	1.57	0.47	4.65
FA 2860	127	2.42	1.71	0.49	4.61
FA 2861	124	2.94	1.47	0.51	4.91
Ky 31 HE [3]	125	2.66	1.50	0.45	4.62
Ky 31 LE [3]	129	2.55	1.38	0.46	4.40
Average	123	2.53	1.55	0.50	4.58
LSD(0.05)	2	0.49	0.24	0.16	0.82

[1]Day when 50% of plants were headed; Day 122=May 1.
[2]Contains proprietary novel endophyte.
[3]LE= Low-endophyte seed (0-2% infected); HE=High-endophyte seed (80% infected).
[4] Did not head by Day 131.

FORAGE PRODUCTION OF SEEDED BERMUDAGRASS CULTIVARS

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

Summary

Forage yields in 2004 of bermudagrass plots seeded in 2002 were higher for 'Cheyenne' than for 'Cherokee'. Total 3-year production was higher for Cheyenne than for any of the other entries.

Introduction

Bermudagrass can be a high-producing, warm-season perennial forage for eastern Kansas when not affected by winterkill. Producers in southeastern Kansas have profited from the use of more winter-hardy varieties that produced more than common bermudas. Seeded types may 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

Five bermudagrass entries were seeded at 8 lb/acre of pure, live seed for hulled seed or 5 lb/acre of hulless seed at the Mound Valley Unit of the Southeast Agricultural Research Center on May 7, 2002. In 2004, plots were fertilized on March 10 with 150-50-60 lb/a of N-P_2O_5-K_2O, and on July 26 with 50 lb/a of N as ammonium nitrate.

Plots were cut when seedheads had emerged on one or more cultivars. This resulted in two harvests in 2002, three in 2003, and four in 2004. Subsamples were collected from the 20 x 3 ft strips taken for yield to determine moisture content of forage.

Results and Discussion

The seeded plots at Mound Valley were fully covered by June, 2003. Spring cover in 2004 was greater ($P<0.05$, Table 1) for Cherokee and 'Johnston's Gold' than for 'Wrangler'.

Forage production in 2004 was greater ($P<0.05$) by May 28 for Cheyenne than for any of the other cultivars (Table 1). Differences between the cultivars were not significant ($P<0.05$) for the next three cuttings, although Cheyenne tended ($P<0.10$) to yield more than Cherokee did in the second and fourth cuttings. Total 2004 yield was higher for Cheyenne than for Cherokee. Total forage production for the three years was higher for Cheyenne than for all other cultivars (Table 1).

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[1]Plant and Soil Sciences Department, Oklahoma State University, Stillwater.

Table 1. Cover and Forage Yield in 2004 and for Three Years, for Bermudagrass Seeded in 2002, Mound Valley Unit, Southeast Agricultural Research Center.

Entry	Spring Cover[1]	2004 Forage Yield 5/28	6/25	7/26	9/2	Total	3-Yr Total
		- - - - - - - - - - tons per acre @ 12% moisture - - - - - - - - - -					
Cherokee	4.1	0.28	0.97	0.75	1.08	3.08	11.05
Guymon	3.9	0.33	1.22	0.72	1.22	3.49	10.73
Wrangler	3.5	0.34	1.08	0.77	1.21	3.39	10.27
Johnston's Gold	4.0	0.31	1.04	0.80	1.17	3.32	10.56
Cheyenne	3.8	0.48	1.30	0.92	1.51	4.21	14.31
Average	3.8	0.35	1.12	0.79	1.24	3.50	11.38
LSD 0.05	0.5	0.10	NS	NS	NS	0.97	1.25

[1]Ratings from 0-5, where 5=100% coverage.

PERFORMANCE OF WARM-SEASON PERENNIAL FORAGE GRASSES

Joseph L. Moyer and Kenneth W. Kelley

Summary

Twelve warm-season perennial grasses seeded in spring, 2001, were harvested for forage production on July 21, 2004. Production averaged 1.46 tons/a. Seven entries produced more ($P<0.05$) forage than an early big bluestem line, which failed to produce a satisfactory stand, and a sand bluestem entry.

Introduction

Warm-season perennial grasses can fill a production void left in forage systems by cool-season grasses. Reseeding improved varieties of certain native species, such as big bluestem and indiangrass, could help fill that summer production "gap." Other warm-season grasses, such as sand bluestem (*Andropogon hallii* Hack.), are used in other areas, and may have potential for certain sites in southeastern Kansas.

Experimental Procedures

Warm-season grass plots (30 ft x 5 ft) were seeded with a cone planter in 10-inch rows on May 10, 2001, at the Columbus Unit, Southeast Agricultural Research Center. Fifty lb/a of diammonium phosphate (18-46-0) were applied with the seed material to facilitate movement through the planter. Big bluestem and sand bluestem entries were seeded at 10 lb pure, live seed (PLS)/a. Indiangrasses were seeded at 8 lb PLS/a. Entries were obtained from the USDA-NRCS Plant Materials Center in Manhattan, the USDA-ARS Southern Plains Research Station, Woodward, Oklahoma, and the USDA-ARS Forage Research Unit, Lincoln, Nebraska. Plots were sprayed with 2,4-D to control weeds in 2001. In 2002, plots were burned in spring and clipped in summer. Plots were burned in spring 2003 and 2004, then a 20 ft x 3 ft area was harvested in 2003 and on July 21, 2004, with a Carter flail harvester at a height of 2 to 3 inches. The remainder of the area was clipped to the same height.

Results and Discussion

Forage yields from the warm-season cultivar test are shown in Table 1. Stands were better in 2004 than in 2003, and yields averaged 1.46 tons per acre. Again, 'TS Early' big bluestem stands and yields were poor, with much of the forage harvested from weedy grass species. 'AB Medium' sand bluestem also produced less ($P<0.05$) forage than three indiangrass entries and four big bluestem entries.

Table 1. Forage Yields of Warm-Season Grass Cultivars, Columbus Unit, Southeast Agricultural Research Center, 2004.

Species	Cultivar	Forage Yield
		- tons/a @ 12% moisture -
Big bluestem	Kaw	1.64
	Pawnee C3 Syn. 2	1.51
	Kaw C3 Syn. 2	1.68
	TS Intermediate	1.48
	TS Early	0.88[1]
Sand bluestem	WW (Woodward)	1.35
	AB Medium	1.07
	CD Tall	1.34
Indiangrass	Oto C3 Syn. 2	1.38
	Holt x Oto Late C3 Syn. 2	1.45
	NE 54 C2	1.68
	Osage	1.66
LSD(0.05)		0.35

[1]Poor stand; some of the forage composed of weedy species.

EFFECTS OF ENDOPHYTE STATUS, RESIDUE BURNING, AND DEFOLIATION ON TALL FESCUE SEED PRODUCTION

Joseph L. Moyer and Daniel W. Sweeney

Summary

The effects on seed production of fescue endophyte, residue management, and spring defoliation were tested. Endophyte status had no effect on clean seed production. Spring burning previous crop residue increased seed yield in one of three years. Defoliation in April to simulate spring grazing reduced seed yield by an average of more than 20% over the three years.

Introduction

Tall fescue is the major pasture grass in southeastern Kansas, and fescue seed is an important complementary crop for many producers. The U.S. census indicates that 46 million pounds of tall fescue seed was produced in Kansas in 2002. Because most producers also use the crop for pasture, information about the impact on seed production of grazing through different growth stages would help them use the resource to better advantage.

Materials and Methods

Adjacent strips of previously established endophyte-infected and endophyte-free Ky 31 tall fescue at the Mound Valley Unit were used as main plots, with burn vs. unburned and three defoliation treatments randomly assigned to subplots in a 2 x 3 factorial arrangement.

Hay was removed from the entire plot area in the summers before treatments. Fertilizer was applied each fall in September (40-40-40 lb/a of – P_2O_5-K_2O), and 150 lb/a of N was applied in late winter before burning treatments.

Designated plots were burned on February 13, 5, and 26 in 2002, 2003, and 2004, respectively. Defoliation at 2-in height was performed to simulate grazing at the 3-leaf or 5-leaf stage, standardized according to heat units (Growing Degree Days, GDD), with a threshold of 32 degrees accumulated after January 1 (Table 1).

Table 1. Date and Cumulative Heat Units (Growing Degree Days, GDD) for Each Stage at which Defoliation Occurred.

Stage	Year	GDD	Date
3-Leaf	2002	460	March 29
	2003	428	March 27
	2004	468	March 25
5-Leaf	2002	568	April 9
	2003	566	April 11
	2004	608	April 6

Heading dates (50% of culms) were recorded in 2002 and 2004. Seed was harvested from plots when the first florets began to shatter in mid-June each year, was dried at 90-100F to constant moisture, then stored under ambient conditions until processed. Seed test weights were measured, the proportion of clean seed was determined with a Dakota blower, and 1000 seeds were weighed (2003 and 2004) after drying at 220°F.

Results and Discussion

Heading date was not affected by infection with endophyte (data not shown). Heading was delayed ($P<0.05$) one day by burning in 2002, but was delayed only in endophyte-free plots by burning in 2004. Defoliation at the 3-leaf and 5-leaf stages delayed heading in 2002 by 1.5 and 2.5 days, respectively, compared with no defoliation. In 2004, defoliation at the 3-leaf stage delayed heading by 2 days and defoliation at the 5-leaf stage delayed heading by an additional 1.5 days (data not shown).

Clean seed yield was not affected ($P>0.10$) by the presence of endophyte in any of the three years (Table 2). Burning enhanced ($P<0.05$) seed yield in 2004 by 41%, but did not affect yields in 2002 or 2003. Defoliation at the 5-leaf stage reduced seed yield in 2002 by 25% compared to no defoliation, and tended ($P<0.10$) to reduce yield in 2004 (Table 2).

