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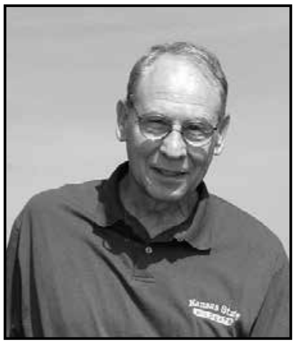
Kansas State University Agricultural Experiment Station and Cooperative Extension Service

LYLE LOMAS
Research Center Head and Animal Scientist

B.S., M.S., Animal Husbandry, University of Missouri
Ph.D., Animal Husbandry, Michigan State University

Lyle provides administrative and research leadership and directs beef cattle research at the Kansas State University Southeast Agricultural Research Center. Lyle joined the staff in 1979 as an animal scientist and became head in 1986. His research interests are beef cattle nutrition and forage utilization by grazing beef cattle.



JOE MOYER
Forage Agronomist

B.S., M.S., Ph.D., Agronomy, Kansas State University

Joe has been a staff member since 1978. His research evaluates forage grass and legume cultivars and management practices and forage utilization by grazing beef cattle.

GRETCHEN F. SASSENRATH
Cropping Systems Agronomist

B.A. Oberlin College
M.S., Biophysics, University of Illinois
Ph.D., Plant Physiology, University of Illinois

Gretchen joined the staff in 2013. Her research focuses on crop production; physiological, edaphic, biotic, and abiotic stressors in cropping systems; and integrated production systems.

DAN SWEENEY
Soil and Water Management Agronomist

B.S., Chemistry, Kentucky Wesleyan College
M.S., Agronomy, Purdue University
Ph.D., Soil Science, University of Florida

Dan joined the staff in 1983. His research focuses on soil fertility, tillage and compaction, water quality, and irrigation.

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Contents

Effects of Various Forage Systems on Grazing and Subsequent Finishing Performance

L.W. Lomas and J.L. Moyer

Summary

A total of 160 mixed black yearling steers were used to compare grazing and subsequent finishing performance from pastures with ‘MaxQ’ tall fescue, a wheat-bermudagrass double-crop system, or a wheat-crabgrass double-crop system in 2010, 2011, 2012, and 2013. Daily gains of steers that grazed ‘MaxQ’ tall fescue, wheat-bermudagrass, or wheat-crabgrass were similar ($P > 0.05$) in 2010, daily gains of steers that grazed wheat-bermudagrass or wheat-crabgrass were greater ($P > 0.05$) than those that grazed ‘MaxQ’ tall fescue in 2011 and 2012, and daily gains of steers that grazed wheat-crabgrass were greater ($P > 0.05$) than those that grazed wheat-bermudagrass and similar ($P > 0.05$) to those that grazed ‘MaxQ’ fescue in 2013. Finishing gains were similar ($P > 0.05$) among forage systems in 2010, 2012, and 2013. In 2011, finishing gains of steers that grazed ‘MaxQ’ tall fescue were greater ($P < 0.05$) than those that grazed wheat-bermudagrass.

Introduction

‘MaxQ’ tall fescue, a wheat-bermudagrass double-crop system, and a wheat-crabgrass double-crop system have been three of the most promising grazing systems evaluated at the Southeast Agricultural Research Center in the past 20 years, but these systems have never been compared directly in the same study. The objective of this study was to compare grazing and subsequent finishing performance of stocker steers that grazed these three systems.