Burning previous crop residue did not consistently increase clean seed yield, but it sometimes increased test weight and/or the percentage of clean seed and reduced the amount of weedy grass seed (data not shown). Spring defoliation at the 5-leaf stage also sometimes reduced seed yield, averaging more than 20% reduction over the 3 years. This possible reduction should be compared with the value of early spring grazing.

Table 2. Yield of Tall Fescue Seed for 3 Years as Affected by Endophyte Infection, Residue Burning, and Spring Defoliation Treatments, Mound Valley Unit, Southeast Agricultural Research Center.

	Year		
Treatment	2002	2003	2004
		- - - - - - lb/a - - - - - -	
Means, Endophyte Status			
E^+	152	317	138
E^-	188	357	139
Pr>F	0.14	0.59	0.88
Means, Burn Treatment			
No	169	380	115
Yes	171	294	162
Pr>F	0.92	0.19	<0.01
Means, Defoliation Time			
None	192[a]	399	146[c]
3-Leaf	174[ab]	268	146[c]
5-Leaf	144[b]	344	124[d]

[a,b, c,d]Means within a column with the same letter are not significantly different at the 5% or 10% level, respectively.

EFFECTS OF POPULATION, PLANTING DATE, AND TIMING OF SUPPLEMENTAL IRRIGATION ON SWEET CORN

Daniel W. Sweeney and M.B. Kirkham[1]

Summary

In 2004, irrigation only increased the individual ear weight, but not number of harvestable ears or total fresh weight, of sweet corn. Early planting increased total ears and individual ear weight, but fresh weight was unaffected. Increasing plant population increased total ears, but reduced individual ear weight.

Introduction

Field corn responds to irrigation, and timing of water deficits can affect yield components. Sweet corn is considered as a possible value-added alternative crop for producers. Even though large irrigation sources, such as aquifers, are lacking in southeastern Kansas, supplemental irrigation could be supplied from the substantial number of small lakes and ponds in the area. Information is lacking on effects of irrigation management, plant population, and planting date on the performance of sweet corn.

Experimental Procedures

The experiment was established on a Parsons silt loam in spring 2002 as a split-plot arrangement of a randomized complete block with three replications. The whole plots included four irrigation schemes: 1) no irrigation, 2) 1.5 in. at VT (tassel), 3) 1.5 in. at R2 (blister), and 4) 1.5 in. at both VT and R2; and two planting dates (targets of late April and mid-May). The subplots were three plant populations of 15,000, 22,500, and 30,000 plants/a. Sweet corn was planted on May 4 and May 20, 2004. Sweet corn from the first planting date was picked on July 15 and 20, and corn from the second planting date was picked on July 30 and August 3, 2004.

Results and Discussion

The total number of ears was 10% less from the late May-planted sweet corn than from sweet corn planted in early May (Table 1), but there were no differences in total fresh weight. Individual ear weight was greater when sweet corn was planted at the later date. Limited irrigation did not affect total number of ears or total fresh weight, probably because of above- average total rainfall during June and July. Irrigations at R2 did result in greater individual ear weight, likely because of intermittent dry periods near R2 for sweet corn planted at either planting date. Increasing plant population resulted in a gradual increase in harvested ears, but even at the 22,500 plant population, there were stalks with nonmarketable ears. In contrast, individual ear weight declined with increasing plant population. Total fresh weight was unaffected by plant population.

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[1] Department of Agronomy, KSU.

Table 1. Effects of Planting Date, Irrigation Scheme, and Plant Population on Sweet Corn, Southeast Agricultural Research Center, 2004.

Treatment	Total Ears	Total Fresh Weight	Individual Ear Weight
	ears/a	ton/a	g/ear
Planting Date (D)			
Date 1	20400	5.13	230
Date 2	18400	5.31	262
LSD (0.05)	1500	NS	6
Irrigation Scheme (I)			
None	19800	5.23	242
VT (1.5 in.)	18300	4.84	241
R2 (1.5 in.)	20400	5.62	251
VT-R2 (1.5 in. at each)	19000	5.18	249
LSD (0.10)	NS	NS	7
Population (P), plants/a			
15000	18400	5.32	263
22500	19600	5.35	248
30000	20200	5.00	226
LSD (0.05)	1300	NS	7
Interactions	D×P	D×P	NS

NITROGEN MANAGEMENT OF SORGHUM GROWN FOR GRAIN AND FORAGE

Daniel W. Sweeney and Joseph L. Moyer

Summary

Sorghum grain yield was increased by N rate up to 120 lb/a or more, but not by timing of N fertilizer application. Stover forage was greatest with 120 lb N/a, when at least two-thirds of the N was applied preplant, and when harvested immediately after grain removal.

Introduction

With increased economic constraints, producers need to find ways to increase revenue by improving production efficiency with minimal additional inputs. After sorghum is harvested for grain, the stover that remains has the potential to be used as livestock feed. The stover could be harvested immediately after grain harvest or left to acquire additional photosynthate until frost because of its perennial characteristics.

Experimental Procedures

The experiment was established on a Parsons silt loam in 2003. The experimental design was a 4 × 3 factorial arrangement of a randomized complete block with four replications. Fertilizer N rates were 40, 80, 120, and 160 lb/a. Fertilizer application timings were 1) 100% applied preplant, 2) two-thirds of the amount applied preplant and one-third applied as a sidedress at the eight-leaf stage, and 3) one-third of the amount applied preplant and two-thirds applied sidedress. A no-N control treatment also was included in each replication.

Results and Discussion

Sorghum grain yield was affected by N rate (Fig. 1), but not by the timing of N fertilizer application (data not shown). A year by N rate interaction was observed (Fig. 1). In 2003, yield response to N was maximized at 120 lb/a and was 22 bu/a greater than yield with no nitrogen. In 2004, however, yield did not seem to be maximized at 160 lb N/a, and was more than 50 bu/a greater at 160 lb N/a than yield with no nitrogen.

Averaged across years, stover harvested for forage after grain harvest was maximized at 120 lb N/a, and was nearly 1 ton/a more forage than yield with no nitrogen (Fig. 2). Stover yield was less when two-thirds of the N was applied as a sidedress, compared with applying all N preplant or only one-third applied as a sidedress (data not shown). The response to N rate was similar for stover left until a killing frost, with maximum forage obtained with 120 lb N/a (Fig. 2). But, in both years, the sorghum did not maintain dry matter, losing about half of the potential forage between harvest and frost. Thus, if a producer uses the stover as a feed source, it should be used as soon as possible after grain harvest.

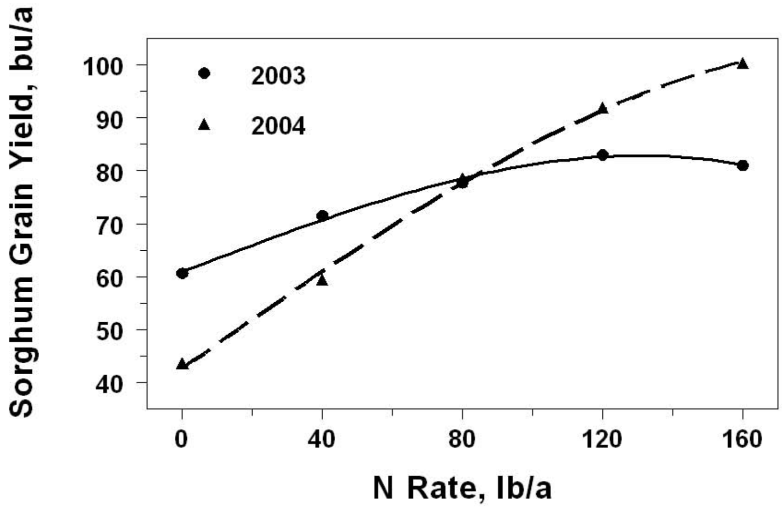

Figure 1. **Effect of N Rate on Sorghum Grain Yield in 2003 and 2004, Southeast Agricultural Research Center.**

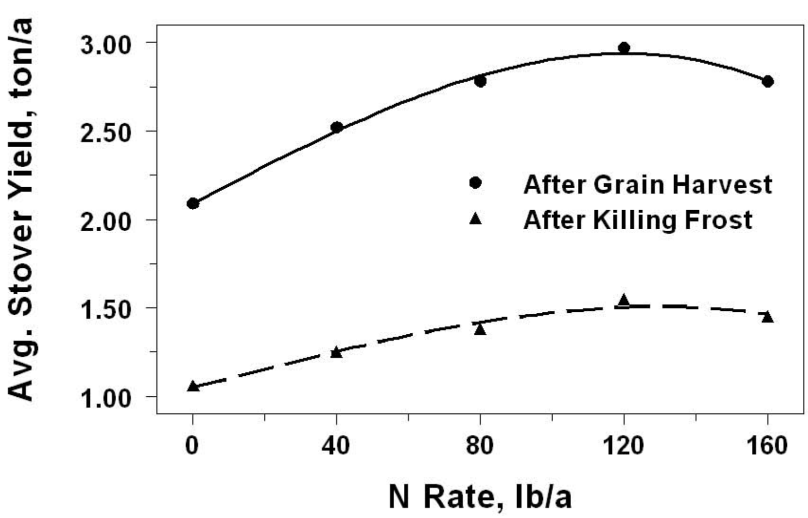

Figure 2. **Effect of N Rate on Stover Yield for Forage Averaged Across Two Years, Southeast Agricultural Research Center.**

USE OF STRIP-TILLAGE FOR CORN PRODUCTION IN A CLAYPAN SOIL[1]

Daniel W. Sweeney, Ray Lamond[2], and Gary Kilgore[3]

Summary

Averaged across years, tillage selection did not significantly affect short-season corn yields. Early spring fertilization and knife (subsurface band) applications of N and P solutions resulted in greater yield than did N-P fertilizer application in late fall or dribble application.

Introduction

The use of conservation tillage systems is promoted to reduce the potential for sediment and nutrient losses. In the claypan soils of southeastern Kansas, crops grown with no tillage may yield less than in systems involving some tillage operation. But strip tillage provides a tilled seed-bed zone where early spring soil temperatures might be greater, while leaving residues intact between the rows as a conservation measure similar to no-tillage.

Experimental Procedures

The experiment was established on a Parsons silt loam in late fall 2002. The experimental design was a split-plot arrangement of a randomized complete block with three replications. The four tillage systems constituting the whole plots were: 1) strip tillage in late fall, 2) strip tillage in early spring, 3) reduced tillage (1 pass with tandem disk in late fall and 1 pass in early spring), and 4) no tillage. The subplots were a 2×2 factorial arrangement of fertilizer timing and fertilizer placement. Fertilizer application timing was targeted for late fall or early spring. Fertilizer placement was dribble [surface band] or knife [subsurface band at 4 in-depth]. Fertilizer rates of 120 lb N/a and 40 lb P_2O_5/a were applied in each fluid fertilizer scheme. Fertilization was done on Dec. 17, 2002, and on April 1, 2003. Short-season corn was planted on April 3, 2003, and harvested on Aug. 25, 2003. For the second year, fertilization was done on Dec. 2, 2003, and on April 5, 2004. Short-season corn was planted on April 6, 2004, and harvested on Sept. 3, 2004.

Results and Discussion

Averaged across the two years, short-season corn yields averaged 123 bu/a with strip tillage done in late fall, 118 bu/a with strip tillage done in spring, 131 bu/a with reduced tillage, and 111 bu/a with no tillage. Because of variable data, these differences were not statistically different. Fertilization done in early spring resulted in average corn yields of 125 bu/a, significantly ($P<0.10$) more than yield with late fall fertilization (116 bu/a). Knife (subsurface band) applications result in statistically greater yield than dribble (surface band) applications (125 vs. 117 bu/a).

[1]This research was partly funded by the Kansas Corn Commission.

[2]Department of Agronomy, KSU.

[3]KSU Southeast Area Extension Office, Chanute.

SOUTHEAST AGRICULTURAL RESEARCH CENTER
KANSAS STATE UNIVERSITY

INTEGRATED AGRICULTURAL MANAGEMENT SYSTEMS: NEOSHO RIVER BASIN SITE[1]

Daniel W. Sweeney, Gary M. Pierzynski[2], Meghan Buckley[2], and Gary L. Kilgore[3]

Summary

Total losses of sediment, nutrients, and pesticides have been variable during 2001 through 2004.

Introduction

The quality of our water resources is an important topic. Agricultural practices are perceived to impact surface water quality by being a non-point source of pollutants. Producers need to use voluntary practices, such as Best Management Practices (BMP), to protect and improve surface water quality in the state. Recent state-wide efforts in Kansas are designed to look at large, field-scale integrations of BMPs to determine their effects on losses of sediment, nutrients, and pesticides into surface waters.

Experimental Procedures

The experiment was established on a Parsons silt loam in spring 1999 at the Greenbush Facility in Crawford County and fully implemented in 2000. The four treatments were: 1) CHL - Conventional tillage (spring chisel, disk, field cultivate, plant); Low management: nitrogen (N) and phosphorus (P) broadcast, with incorporation by tillage; and atrazine and metolachlor herbicides applied preemergence, 2) CHH - Conventional tillage; High management: N and P knifed in, followed by tillage; metolachlor applied preemergence and atrazine applied postemergence, 3) NTL - No tillage; Low management: N and P broadcast; atrazine and metolachlor applied preemergence, and 4) NTH - No tillage; High management: N and P knifed in; metolachlor applied preemergence and atrazine applied postemergence. For grain sorghum, the total N rate was 120 lb/a and P was 40 lb P_2O_5/a. Grain sorghum was planted in 2000, 2001, and 2003, and soybean was planted in 2002 and 2004.

At the downslope end of each 1-acre plot, a soil berm was constructed to divert surface water flow through a weir. In March 2001, soil berms were planted with fescue grass and covered with erosion matting material to minimize the potential for berm erosion to affect sediment values from runoff samples, as seemed to occur in 2000. Each weir was equipped with an ISCO® sampler that recorded flow amounts and collected runoff

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[1]This research has been partly funded by the Kansas Fertilizer Research Fund; the Kansas Corn, Sorghum, Soybean, and Wheat Commissions; and the USDA Integrated Research, Education, and Extension Water Quality Program.

[2]Department of Agronomy, KSU.

[3]KSU Southeast Area Extension Office, Chanute.

samples. Water samples were analyzed at the Soil Testing Laboratory for sediment, nutrients, and selected herbicides.

Results and Discussion

Runoff, concentrations, and loading rates of potential pollutants during 2001 through 2004 have been variable (Tables 1 and 2), with no consistent trends. No tillage with high management resulted in greater runoff in 2001 and 2002, but there were no significant differences in runoff volume between treatments in 2003 or 2004. For a few measured parameters, seasonal total losses seemed to be related to the runoff volume. Regardless, measured sediment, nutrient, and pesticide loadings and concentrations often seemed small.

Table 1. Seasonal Runoff Volume and Flow-weighted Concentrations of Sediment, Total N, Ammonium, Nitrate, Total P, Bioavailable P (BAP), Soluble P, Atrazine, and Metolachlor in Runoff at Crawford County in 2001 through 2004.

Treatment	Runoff	Sediment	Total-N	Ammonium	Nitrate	Total-P	BAP	Soluble-P	Atrazine	Metolachlor
	-m^3/ha-	----------mg/L----------						----------µg/L----------		
					2001: Sorghum					
CHL	940c	660a	3.9a	0.3a	1.2a	0.9a	0.5a	500a	5.4a	5.9a
CHH	1330b	330a	3.5a	0.2a	1.6a	1.0a	0.6a	710a	10a	8.6a
NTL	770c	350a	4.9a	0.3a	2.8a	1.1a	0.6a	820a	45a	28a
NTH	2040a	430a	5.1a	0.3a	2.8a	1.0a	0.5a	570a	6.3a	15a
					2002: Soybeans					
CHL	2310b	38a	2.0c	0.3a	0.4ab	0.6b	0.5b	460a	0.7a	14a
CHH	3200b	34a	2.3bc	0.3a	0.2c	0.6b	0.5b	500a	0.1a	11a
NTL	2640b	40a	2.7a	0.3a	0.3bc	0.9a	0.9a	750a	0.1a	36a
NTH	4690a	37a	2.6ab	0.2a	0.5a	0.6b	0.6b	490a	0.2a	9.3a
					2003: Sorghum					
CHL	1030a	290b	6.6a	0.6b	3.9a	0.9b	0.6a	570a	3.9a	2.9a
CHH	750a	110b	14a	5.0b	7.0a	4.0ab	3.7a	3740a	2.9a	2.5a
NTL	510a	930a	26a	12a	6.9a	6.4a	5.5a	5430a	8.7a	5.5a
NTH	840a	110b	7.4a	0.8b	4.0a	1.1b	0.8a	800a	9.7a	13a
					2004: Soybeans					
CHL	660a	110a	4.1a	0.6a	1.6a	0.7a	0.4a	430a	0.3a	1.7a
CHH	2310a	120a	3.0a	0.2a	1.0a	0.5a	0.3a	340a	0.1a	5.2a
NTL	740a	260a	3.4a	0.4a	1.3a	0.8a	0.6a	570a	0.2a	16a
NTH	1390a	100a	2.7a	0.1a	1.1a	0.6a	0.4a	440a	ND†a	0.2a

† indicates none detected in test – detection limit: 1 µg/L

Means within a column and year with same letter are not significantly different at p=0.20

Table 2. Seasonal Total Losses of Sediment, Total N, Ammonium, Nitrate, Total P, Bioavailable P (BAP), Soluble P, Atrazine, and Metolachlor at Crawford County in 2001 through 2004.

Treatment	Sediment	Total-N	Ammonium	Nitrate	Total-P	BAP	Soluble-P	Atrazine	Metolachlor
	----------	----------	----------	---------kg/ha---------	----------	----------	----------	-----g/ha-----	----------
				2001: Sorghum					
CHL	900a	4.2b	0.2a	1.4c	0.9b	0.4b	0.4a	7.5a	7.8a
CHH	460a	4.5b	0.3a	2.0b	1.2b	0.7ab	0.9a	19.6a	11.0a
NTL	230a	3.2c	0.2a	1.8bc	0.8b	0.5b	0.6a	33.2a	26.4a
NTH	880a	10.2a	0.6a	5.7a	1.9a	1.1a	1.1a	18.4a	30.5a
				2002: Soybeans					
CHL	87a	5.1b	0.8b	0.9b	7.0a	1.2a	1.1a	1.1a	30.5a
CHH	100a	7.1b	1.1a	0.7b	8.4a	1.7a	1.6a	0.6a	28.5a
NTL	100a	7.7b	0.7b	1.0b	15.6a	2.4a	2.1a	0.6a	101a
NTH	200a	12.8a	1.1a	2.5a	11.2a	2.7a	2.4a	0.8a	47.1a
				2003: Sorghum					
CHL	240a	6.5a	0.6b	4.0a	0.9a	0.6a	0.6a	5.3a	3.2b
CHH	100a	15.5a	4.4a	5.9a	3.3a	1.4a	3.1a	2.3a	2.2b
NTL	480a	9.9a	6.4a	3.4a	3.3a	2.8a	2.8a	5.8a	3.7ab
NTH	100a	6.4a	1.3b	2.4a	1.0a	0.7a	0.7a	6.7a	6.3a
				2004: Soybeans					
CHL	71a	2.4a	0.3a	1.0a	0.4a	0.2a	0.3a	0.16a	1.1a
CHH	330a	7.2a	0.4a	2.2a	1.4a	1.0a	1.1a	0.10a	19.0a
NTL	200a	2.5a	0.3a	1.0a	0.6a	0.4a	0.4a	0.13a	12.3a
NTH	130a	3.9a	0.1a	1.5a	0.8a	0.5a	0.6a	ND†a	0.4a

† indicates none detected in test – detection limit: 1 µg/L

Means within a column and year with same letter are not significantly different at p=0.20

EFFECTS OF CROPPING SYSTEMS ON WINTER WHEAT AND DOUBLE-CROP SOYBEAN YIELD[1]

Kenneth W. Kelley and Daniel W. Sweeney

Summary

Over an 8-yr period, wheat yields averaged 57 bu/a following soybeans, 55 bu/a following corn, and 54 bu/a following grain sorghum where liquid N and P fertilizer were knifed below crop residues. But wheat yields were affected very little by tillage method (no-till vs. disk). Previous crop before wheat significantly influenced double-crop soybean yields in all years. Soybean yields were greatest when corn and grain sorghum preceded wheat and least when soybeans preceded wheat.