Experimental Procedures

Forty mixed black yearling steers were weighed on two consecutive days each year and allotted on April 6, 2010 (633 lb); March 23, 2011 (607 lb); March 22, 2012 (632 lb); and April 4, 2013 (678 lb) to three four-acre pastures of ‘Midland 99’ bermudagrass and three 4-acre pastures of ‘Red River’ crabgrass that had previously been no-till seeded with approximately 120 lb/a of ‘Fuller’ hard red winter wheat on September 30, 2009, and September 22, 2010, and 130 lb/a and 95 lb/a of ‘Everest’ hard red winter wheat on September 27, 2011, and September 25, 2012, respectively, and four 4-acre established pastures of ‘MaxQ’ tall fescue (4 steers/pasture). All pastures were fertilized with 80-40-40 lb/a of $N\text{-}P_2O_5\text{-}K_2O$ on March 3, 2010; January 27, 2011; January 25, 2012; and February 19, 2013. Bermudagrass and crabgrass pastures received an additional 46 lb/a of nitrogen (N) on May 28, 2010; June 10, 2011; May 18, 2012; and July 3, 2013. Fescue pastures received an additional 46 lb/a of N on August 31, 2010; September 15, 2011; and September 18, 2013. An additional 5 lb/a, 4 lb/a, and 4 lb/a of crabgrass seed was broadcast on crabgrass pastures on April 8, 2011, April 4, 2012, and May 7, 2013, respectively.

Pasture was the experimental unit. No implants or feed additives were used. Weight gain was the primary measurement. Cattle were weighed every 28 days, and forage availability was measured approximately every 28 days with a disk meter calibrated for wheat, bermudagrass, crabgrass, or tall fescue. 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. Wheat-bermudagrass and wheat-crabgrass pastures were grazed continuously until September 14, 2010 (161 days); September 7, 2011 (168 days); and September 10, 2013 (159 days); fescue pastures were grazed continuously until November 9, 2010 (217 days); October 21, 2011 (212 days); and October 29, 2013 (208 days). In 2012, all pastures were grazed continuously until August 23 (144 days), when grazing on all pastures was terminated due to limited forage availability because of below-average precipitation. Steers were weighed on two consecutive days at the end of the grazing phase.

After the grazing period, cattle were moved to a finishing facility, implanted with Synovex-S (Zoetis, Madison, NJ), and fed a diet of 80% whole-shelled corn, 15% corn silage, and 5% supplement (dry matter basis). Finishing diets were fed for 94 days (wheat-bermudagrass and wheat-crabgrass) or 100 days (fescue) in 2010, 98 days (wheat-bermudagrass and wheat-crabgrass) or 96 days (fescue) in 2011, 105 days in 2012, and 105 days (wheat-bermudagrass and wheat-crabgrass) or 91 days (fescue) in 2013. All steers were slaughtered in a commercial facility, and carcass data were collected.

Results and Discussion

Grazing and subsequent finishing performance of steers that grazed 'MaxQ' tall fescue, a wheat-bermudagrass double-crop system, or a wheat-crabgrass double-crop system are presented in Tables 1, 2, 3, and 4 for 2010, 2011, 2012, and 2013, respectively. Daily gains of steers that grazed 'MaxQ' tall fescue, wheat-bermudagrass, or wheat-crabgrass were similar ($P > 0.05$) in 2010, but total grazing gain and gain/a were greater ($P < 0.05$) for 'MaxQ' tall fescue than wheat-bermudagrass or wheat-crabgrass because steers grazed 'MaxQ' tall fescue for more days. Gain/a for 'MaxQ' fescue, wheat-bermudagrass, and wheat-crabgrass were 362, 286, and 258 lb/a, respectively. 'MaxQ' tall fescue pastures had greater ($P < 0.05$) average available forage dry matter (DM) than wheat-bermudagrass or wheat-crabgrass. Grazing treatment in 2010 had no effect ($P > 0.05$) on subsequent finishing gains. Steers that grazed 'MaxQ' were heavier ($P < 0.05$) at the end of the grazing phase, maintained their weight advantage through the finishing phase, and had greater ($P < 0.05$) hot carcass weight than those that grazed wheat-bermudagrass or wheat-crabgrass pastures. Steers that previously grazed wheat-bermudagrass or wheat-crabgrass had lower ($P < 0.05$) feed:gain than those that had grazed 'MaxQ.'