Introduction

Winter wheat is often rotated with other crops, such as soybeans, grain sorghum, and corn, to diversify cropping systems in southeastern Kansas. Wheat typically is planted with reduced tillage, although the acreage of wheat planted with no-tillage has increased significantly in recent years. In extreme southeastern Kansas, double-crop soybeans traditionally are planted after wheat harvest. Like wheat, more double-crop acreage is being planted with conservation tillage methods. This research investigates the combined effects of both crop rotation and tillage on yields of winter wheat and double-crop soybean in a 2-yr crop rotation.

Experimental Procedures

In 1996, a 2-yr crop rotation study consisting of corn, grain sorghum, or soybeans in rotation with wheat and double-crop soybean was started at the Columbus Unit on two adjacent sites. Tillage treatments were: 1) plant all crops with conventional tillage and 2) plant all crops with no tillage. Fertilizer N (120 lb N/a as liquid 28 % N) and P (68 lb P_20_5/a as liquid 10 - 34 - 0) were applied preplant at a depth of 4 to 6 in. with a coulter-knife applicator. Potassium fertilizer (120 lb K_20/a) was broadcast applied. In conventional tillage systems for wheat, disk tillage was performed before fertilizer application and planting. Wheat was planted with a no-till drill in 7.5-in. rows at a seeding rate of 90 to 120 lb/a, depending on date of planting. In the no-till system, weeds that emerged before planting were controlled with a preplant application of glyphosate. In early spring, wheat was sprayed with a postemergence herbicide to control broadleaf weeds when needed.

Double-crop soybeans (MG IV) were planted in late June or early July after wheat harvest. Row spacing for double-crop soybeans differed over years. During the first 3 years of the study, soybeans were planted in 30-in. rows; in the last 5 years, row spacing has been 7.5-in.

Tillage method for double-crop soybeans also has differed over years. From 1997 to 2002, two tillage methods were evaluated (no-till and disk tillage). Since 2003, all double-crop plots have been planted no-till. Weeds were effectively controlled with herbicides.

[1]This research was partly funded by the Kansas Soybean Commission.

Results and Discussion

Wheat Results (Table 1)

In this 2-yr rotation, previous crop (corn, grain sorghum, or soybeans) has had a smaller effect on wheat yield, compared with previous fertilizer research trials, mainly because fertilizer N and P was knifed below crop residues in all rotations and tillage systems before planting. In addition, the rate of N applied (120 lb/a) has been high enough for the yields produced. For the 8-yr period, wheat yields averaged 57 bu/a following soybeans, 55 bu/a following corn, and 54 bu/a following grain sorghum.

Wheat yields also were affected very little by tillage method. When wheat was planted during the optimum planting window of October, grain yields were relatively good, regardless of tillage system. Results indicate that wheat planted no-till into previous summer crop residues will yield similarly to wheat planted with reduced tillage methods, provided that good management practices, such as sub-surface placement of fertilizer N and P, are used.

Double-crop Soybean Results (Table 2)

Previous crop before wheat significantly influenced double-crop soybean yields in nearly all years. Soybean yields were greatest when corn and grain sorghum preceded wheat and least when soybeans preceded wheat. Nutrient analyses of double-crop soybean plants have shown very little difference in nutrient uptake between previous crops (data not shown). More research is needed to determine why the observed yield response occurs.

In the initial years of the study, double-crop soybean yields were similar between reduced and no-till methods. In the last few years, however, double-crop soybean yields have been significantly greater when planted no-till. There initially was concern that soybean root growth would be reduced in no-till systems, but recent data suggest that no-till planted double-crop soybeans are better able to withstand drought stress conditions. Additional research is planned to further evaluate the effects of conservation management practices on soil quality characteristics, such as quantities of soil carbon and organic matter.

Table 1. Effects of Previous Crop and Tillage on Winter Wheat Yield, Columbus Unit, Southeast Agricultural Research Center, 1997 - 2004.

Previous Crop before Wheat	Tillage	Winter Wheat Yield 1997	1998	1999	2000	2001	2002	2003	2004	8-yr avg.
		-----------------	-----------------	-----------------	-----------------	bu/a	-----------------	-----------------	-----------------	-----------------
Corn	NT	36.7	57.2	40.1	61.9	70.8	40.2	76.5	53.1	54.6
Corn	RT	39.1	61.8	40.5	61.6	65.9	42.1	78.1	56.4	55.7
Gr sorghum	NT	34.1	59.1	40.0	55.1	70.8	33.3	75.9	53.7	52.8
Gr sorghum	RT	37.5	61.2	44.6	59.8	68.2	37.2	72.4	58.9	55.0
Soybeans	NT	36.4	61.6	37.5	65.0	73.7	45.2	85.5	59.2	58.0
Soybeans	RT	36.0	63.1	43.4	63.1	72.3	41.3	75.5	56.0	56.3
Means:										
Corn		37.9	59.5	40.3	61.8	68.4	41.2	77.3	54.8	55.2
Gr sorghum		35.8	60.1	42.3	57.5	69.5	35.2	74.2	56.3	53.9
Soybeans		36.2	62.3	40.5	64.0	73.0	43.3	80.5	57.6	57.2
LSD (0.05)		NS	2.4	NS	3.2	NS	2.2	5.2	2.7	
No-till		35.7	59.3	39.2	60.6	71.7	39.6	79.3	55.3	55.1
Reduced-till		37.5	62.0	42.8	61.5	68.8	40.2	75.4	57.1	55.7
LSD 0.05		NS	2	NS	NS	NS	NS	NS	NS	
Planting date		Dec. 12	Oct. 22	Nov. 25	Oct. 25	Oct. 25	Oct. 23	Oct. 17	Oct. 24	

Tillage: NT = no-tillage; RT = reduced tillage (disking for wheat; chisel - disk for corn, grain sorghum and soybean in yr-1 of rotation).

Table 2. Effects of Previous Crop and Tillage on Double-Crop Soybean Yield, Columbus Unit, Southeast Agricultural Research Center, 1997 - 2004.

Previous Crop before Wheat	Tillage	Double-crop Soybean Yield 1997	1998	1999	2000	2001	2002	2003	2004	8-yr avg.
		-------------------	----------	----------	----------	bu/a	----------	----------	----------	-------------------
Corn	NT	38.5	31.8	27.7	9.4	36.9	32.9	36.4	46.7	32.5
Corn	RT	39.3	31.2	24.5	10.0	30.4	29.8	39.6	44.3	31.1
Gr sorghum	NT	39.4	30.9	28.4	11.5	36.8	33.4	38.9	46.4	33.2
Gr sorghum	RT	40.3	32.2	26.0	9.8	32.2	30.3	36.0	43.7	31.3
Soybeans	NT	33.2	26.2	26.9	9.7	31.7	28.2	30.3	41.4	28.5
Soybeans	RT	32.8	26.3	20.8	8.6	25.8	25.6	29.1	40.0	26.1
Means:										
Corn		38.9	31.5	26.1	9.7	33.7	31.3	38.0	45.5	31.8
Gr sorghum		39.9	31.6	27.2	10.7	34.5	31.8	37.4	45.1	33.2
Soybeans		33.0	26.3	23.9	9.1	28.7	26.9	29.7	40.7	27.3
LSD 0.05		2.3	3.0	2.4	1.3	2.6	1.7	2.1	1.4	
No-till		37.0	29.6	27.7	10.2	35.1	31.5	35.2	44.8	31.4
Reduced-till		37.5	29.9	23.8	9.4	29.5	28.5	34.9	42.7	29.5
LSD 0.05		NS	NS	1.9	NS	2.2	1.4	NS	1.1	

In 2000, yields were influenced by summer drought and early freeze damage.
Since 2003, all double-crop soybeans have been planted with no-tillage (NT).
Reduced tillage (RT) consisted of disking before wheat planting.

EFFECTS OF TILLAGE, ROW SPACING, AND HERBICIDE ON FULL-SEASON SOYBEANS FOLLOWING GRAIN SORGHUM[1]

Kenneth W. Kelley

Summary

Over a 6-yr period, with conventional tillage, yields were greater when soybeans were planted in 15-in. rows. With no-tillage, however, a narrower row spacing (7.5-in.) resulted in greater yields. A sequential application of glyphosate, or a preplant residual herbicide treatment followed by glyphosate, resulted in yields similar to the single glyphosate applied 3 wks after planting.

Introduction

In recent years, improved equipment and herbicide technology has prompted more interest in the no-till planting of glyphosate-resistant soybeans in narrow rows. For optimum yield potential, however, adequate weed control is important. This research investigates the interactions of tillage, row spacing, and glyphosate herbicide application on full-season soybeans following grain sorghum.

Experimental Procedures

Beginning in 1999, a 2-year rotation study involving soybeans and grain sorghum was established at the Columbus Unit on two adjacent sites. Main plot treatments consist of a factorial combination of conventional tillage (CT) and no-tillage (NT) with three different row spacings (7.5,15, and 30 in.). Subplot treatments for soybeans consist of four glyphosate herbicide applications: 1) full rate at 3 wks after planting, 2) full rate at 3 wks and reduced rate at 5 wks after planting; 3) preplant residual herbicide (Prowl) + glyphosate at 3 wks after planting, and 4) control (glyphosate at 10 wks). Conventional tillage treatments consisted of disking, chiseling, disking, and field cultivating before planting. Soybean planting population was targeted at 225,000 seeds/a for 7.5-in. rows, 175,000 seeds/a for 15-in. rows, and 125,000 seeds/a for 30-in. rows.