In 2011, daily gains, total gain, and gain/a of steers that grazed wheat-bermudagrass or wheat-crabgrass were greater ($P < 0.05$) than 'MaxQ' fescue. Gain/a for 'MaxQ' fescue, wheat-bermudagrass, and wheat-crabgrass were 307, 347, and 376 lb/a, respectively. 'MaxQ' tall fescue pastures had greater ($P < 0.05$) average available forage DM than wheat-bermudagrass or wheat-crabgrass. This was likely due to greater forage production by 'MaxQ' and/or greater forage intake by steers grazing wheat-bermudagrass and wheat-crabgrass. Steers that grazed 'MaxQ' had greater ($P < 0.05$) finishing gain than those that grazed wheat-bermudagrass and lower ($P < 0.05$) feed:gain than those that grazed wheat-bermudagrass or wheat-crabgrass. Carcass weight was similar ($P > 0.05$) among treatments.

In 2012, daily gains, total gain, and gain/a of steers that grazed wheat-bermudagrass or wheat-crabgrass were greater ($P < 0.05$) than ‘MaxQ’fescue. Gain/a for ‘MaxQ’ fescue, wheat-bermudagrass, and wheat-crabgrass were 226, 325, and 313 lb/a, respectively. ‘MaxQ’ tall fescue pastures had greater ($P < 0.05$) average available forage DM than wheat-bermudagrass or wheat-crabgrass. Grazing treatment had no effect ($P > 0.05$) on subsequent finishing performance or carcass characteristics.

In 2013, daily gain was greater ($P < 0.05$) for steers that grazed wheat-crabgrass than for those that grazed wheat-bermudagrass, and daily gain from ‘MaxQ’ fescue and wheat-bermudagrass were similar ($P > 0.05$). Gain/a for ‘MaxQ’ fescue, wheat-bermudagrass, and wheat-crabgrass were 338, 244, and 316 lb/a, respectively. Gain/a was greater ($P < 0.05$) for ‘MaxQ’ fescue and wheat-crabgrass than for wheat-bermudagrass. Overall gain was not different between forage systems; however, steers grazed ‘MaxQ’fescue for 49 more days than wheat-bermudagrass or wheat-crabgrass. Total daily gain was greater ($P < 0.05$) for wheat-crabgrass than for ‘MaxQ’ tall fescue. ‘MaxQ’ tall fescue pastures had greater ($P < 0.05$) average available forage DM than wheat-bermudagrass or wheat-crabgrass and wheat-bermudagrass pastures had more ($P < 0.05$) available forage DM than wheat-crabgrass. Grazing treatment had no effect ($P > 0.05$) on subsequent finishing daily gain or carcass characteristics.

Hotter, drier weather during the summer of 2011 and 2012 likely provided more favorable growing conditions for bermudagrass and crabgrass than for fescue, which was reflected in greater ($P < 0.05$) gains by cattle grazing those pastures. Lack of precipitation also reduced the length of the grazing season for ‘MaxQ’ fescue pastures in 2012, which resulted in less fall grazing and lower gain/a than was observed for those pastures in 2010, 2011, and 2013.

Table 1. Effects of forage system on grazing and subsequent performance of stocker steers, Southeast Agricultural Research Center, 2010

	Forage system[1]		
Item	'MaxQ' fescue	Wheat-bermudagrass	Wheat-crabgrass
Grazing phase			
No. of days	217	161	161
No. of head	16	12	12
Initial weight, lb	633	633	633
Ending weight, lb	995a	919b	891b
Gain, lb	362a	286b	258b
Daily gain, lb	1.67	1.78	1.60
Gain/a, lb	362a	286b	258b
Average available forage dry matter, lb/a	6214a	3497b	3174c
Finishing phase			
No. of days	100	94	94
Beginning weight, lb	995a	919b	891b
Ending weight, lb	1,367a	1,281b	1,273b
Gain, lb	372	361	382
Daily gain, lb	3.72	3.84	4.07
Daily dry matter intake, lb	27.3a	24.6b	25.2b
Feed:gain	7.35a	6.42b	6.22b
Hot carcass weight, lb	847a	794b	790b
Backfat, in.	0.43	0.38	0.35
Ribeye area, sq. in.	12.5	12.5	12.2
Yield grade	2.8	2.5	2.5
Marbling score[2]	649	590	592
Percentage USDA choice grade	100	92	83
Overall performance (grazing plus finishing)			
No. of days	317	255	255
Gain, lb	734a	648b	640b
Daily gain, lb	2.32a	2.54b	2.51ab

[1] Means within a row followed by the same letter do not differ ($P < 0.05$).

[2] 500 = small, 600 = modest, 700 = moderate.

Table 2. Effects of forage system on grazing and subsequent performance of stocker steers, Southeast Agricultural Research Center, 2011

	Forage system[1]		
Item	'MaxQ' fescue	Wheat-bermudagrass	Wheat-crabgrass
Grazing phase			
No. of days	212	168	168
No. of head	16	12	12
Initial weight, lb	607	607	607
Ending weight, lb	914a	954b	982b
Gain, lb	307a	347b	376b
Daily gain, lb	1.45a	2.07b	2.24b
Gain/a, lb	307a	347b	376b
Average available forage dry matter, lb/a	5,983a	4,172b	3,904c
Finishing phase			
No. of days	96	98	98
Beginning weight, lb	914a	954b	982b
Ending weight, lb	1,355	1,344	1,385
Gain, lb	442a	389b	403ab
Daily gain, lb	4.60a	3.97b	4.11ab
Daily dry matter intake, lb	27.9	28.0	29.3
Feed:gain	6.09a	7.07b	7.13b
Hot carcass weight, lb	841	833	859
Backfat, in.	0.41	041	0.44
Ribeye area, sq. in.	12.9	13.0	13.3
Yield grade	2.6	2.7	2.8
Marbling score[2]	619	640	612
Percentage USDA choice grade	100	92	92
Overall performance (grazing plus finishing)			
No. of days	308	266	266
Gain, lb	749	737	779
Daily gain, lb	2.43a	2.77b	2.93b

[1] Means within a row followed by the same letter do not differ ($P < 0.05$).

[2] 600 = modest, 700 = moderate.

Table 3. Effects of forage system on grazing and subsequent performance of stocker steers, Southeast Agricultural Research Center, 2012

	Forage system[1]		
Item	'MaxQ' fescue	Wheat-bermudagrass	Wheat-crabgrass
Grazing phase			
No. of days	144	144	144
No. of head	16	12	12
Initial weight, lb	632	632	632
Ending weight, lb	858a	957b	945b
Gain, lb	226a	325b	313b
Daily gain, lb	1.57a	2.26b	2.17b
Gain/a, lb	226a	325b	313b
Average available forage dry matter, lb/a	5,983a	4,172b	3,904c
Finishing phase			
No. of days	105	105	105
Beginning weight, lb	858a	957b	945b
Ending weight, lb	1,355	1,409	1,431
Gain, lb	497	451	486
Daily gain, lb	4.73	4.30	4.63
Daily dry matter intake, lb	30.7	28.3	29.1
Feed:gain	6.53	6.61	6.28
Hot carcass weight, lb	840	873	887
Backfat, in.	0.44	0.38	0.45
Ribeye area, sq. in.	12.6	12.8	13.3
Yield grade	2.8	2.7	2.8
Marbling score[2]	625	591	603
Percentage USDA choice grade	100	83	92
Overall performance (grazing plus finishing)			
No. of days	249	249	249
Gain, lb	722	776	799
Daily gain, lb	2.90	3.12	3.21

[1] Means within a row followed by the same letter do not differ ($P < 0.05$).

[2] 500 = small, 600 = modest, 700 = moderate.