Results and Discussion

Full-season soybean yield results for 2004 are shown in Table 1. In 2004, soybean yields were greater when planted in 7.5- and 15-in. row spacing, regardless of tillage system. Weed competition was light, which resulted in only small yield differences between herbicide treatments, except for the control (glyphosate 10 wks after planting).

A 6-yr summary of soybean yields is shown in Table 2. In general, with conventional tillage, yields were greater when soybeans were planted in 15-in. row spacing. With no-tillage, however, yields were slightly better with 7.5-in. row spacing. On average, soybean yields were similar for CT and NT. In addition, with only light to moderate weed competition in most years, one application of glyphosate 3 wks after planting provided adequate weed control.

[1]This research was partly funded by the Kansas Soybean Commission.

Table 1. Effects of Tillage, Row Spacing, and Herbicide on Full-Season Soybean Yield Following Grain Sorghum, Columbus Unit, Southeast Ag Research Center, 2004.

Row Spacing	Tillage Method[1]	Herbicide Treatment[2] PP+ 3 wks	3 wks	3 + 2 wks	10 wks	Avg.
		---------- Soybean Yield (bu/a) ----------				
7.5-in.	CT	41.9	42.2	43.9	38.8	41.7
15-in.	CT	44.3	43.0	45.2	37.7	42.5
30-in.	CT	38.1	39.1	39.8	31.5	37.1
7.5-in.	NT	43.6	43.9	46.2	40.3	43.5
15-in.	NT	43.7	42.8	45.4	38.5	42.6
30-in.	NT	40.9	41.3	41.8	33.9	39.5
Means:						
Row	7.5-in.	42.6				
spacing	15-in.	42.6				
	30-in.	38.3				
	LSD 0.05	1.3				
Tillage	CT	40.5				
	NT	41.8				
	LSD 0.05	1.1				
Herbicide	PP+ 3 wks	42.1				
	3 wks	42.0				
	3 + 2 wks	43.7				
	10 wks	36.8				
	LSD 0.05	0.8				

[1] CT = conventional tillage (disk - chisel - disk - field cultivate); NT = no-tillage.
[2] Herbicide treatments consisted of postemergent applications of glyphosate. Full rate (1 qt/a) at 3 wks after planting and reduced rate (1 pt/a) at 5 wks after planting. Control treatment (10 wks after planting) consisted of 1.5 qt/a of glyphosate. Preplant (PP) treatment consisted of Prowl applied at 2.4 pt/a.

Table 2. Effects of Tillage, Row Spacing, and Herbicide on Full-Season Soybean Yield Following Grain Sorghum, Columbus Unit, 6-yr Average, 1999 - 2004.

Row Spacing	Tillage Method[1]	Herbicide Treatment[2] PP+ 3 wks	3 wks	3 + 2 wks	10 wks	Avg.
		Soybean Yield (bu/a)				
7.5-in.	CT	26.7	27.4	27.7	22.5	26.1
15-in.	CT	28.4	28.1	29.2	24.4	27.5
30-in.	CT	26.1	26.1	27.0	19.5	24.7
7.5-in.	NT	28.8	29.6	29.3	25.1	28.2
15-in.	NT	28.4	28.0	28.6	23.9	27.3
30-in.	NT	27.1	27.2	27.6	20.7	25.6
Means:						
Row	7.5-in.	27.1				
spacing	15-in.	27.4				
	30-in.	25.2				
	LSD 0.05	1.3				
Tillage	CT	26.1				
	NT	27.0				
	LSD 0.05	NS				
Herbicide	PP+ 3 wks	27.6				
	3 wks	27.7				
	3 + 2 wks	28.2				
	10 wks	22.7				
	LSD 0.05	1.0				

[1] CT = conventional tillage (disk - chisel - disk - field cultivate); NT = no tillage.
[2] Herbicide treatments consisted of postemergent applications of glyphosate. Full rate (1 qt/a) at 3 wks after planting and reduced rate (1 pt/a) at 5 wks after planting. Control treatment (10 wks after planting) consisted of 1.5 qt/a of glyphosate. Preplant (PP) treatment consisted of Prowl applied at 2.4 qt/a.

EFFECT OF SOIL pH ON CROP YIELD

Kenneth W. Kelley

Summary

Grain yields of grain sorghum, soybeans, and wheat increased as soil acidity decreased with lime application. Yields were greatest, however, when pH was near the neutral range of 7.0.

Introduction

In southeastern Kansas, nearly all topsoils are naturally acidic (pH less than 7.0). Agricultural limestone is applied to correct soil acidity and to 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 levels of soil pH.

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 in a 3-yr crop rotation consisting of [wheat - double-cropped soybeans] - grain sorghum - soybeans. 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. Yields generally were greatest, however, when soil pH was near the neutral range of 7.0. Plant nutrient availability (nitrogen and phosphorus) also increased as soil acidity decreased (data not shown).

Table 1. Effects of Soil pH on Crop Yields, Parsons Unit, Southeast Agricultural Research Center.

	Grain Yield			
	Grain Sorghum	Full-season Soybean	Double-crop Soybean	Wheat
Soil pH[1]	(4-yr avg)	(4-yr avg)	(3-yr avg)	(3-yr avg)
(0 - 6 in.)	bu/a	bu/a	bu/a	bu/a
5.2	83.8	28.2	17.6	45.4
5.5	89.9	30.3	20.3	46.1
6.3	96.3	33.6	22.0	47.3
6.7	99.3	34.2	23.3	49.1
7.2	99.0	35.0	22.3	48.2
LSD 0.05	4.2	1.9	1.1	2.7

[1] Average pH from 2001 to 2004.

EFFECTS OF TILLAGE ON FULL-SEASON SOYBEAN YIELD

Kenneth W. Kelley and Daniel W. Sweeney

Summary

Full-season soybean yields have differed over time with tillage method at two different sites. In general, when drier-than-normal conditions occur, soybean yields have been greater when soybeans were planted no-till following corn or grain sorghum; when summer rainfall is above normal, however, tillage has had less effect on full-season soybean yield.

Introduction

In southeastern Kansas, full-season soybeans often are rotated with other crops, such as corn and grain sorghum, to diversify cropping systems. Soybeans previously have been planted with conventional tillage (chisel - disk - field cultivate) following corn or grain sorghum, but improved equipment technology has made no-till planting more feasible. Thus, this research evaluates the long-term effects of tillage method on full-season soybean yield.

Experimental Procedures

From 1995 through 2002, a 3-yr crop rotation was evaluated at both the Columbus and Parsons Units. The rotation consisted of [corn or grain sorghum] - soybeans - [wheat and double-crop soybeans], and tillage effects on full-season soybean yields were evaluated every 3 yrs. Tillage treatments were: 1) plant all crops with conventional tillage (CT); 2) plant all crops with no-tillage (NT); and 3) alternate CT and NT systems. Beginning in 2003, the 3-yr rotation was changed to a 2-yr rotation, which consisted of soybeans following grain sorghum. Tillage effects on soybean yield were evaluated each year both at 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 were greater with CT than with NT during the first two cropping cycles. In recent years, however, soybean yields with continuous NT have been equal to or greater than CT. But soybean yields for NT following CT have been significantly lower than those for continuous NT or continuous CT. At the Parsons Unit, tillage systems had no significant effect on soybean yields in 1996, 1999, and 2004. But in 2002 and 2003, soybean yields were often greater for NT than CT.

Results suggest that the effects of tillage on soybean yields have changed over time. Additional research is needed to evaluate long-term effects of no-tillage and continuous tillage on soybean yield and on changes in soil properties, such as soil carbon and nitrogen.

Table 1. Effects of Tillage Systems on Full-Season Soybean Yield, Southeast Agricultural Research Center, 1996 - 2004.

	Full-Season Soybean Yield					
Tillage system	1996[1]	1999[1]	2002[1]	2003[2]	2004[2]	5-yr avg.
	---------------------------------- bu/a	----------------------------------				
			Columbus Unit			
NT only	48.4	18.1	27.0	35.7	46.1	35.1
NT following CT	46.0	14.2	26.0	29.3	38.4	30.8
CT only	53.9	20.3	23.4	35.8	43.2	35.3
CT following NT	54.4	20.0	26.5	36.9	40.3	35.6
LSD 0.05:	4.9	1.3	1.4	2.0	3.7	
			Parsons Unit			
NT only	45.3	15.8	32.4	34.9	42.4	34.2
NT following CT	43.7	14.9	32.1	33.5	42.2	33.3
CT only	45.2	15.5	27.9	30.8	45.1	32.9
CT following NT	45.8	16.0	29.6	35.1	43.8	34.1
LSD 0.05:	NS	NS	3.9	2.8	NS	

[1] 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.
[2] Previous crop was grain sorghum.
NT = no-tillage.
CT = conventional tillage (disk - chisel - disk - field cultivate).

HERBICIDE RESEARCH

Kenneth W. Kelley

Summary

Corn herbicide performance evaluations were conducted in Neosho and Cherokee Counties in 2004. Weed control was good to excellent in both trials.

Introduction

Chemical weed control is an important management tool for row-crop production. In recent years, new technology has provided several different methods to control weeds, especially for crops like corn and soybeans. Herbicide research trials are conducted annually to evaluate new and commonly used herbicide products for effects on weed control.

Experimental Procedures

In 2004, corn herbicides were evaluated at a Neosho river-bottom site and at an upland site at the Columbus Unit. At the river-bottom site, both preemerge and postemerge herbicide treatments were evaluated; at the Columbus Unit, only postemerge herbicides were applied. Herbicide treatments were applied with a CO_2 back-pack sprayer and replicated three or four times. Weed control ratings were made two weeks after the last postemerge application. Glyphosate-resistant corn was planted at both locations. At the Columbus Unit, all plots also received a premerge application of Dual II Magnum (1 pt/a) to control early grass weeds.