Table 4. Effects of forage system on grazing and subsequent performance of stocker steers, Southeast Agricultural Research Center, 2013

	Forage system[1]		
Item	'MaxQ' fescue	Wheat-bermudagrass	Wheat-crabgrass
Grazing phase			
No. of days	208	159	159
No. of head	16	12	12
Initial weight, lb	678	678	678
Ending weight, lb	1017a	923b	994a
Gain, lb	338a	244b	316a
Daily gain, lb	1.63ab	1.54a	1.99b
Gain/a, lb	338a	244b	316a
Average available forage dry matter, lb/a	6,290a	3,590b	2,980c
Finishing phase			
No. of days	91	105	105
Beginning weight, lb	1,017a	923b	994a
Ending weight, lb	1,390	1,387	1,480
Gain, lb	374a	464b	486b
Daily gain, lb	4.11	4.42	4.63
Daily dry matter intake, lb	27.1	27.7	28.1
Feed:gain	6.64	6.29	6.09
Hot carcass weight, lb	862	860	918
Backfat, in.	0.40	0.38	0.46
Ribeye area, sq. in.	12.7	13.6	13.5
Yield grade	2.6	2.2	2.4
Marbling score[2]	594	599	612
Percentage USDA choice grade	94	100	92
Overall performance (grazing plus finishing)			
No. of days	299	264	264
Gain, lb	712	708	802
Daily gain, lb	2.38ac	2.68bc	3.04b

[1] Means within a row followed by the same letter do not differ ($P < 0.05$).

[2] 500 = small, 600 = modest, 700 = moderate.

Effects of Cultivar and Distillers Grains Supplementation on Grazing and Subsequent Finishing Performance of Stocker Steers Grazing Tall Fescue Pasture

L.W. Lomas and J.L. Moyer

Summary

Two hundred eighty-eight yearling steers grazing tall fescue pastures were used to evaluate the effects of fescue cultivar and dried distillers grains (DDG) supplementation during the grazing phase on available forage, grazing gains, subsequent finishing gains, and carcass characteristics. Fescue cultivars evaluated were high-endophyte 'Kentucky 31' and low-endophyte 'Kentucky 31,' 'HM4,' and 'MaxQ.' Steers were either fed no supplement or were supplemented with DDG at 1.0% body weight per head daily in 2009 or 0.75% of body weight per head daily in 2010, 2011, and 2012 while grazing. Steers that grazed pastures of low-endophyte 'Kentucky 31,' 'HM4,' or 'MaxQ' gained significantly more ($P < 0.05$) and produced more ($P < 0.05$) gain/a than those that grazed high-endophyte 'Kentucky 31' pastures. Gains of cattle that grazed low-endophyte 'Kentucky 31,' 'HM4,' or 'MaxQ' were similar ($P > 0.05$). Subsequent finishing gains were similar ($P > 0.05$) among fescue cultivars in 2009 and 2012; however, steers that previously grazed high-endophyte 'Kentucky 31' had greater ($P > 0.05$) finishing gains that those that had grazed 'HM4' or 'MaxQ' in 2010 and greater ($P < 0.05$) finishing gains than those that grazed low-endophyte 'Kentucky 31' or 'HM4' in 2011. Supplementation of grazing steers with DDG supported a higher stocking rate and resulted in greater ($P < 0.05$) grazing gain, gain/a, hot carcass weight, ribeye area, and overall gain and reduced the amount of fertilizer needed by providing approximately 60 lb/a, 50 lb/a, 50 lb/a, and 30 lb/a of nitrogen (N) in 2009, 2010, 2011, and 2012, respectively, primarily from urine of grazing cattle.