Results and Discussion

Weed control ratings for the various herbicide treatments are shown in Table 1 (Neosho Co.) and Table 2 (Columbus Unit). Weed ratings were taken in late May and represent a visual observation of weeds controlled.

At the river-bottom site in Neosho County, weed competition was mainly from broadleaf weeds. Weed control was good to excellent for all treatments evaluated.

At the Columbus Unit, weed control also was good to excellent for all treatments evaluated, but Callisto and/or glyphosate treatments provided the best overall broadleaf weed control.

Table 1. Comparison of Herbicides and Application Method for Weed Control in Corn, Neosho County, 2004.

TRT	Herbicide	Application Time[1]	Rate	Weed Control Broadleaf[2]	Weed Control Grass[3]
			prod./a	%	%
1	Bicep II Mag	PRE	2.1 qt	92	100
2	Bicep II Mag	PRE	2.1 qt	93	100
2	Hornet	PRE	3 oz		
3	Dual II	PRE	1.75 pt	99	100
3	Atrazine-4L	PRE	0.625 qt		
3	Callisto	PO	3 oz		
3	Crop oil	PO	1 %		
4	Guardsman Max	PRE	4 pt	92	100
5	Guardsman Max	PRE	4 pt	92	100
5	Balance Pro	PRE	2.25 oz		
6	G-Max Lite	PRE	3 pt	100	100
6	Celebrity Plus	PO	4.7 oz		
6	NIS	PO	0.25 %		
6	28 % N	PO	1 qt		
7	Epic	PRE	12 oz	95	100
7	Atrazine-4L	PRE	2 qt		
8	Bullet	PRE	4 qt	92	100
9	Degree Xtra	PRE	3.5 qt	92	100
10	Degree Xtra	PRE	2 qt	100	100
10	Roundup Ultra WM	PO	22 oz		
11	Atrazine-4L	PRE	2 qt	95	90
12	No herbicide	---	---	0	0
	LSD (0.05)			5	6

[1] Application time: PRE (preemerge) = April 8; PO (postemerge) = May 20.
Planting date: April 7, 2004. Weed rating: May 28, 2004.
[2] Broadleaf weeds (cocklebur, velvetleaf, common waterhemp, and ivyleaf morningglory).
[3] Grass weeds (crabgrass).

Table 2. Comparison of Herbicides for Weed Control in Corn, Columbus Unit, Southeast Agricultural Research Center, 2004.

TRT	Herbicide	Application Time[1]	Rate	Broadleaf Weed Control[2]
			prod./a	%
1	Atrazine-4L	PO	2 qt	95
1	Crop oil	PO	1 qt	
2	Callisto	PO	3 oz	100
2	Atrazine-4L	PO	1 pt	
2	Crop oil	PO	1 %	
3	Hornet	PO	3 oz	98
3	Atrazine-4L	PO	1 qt	
3	Crop oil	PO	1 %	
4	Distinct	PO	6 oz	98
4	Atrazine-4L	PO	1 qt	
4	NIS	PO	0.25 %	
4	28 % N	PO	1 qt	
5	Yukon	PO	4 oz	97
5	NIS	PO	0.25 %	
6	Marksman	PO	2 pt	96
7	Resource	PO	4 oz	95
7	Atrazine-4L	PO	1 pt	
7	Crop oil	PO	1 pt	
8	Aim 2 EW	PO	0.5 oz	95
8	Atrazine-4L	PO	1 qt	
8	NIS	PO	0.25 %	
9	Field Master	PO	4 qt	100
10	Roundup Ultra WM	PO	22 oz	100
11	No herbicide	---	---	0
	LSD (0.05)	---	---	5

[1] Application time of postemerge (PO) herbicides: May 11, 2004. Planting date: April 15.
[2] Broadleaf weeds: common waterhemp and cocklebur. Weed rating: May 26.

PERFORMANCE TEST OF DOUBLE-CROPPED SOYBEAN VARIETIES

James H. Long and Gary L. Kilgore[1]

Summary

Sixteen double-cropped soybean varieties were planted following winter wheat at the Parsons unit and evaluated for yield and other agronomic characteristics throughout the summer of 2004. Overall, grain yields were good; with the late-season drought conditions, variety differences were seen. Yields ranged from 24.6 bu/a to 35.2 bu/a. Grain yields were not strongly related to maturity, although mid to late Maturity Group (MG) IV varieties that matured from Julian day 270 to 280 caught timely rains and had yields equal to, or better than, later MG V varieties.

Introduction

Double-cropped soybean is an opportunistic crop grown after winter wheat across a wide area of southeastern Kansas. Because this crop is vulnerable to weather-related stress, such as drought and early frosts, it is important that the varieties not only have good yield potential under these conditions but also have the plant structure to allow them to set pods high enough to be harvested. They also should mature before threat of frost.

Experimental Procedures

Soybean varieties were planted into good moisture following winter wheat harvest at the Southeast Agricultural Research Center at Parsons. The soil is a Parsons silt loam. The wheat stubble was burned, the soil was field cultivated, and soybeans were then planted with John Deere 7000 planter units. Ultra Max Roundup was sprayed at 22 oz/a, when appropriate, after planting. Round-up-tolerant varieties were used. Soybeans were planted on June 17, 2004, at 10 seeds per ft of row. Harvest occurred November 8, 2004.

Results and Discussion

Soils were moist after rains throughout May, June, and early July, and plant stands were excellent. Excellent growing conditions prevailed early, but drought occurred in August and September. Even so, timely rains provided for excellent yields of 30 bu/a in some varieties. Yields ranged from 24.6 bu/a to 35.1 bu/a (Table 1). Several varieties yielded more than 28 bu/a, and could be considered good yielders in 2004. The timely rains in August had a lot to do with determining top-yielding varieties, catching the timely rains needed to improve pod set and retention. Overall plant heights were good, reflecting the moist early conditions.

[1]KSU Southeast Area Extension Office, Chanute.

Table 1. Yields for a Variety Test of Double-cropped Soybean at the Southeast Agricultural Research Center, 2001-2004.

Brand	Variety	Maturity	Height	Grain Yield			
				2001	2002	2003	2004
		Julian day[1]	-in-	bu/a			
Midland	9A545NRS	290	31.8	---	---	---	28.7
Midland	9A564NRS	283	31.3	---	---	25.5	27.3
Midland	9A485XRR	271	25.5	---	---	---	28.9
Asgrow	5301	290	32.5	---	---	---	30.9
Garst	5012RR	289	34.5	---	---	---	28.9
Pioneer	94M90	271	26.0	---	---	---	27.4
Pioneer	95B42	292	34.5	---	22.0	29.8	30.1
Pioneer	95B53	292	31.0	---	---	---	27.1
Stine	4842Y	271	25.5	---	---	---	26.8
Stine	5142-4	272	25.5	---	---	---	25.6
Stine	5322-4	273	23.5	---	---	---	29.0
NK	S57-P1	290	34.8	---	20.1	32.0	26.8
NK	S49Q9	271	29.3	---	---	---	35.2
Dyna-Gro	36M49	271	27.0	---	---	---	30.8
Dyna-Gro	33B52	291	33.3	---	---	---	30.0
Dyna-Gro	3562NRR	293	32.3	---	---	---	24.6
Dekalb	46-51	271	25.3	---	---	---	33.1
Average		---	33.1	16.9	19.1	26.6	28.9
LSD 0.05		5.0	3.7	2.7	4.4	4.0	4.5

[1] Julian Day 270 = September 27, 280=October 7, and 290=October 17.

PERFORMANCE TEST OF RIVER-BOTTOM SOYBEAN VARIETIES

James H. Long and Gary L. Kilgore[1]

Summary

Eleven soybean varieties typically grown on deep river-bottom soils were planted at Erie, Kansas, and evaluated for yield and other agronomic characteristics throughout the summer of 2004 Grain yields were excellent, and variety differences were seen with this very productive soil. Yields ranged from 35.8 to 50.7 bu/a. The shorter-season Maturity Group (MG) III and IV varieties yield as well as or better than MG V varieties when grown on deep soils. Most soybean plants were more than 3 feet tall, and there was significant lodging.

Introduction

Full-season soybeans are grown on the highly productive river-bottom soils of southeastern Kansas. Because this crop is not as vulnerable to weather-related stress, such as drought, it is important that the varieties have good yield potential and minimal lodging. In addition, the crop should be harvested before fall rains make clayey soils impassable or heavier precipitation causes flooding.

Experimental Procedures

Eleven soybean varieties were grown after corn in 2003. The farmer/cooperator was Joe Harris. The soil is a Lanton deep silt loam that sits on the Neosho River flood plain approximately 1750 feet from the river channel. The soil was chiseled and disked; Dual II® herbicide was applied at the rate of 3 pints/a; and the soil was field cultivated before planting. Soybeans were planted on June 8, 2004, at 10 seeds/ft of row. Plants emerged to form an excellent stand. All varieties were Round-up tolerant, and 22 oz/a of Roundup Weathermax® herbicide was applied postemergent 28 days after planting. The soybean were harvested on December 16, 2004.

Results and Discussion

Warm and moist conditions persisted throughout the summer, with periods of very cool temperatures. Soybean plants grew well throughout the season because of the deep moisture and timely rains.

Yields ranged from 35.8 bu/a to 50.7u/a (Table 1). Several varieties yielded more than 45 bu/a for the 2004 growing season. Consideration should be given to plant height and its effect on lodging, as well as on plant maturity. Overall plant height ranged from 33 to 41.8 in. Lodging was a problem for some varieties during the 2004 growing season. Most varieties in these maturity ranges are indeterminate in growth habit.

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[1]KSU Southeast Area Extension Office, Chanute.

Table 1. Yields for a Variety Test of River-bottom Soybeans at Erie, Kansas, 2002-2004.

Brand	Variety	Maturity	Height	Lodging[1]	Grain Yield		
					2002	2003	2004
		Julian day[2]	-in-		bu/a		
Midland	9A442NRR	272	40.0	0.8	40.3	41.0	46.8
Midland	9B445NRS	272	33.3	0.3	---	---	46.5
Asgrow	3801	269	33.0	0.5	---	---	45.1
Pioneer	93M80	270	39.3	0.3	---	---	46.4
Pioneer	94B73	274	37.3	0.8	---	38.7	50.7
Stine	4842Y	272	36.0	1.0	---	---	47.7
Dekalb	37-51	269	33.8	2.3	---	---	45.3
Dynagro	33B52	293	36.3	4.8	---	---	42.4
Dynagro	36M49	272	36.5	4.0	---	---	41.7
Dynagro	3562NRR	293	37.0	4.0	---	---	35.8
Garst	D484RR	274	41.8	1.0	---	---	41.6
Average		---	36.8	1.9	40.9	38.5	44.5
LSD 0.05		1.4	3.4	1.2	4.9	2.5	3.9

[1] Lodging scored from 1to 10, with 1=all standing and 10=all lodged.

[2] Julian Day 270 = September 27, 280=October 7, and 290=October 17.

PERFORMANCE TEST OF COTTON VARIETIES

James H. Long, Gary Kilgore[1], Scott Staggenborg[2], and Stewart Duncan[3]

Summary

Twenty-two cotton varieties were planted at Parsons, Kansas, and were evaluated for yield and other agronomic characteristics throughout the summer of 2004. Lint yields were average or better, and variety differences were seen. Yields ranged from 371 lb/a to 961 lb/a of lint. Quality is reported on the individual varieties. Quality should be strongly considered because it will affect the final price of the crop.

Introduction

Cotton is a new crop for southeastern Kansas but is already grown on nearly 100,000 acres in the state. The crop is somewhat drought tolerant. Many of the varieties tested are grown on the high plains of Texas and in Oklahoma. Some factors that may influence the amount of cotton grown in this region are potential insect problems and the management decisions associated with cotton, such as having an early harvest before fall rains arrive.

Experimental Procedures

Twenty-two cotton varieties were grown following grain sorghum in 2003. The soil at the Parsons unit of the Southeast Agricultural Research Center is a Parsons silt loam. The soil was disked twice. Treflan® herbicide was applied, and then the soil was field cultivated before planting. Cotton was planted on May 26, 2004. Cotoran® and Staple® were applied pre-emergent to help control broadleaf weeds. Target population was 43,000 plants/acre. Plants emerged to form an adequate stand. Cotton lint was harvested on December 14, 2004. The cotton was ginned at Manhattan, and lint quality was then determined by HVI (high volume instrumentation) testing.

Results and Discussion

The summer of 2004 was the coolest on record, and fields stayed moist nearly the entire summer. If it had not been for a much later killing frost than is normal, lint yields would have been drastically reduced. The cotton grew well throughout the season, yet did not mature until very late. Yields ranged from 371 lb/a to 961 lb/a (Table 1). DP&L DP444 BG/RR and Stoneville ST 4892BR had, by far, the greatest lint yield. DP&L 2145RR yielded more than 800 lb/a lint for the two- and three-year average and should be considered a top yielder (Table 2). Several varieties have above-average yields over that period. Quality characteristics indicate differences between varieties that may affect the price at the gin and these should be considered, especially if the qualities are much poorer than average. Turnout was high again this year due, in part, to a burr extractor on the cotton stripper.

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[1]KSU Southeast Area Extension Office, Chanute.

[2]Department of Agronomy, KSU.

[3]KSU Northeast Area Extension Office, Manhattan.

Table 1. Yield and Quality of Cotton Varieties at Parsons Unit, Southeast Agricultural Research Center, 2004.

Brand	Variety	Lint	TO	Mic	Length	Unifor	Strength	Color	Grade
		lb/a	%		in	%	g/tex		
AFD	3511RR	596	0.28	3.6	1.02	81.8	27.3	52	2
AFD	3602RR	371	0.28	3.3	1.09	81.4	29.5	52	1
All-Tex	ExcessRR	578	0.29	3.3	1.08	82.4	29.2	53	1
All-Tex	XpressRR	470	0.26	3.5	1.04	82.3	27.7	62	1
BCG	28R	559	0.27	3.5	1.08	80.3	27.2	52	1
BCG	50R	480	0.28	3.8	1.03	81.1	27.0	53	1
DP&L	2145RR	733	0.31	3.9	1.00	81.3	26.5	52	2
DP&L	2167RR	422	0.31	4.3	0.99	81.3	26.0	53	2
DP&L	2168RR	435	0.29	3.5	1.01	80.1	26.8	54	1
DP&L	2280BGRR	689	0.29	3.4	1.05	80.2	26.6	62	1
DP&L	DP432RR	532	0.28	3.4	1.06	81.5	27.4	53	3
DP&L	DP434RR	525	0.28	3.0	1.10	80.4	26.1	53	1
DP&L	DP444BG/RR	961	0.36	3.2	1.07	82.1	27.6	51	1
Fibermax	FM960BR	728	0.32	3.5	1.04	81.2	29.2	52	1
Fibermax	FM960RR	752	0.35	2.9	1.10	81.0	28.2	52	1
HW Gen.	HW520RR	557	0.30	3.4	1.07	80.3	27.8	52	2
Stoneville	NG1553R	536	0.30	3.5	1.12	82.6	32.2	41	4
Stoneville	NG2448R	710	0.30	3.8	1.06	83.2	28.7	52	1
Stoneville	ST3636B2R	691	0.30	3.3	1.04	79.3	25.2	53	1
Stoneville	ST3969R	376	0.27	3.2	1.07	80.6	28.6	52	1
Stoneville	ST4892BR	886	0.29	3.7	1.06	82.8	28.1	53	1
Stoneville	ST3664R	437	0.30	3.5	1.01	81.0	26.9	43	4
	Average	739	0.33	3.4	1.06	81.25	30.2	--	--
	CV (%)	13	6	8	3	1	3	--	--
	LSD 0.05	109	.03	0.8	0.06	2.6	2.8	--	--

Table 2. Average Lint Yield (lb/a) of Cotton Varieties at the Parsons Unit, Southeast Agricultural Research Center, 2002-2004.

Brand	Variety	2004	2003	2002	2-Yr Avg	3-Yr Avg
AFD	3511RR	596	627		612	
AFD	3602RR	371				
All-Tex	ExcessRR	578				
All-Tex	XpressRR	470				
BCG	28R	559				
BCG	50R	480				
DP&L	2145RR	733	918	778	826	810
DP&L	2167RR	422	800	621	611	614
DP&L	2168RR	435				
DP&L	2280BGRR	689	871	615	780	725
DP&L	DP432RR	532				
DP&L	DP434RR	525				
DP&L	DP444BGRR	961				
Fibermax	FM960BR	728				
Fibermax	FM960RR	752				
HW Gen.	HW520RR	557				
Stoneville	NG1553R	536	771		654	
Stoneville	NG2448R	710	697		703	
Stoneville	ST3636B2R	691				
Stoneville	ST3664R	437				
Stoneville	NG3969R	376				
Stoneville	ST4892BR	886				
	Average	594	739	598	667	644
	CV(%)	11	13	18	12	14
	LSD(0.05)	76	109	125	93	103

COTTON INSECT MANAGEMENT IN SOUTHEAST KANSAS

James H. Long, Scott Staggenborg[1], and Stewart Duncan[2]

Summary

Early-season control of thrips increased plant stand and lint yields of cotton. Plants without this early-season thrip control were stunted and had later boll set. This response was consistent across years as typical, cool early-season temperatures slowed plant development and allowed for extensive damage. Use of a mid-season treatment for bollworms had less effect on lint yield and stand. Greatest lint yields were seen when bollworm and thrip treatments were combined.

Introduction

Cotton (*Gossypium hirsutum L.)* is a new crop in the Central Great Plains region of the United States. Production in Kansas has increased to nearly 100,000 acres in 2004, and future increases are likely. Most cotton is grown in the southern counties of the state. Reasons for the acreage increase include a low cost of production, compared with irrigated corn, in the western areas of the state and the ability to withstand periodic summer drought in the central and eastern regions. Another perceived advantage of cotton production in Kansas is the apparent lack of insect pressure such as seen in the southern United States. But little research has been done to determine insect pressure and insect-management needs of cotton in Kansas. This research was conducted from 2001 until 2003 at the Southeast Agricultural Research Center (SEARC) at Parsons.

Experimental Procedures

Cotton (variety DP&L 2156RR) was planted each year in mid May. A no-insecticide control (None) was compared with an early-season treatment for thrips (CygonE), an early plus mid-season treatment to protect first squares (Cygon 2X), and a late-season treatment for bollworms (BW). Several combinations of treatments were also used. Cotton was stripped from the plants after October 1 of each year with a modified production stripper. Cotton lint yields were determined by mechanically ginning lint samples and weighing lint on a dry basis. Cygon treatments were .22 kg/ha active ingredient of product; the bollworm treatment (BW) was Orthene S at .56 kg/ha active ingredient of product. The soil was a Parsons silt loam, a fine mixed, thermic Mollic Albaqualf.

Results and Discussion

Cotton lint yield was doubled by using an early insecticide treatment for thrips (Figure 1). Any treatment that controlled thrips early in the season had greatly increased lint yield over the no-treatment or bollworm-only treatment. Most of the yield increase came as a result of increased stands with use of an early thrip treatment (Figure 2.) Stands were increased an average of 10-15% over the course of the study again in 2004 due, in part, to a burr extractor on the cotton stripper.

[1]Department of Agronomy, KSU.

[2]KSU Northeast Area Extension Office, Manhattan.