Introduction

Tall fescue, the most widely adapted cool-season perennial grass in the United States, is grown on approximately 66 million acres. Although tall fescue is well adapted in the eastern half of the country between the temperate North and mild South, presence of a fungal endophyte results in poor performance of grazing livestock, especially during the summer. Until recently, producers with high-endophyte tall fescue pastures had two primary options for improving grazing livestock performance. One option was to destroy existing stands and replace them with endophyte-free fescue or other forages. Although it supports greater animal performance than endophyte-infected fescue, endophyte-free fescue has been shown to be less persistent under grazing pressure and more susceptible to stand loss from drought stress. In locations where high-endophyte tall fescue must be grown, the other option was for producers to adopt management strategies that reduce the negative effects of the endophyte on grazing animals, such as diluting the effects of the endophyte by incorporating legumes into existing pastures or providing supplemental feed. In recent years, new tall fescue cultivars have been developed with a non-toxic endophyte that provides vigor to the fescue plant without negatively affecting performance of grazing livestock.

Growth in the ethanol industry has resulted in increased availability of distillers grains, which have been shown to be an excellent feedstuff for supplementing grazing cattle because of their high protein and phosphorus content. Distillers grains contain approximately 4% to 5% N, and cattle consuming them excrete a high percentage of this N in their urine and feces; therefore, feeding DDG to grazing cattle will provide N to the pastures. Objectives of this study were to (1) evaluate two of these new cultivars in terms of forage availability, stand persistence, and grazing and subsequent finishing performance of stocker steers and compare them with high- and low-endophyte 'Kentucky 31' tall fescue; (2) evaluate DDG supplementation of cattle grazing these pastures; and (3) determine the contribution of DDG as a nitrogen fertilizer source.

Experimental Procedures

Seventy-two mixed black yearling steers were weighed on two consecutive days and allotted to 16 5-acre established pastures of high-endophyte 'Kentucky 31' or low-endophyte 'Kentucky 31,' 'HM4,' or 'MaxQ' tall fescue (4 replications per cultivar) on March 26, 2009 (569 lb); March 24, 2010 (550 lb); March 23, 2011 (536 lb); and March 22, 2012 (550 lb). 'HM4' and 'MaxQ' are cultivars that have a non-toxic endophyte. Four steers were assigned to two pastures of each cultivar and received no supplementation, and five steers were assigned to two pastures of each cultivar and supplemented with DDG at 1.0% or 0.75% body weight per head daily during the grazing phase in 2009 or 2010, 2011, and 2012, respectively. All pastures were fertilized with 80 lb/a N and P_2O_5 and K_2O as required by soil test on February 5, 2009; February 10, 2010; and January 27, 2011; and 90 lb/a N on January 25, 2012. Pastures with steers that received no supplement were fertilized with 60 lb/a N on September 16, 2009, 46 lb/a N on August 30, 2011 and September 15, 2011, and 30 lb/a N on August 10, 2012. This was calculated to be approximately the same amount of N from DDG that was excreted on pastures by supplemented steers during the entire grazing season.

Cattle in each pasture were group-fed DDG in meal form in bunks on a daily basis, and pasture was the experimental unit. No implants or feed additives were used. Weight gain was the primary measurement. Cattle were weighed every 28 days; quantity of DDG fed was adjusted at that time. Forage availability was measured approximately every 28 days with a disk meter calibrated for tall fescue. Cattle were treated for internal and external parasites before being turned out to pasture and later vaccinated for protection from pinkeye. Steers had free access to commercial mineral blocks that contained 12% calcium, 12% phosphorus, and 12% salt. Two steers in 2009 and one steer in 2012 were removed from the study for reasons unrelated to experimental treatment. Pastures were grazed continuously until October 13, 2009 (201 days); November 3, 2010 (224 days); October 19, 2011 (210 days); and August 21, 2012 (152 days), when steers were weighed on two consecutive days and grazing was terminated.

After the grazing period, cattle were moved to a finishing facility, implanted with Synovex-S (Zoetis, Madison, NJ), and fed a diet of 80% whole-shelled corn, 15% corn silage, and 5% supplement (dry matter basis). Cattle that received no supplement or were supplemented with DDG while grazing were fed a finishing diet for 119 or 99 days and for 112 or 98 days, respectively, in 2009 and 2011, for 106 days in 2010, and for 113 days in 2012. All steers were slaughtered in a commercial facility, and carcass data were collected.