Figure 1. Effect of Insect Management on Production of Cotton Lint (lb/a) at Parsons, Kansas

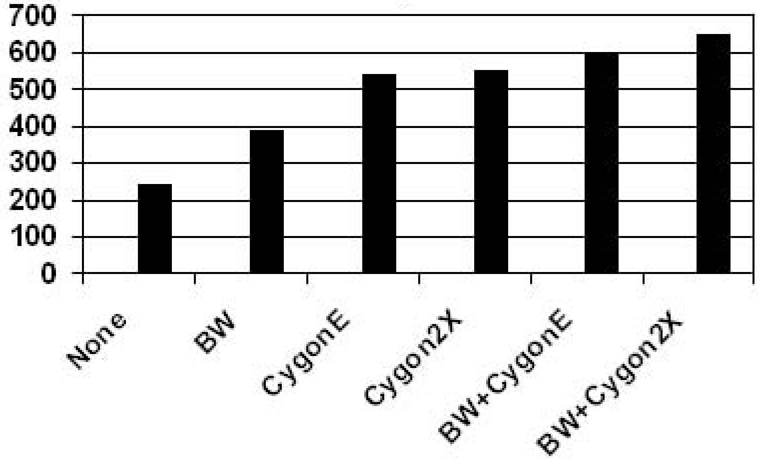
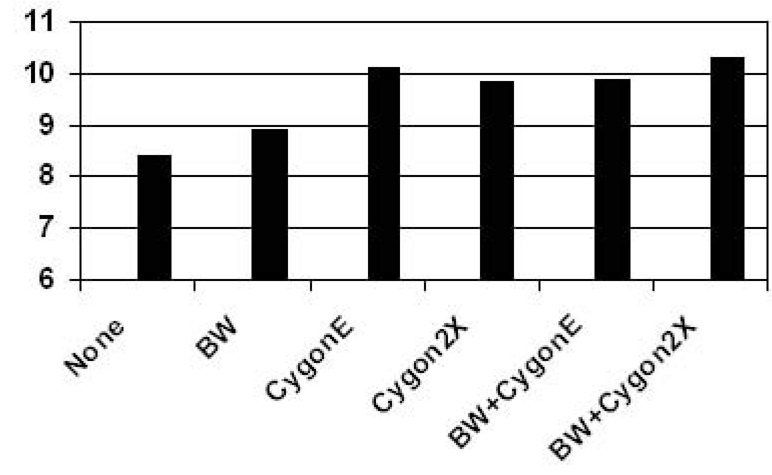


Figure 2. Effect of Insect Management on Plant Stand (plants/3ft) of Cotton at Parsons, Kansas



ANNUAL SUMMARY OF WEATHER DATA FOR PARSONS, KANSAS - 2004

Mary Knapp[1]

2004 DATA

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Avg. Max	42.8	44.4	60.2	66.4	78.2	82.1	85.2	84.4	84.6	71.0	57.0	48.0	67.0
Avg. Min	22.7	23.7	38.7	45.9	58.2	62.7	65.5	63.0	56.9	49.5	40.4	25.0	46.0
Avg. Mean	32.8	34.1	49.4	56.2	68.2	72.4	75.4	73.7	70.8	60.2	48.7	36.5	56.5
Precip	1.43	0.50	5.38	4.50	3.69	5.47	3.34	2.80	1.55	3.05	6.38	1.05	39.17
Snow	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
Heat DD*	1006	903	493	287	81	0	0	7	10	185	498	891	4361
Cool DD*	0	0	3	19	184	229	330	282	189	34	0	0	1270
Rain Days	6	4	10	6	7	11	11	4	1	7	15	3	85
Min < 10	4	2	0	0	0	0	0	0	0	0	0	3	9
Min < 32	26	25	10	0	0	0	0	0	0	0	6	22	89
Max > 90	0	0	0	0	0	1	9	8	4	0	0	0	22

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	85	91.1	90	81	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	58	46.3	34.9	24.8	45.1
Avg. Mean	30.2	36.4	46	55.6	65.2	74.2	79.7	78	69.5	58.4	45.2	34.6	56.1
Precip	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	3	1.5	0	0	0	0	0	0	0	2	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

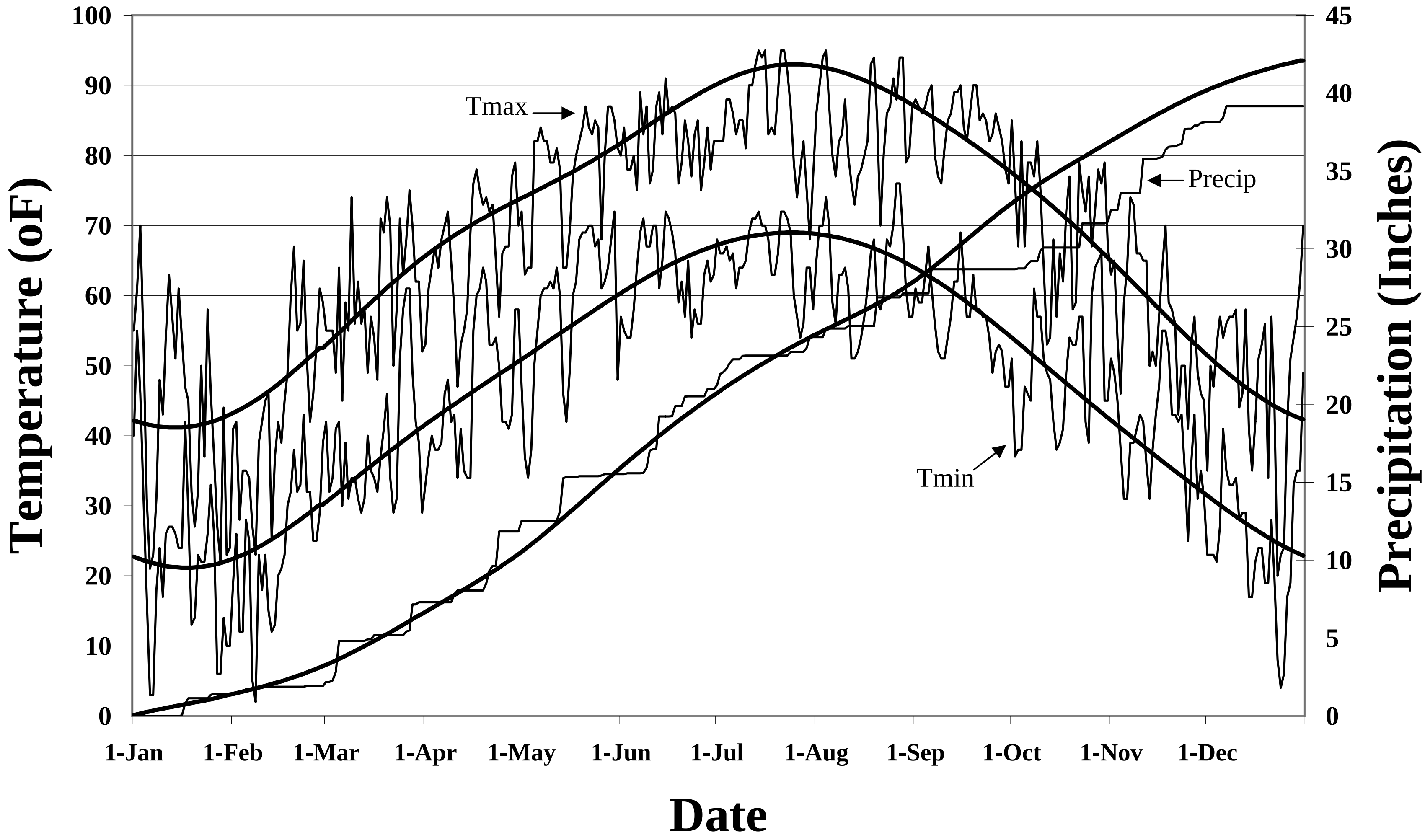
DEPARTURE FROM NORMAL

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Avg. Max	2.6	-2.8	3.0	-0.7	2.2	-2.9	-5.9	-5.6	3.6	0.5	1.5	3.6	-0.1
Avg. Min	2.5	-1.9	3.9	1.8	3.8	-0.7	-2.8	-3.0	-1.1	3.2	5.5	0.2	1.0
Avg. Mean	2.6	-2.3	3.4	0.6	3.0	-1.8	-4.3	-4.3	1.3	1.8	3.5	1.9	0.4
Precip	0.06	-1.28	2.01	0.71	-1.7	0.65	-0.49	-0.62	-3.38	-0.99	3.09	-0.98	-2.92
Snow	0.0	-3.0	-1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-2.0	0.0	-6.5
Heat DD	-73	103	-97	-8	-14	-6	0	4	-41	-44	-96	-51	-323
Cool DD	0	0	3	6	83	-54	-126	-124	2	10	0	0	-200

* 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] Assistant Specialist, Weather Data Library, KSU.

Parsons Annual Weather Summary - 2004



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R & F Farm Supply, Erie, KS
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RESEARCH CENTER PERSONNEL

Lyle Lomas	Research Center Head & Animal Scientist
Fredrick Black	Agricultural Technician
Larry Buffington	Custodial Specialist
Connie Clingan	Office Assistant
Larry Ellis	Agricultural Technician
TaLana Erikson	Animal Science Technician II
Terry Green	Animal Science Technician II
Marla Sexton	Accountant I
James Long	Crop Variety Development Agronomist
Kelly Kusel	Research Technologist
Joyce Erikson	Agricultural Technician
Kenneth Kelley	Crops and Soils Agronomist
Michael Dean	Plant Science Technician II
Joseph Moyer	Forage Agronomist
Mike Cramer	Plant Science Technician II
Kenneth McNickle	Agricultural Technician
Daniel Sweeney	Soil and Water Management Agronomist
Bobby Myers	Plant Science Technician II
David Kerley	Agricultural Technician

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Kansas State University Agricultural Experiment Station and Cooperative Extension Service, Manhattan 66506

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