Results and Discussion

Because no significant interactions occurred ($P > 0.05$) between cultivar and supplementation treatment, grazing and subsequent finishing performance are pooled across supplementation treatment and presented by tall fescue cultivar in Tables 1, 2, 3, and 4 for 2009, 2010, 2011, and 2012, respectively, and by supplementation treatment in Tables 5, 6, 7, and 8 for 2009, 2010, 2011, and 2012, respectively.

During all four years, steers that grazed pastures of low-endophyte 'Kentucky 31,' 'HM4,' or 'MaxQ' gained significantly more ($P < 0.05$) and produced more ($P < 0.05$) gain/a than those that grazed high-endophyte 'Kentucky 31' pastures (Tables 1, 2, 3, and 4). Gains of cattle that grazed low-endophyte 'Kentucky 31,' 'HM4,' or 'MaxQ' were similar ($P > 0.05$). Daily gains of steers grazing pastures with high-endophyte 'Kentucky 31,' low-endophyte 'Kentucky 31,' 'HM4,' or 'MaxQ' were 1.70, 2.35, 2.25, and 2.33 lb/head, respectively, in 2009; 1.56, 1.91, 1.97, and 2.04 lb/head, respectively, in 2010; 1.47, 2.00, 1.96, and 1.95 lb/head, respectively, in 2011; and 1.00, 1.93, 2.06, and 2.04 lb/head, respectively, in 2012. Gain/a from pastures with high-endophyte 'Kentucky 31,' low-endophyte 'Kentucky 31,' 'HM4,' and 'MaxQ' were 318, 438, 415, and 428 lb/a, respectively, in 2009; 322, 390, 400, and 416 lb/a, respectively, in 2010; 288, 385, 377, and 378 lb/a, respectively, in 2011; and 145, 271, 288, and 286 lb/a, respectively, in 2012.

In 2009, subsequent finishing gains and feed efficiency were similar ($P > 0.05$) among fescue cultivars (Table 1). Steers that previously grazed low-endophyte 'Kentucky 31,' 'HM4,' or 'MaxQ' maintained their weight advantage through the finishing phase and had greater ($P < 0.05$) final finishing weights, hot carcass weights, overall gains, and overall daily gains than those that previously grazed high-endophyte 'Kentucky 31.' Final finishing weights, hot carcass weights, overall gains, and overall daily gains were similar ($P > 0.05$) among steers that previously grazed low-endophyte 'Kentucky 31,' 'HM4,' or 'MaxQ.' Backfat thickness and percentage of carcasses graded choice or higher were similar ($P > 0.05$) among fescue cultivars.

In 2010, steers that previously grazed high-endophyte 'Kentucky 31' had greater ($P < 0.05$) finishing gains than those that had grazed 'HM4' or 'MaxQ,' finishing gains similar ($P > 0.05$) to those that grazed low-endophyte 'Kentucky 31,' lower ($P < 0.05$) hot carcass weight than those that grazed 'MaxQ,' hot carcass weight similar ($P > 0.05$) to those that grazed low-endophyte 'Kentucky 31' or 'HM4,' and less ($P < 0.05$) fat thickness than those that grazed low-endophyte 'Kentucky 31,' 'HM4,' or 'MaxQ' (Table 2). Feed:gain and percentage of carcasses grading choice or higher were similar ($P > 0.05$) among fescue cultivars. Overall gain of steers that grazed high-endophyte 'Kentucky 31' was greater ($P < 0.05$) than that of steers that grazed low-endophyte 'Kentucky 31' or 'MaxQ' and similar ($P > 0.05$) to that of steers that grazed 'HM4.'

In 2011, steers that previously grazed high-endophyte 'Kentucky 31' had greater ($P < 0.05$) finishing gains and lower ($P < 0.05$) feed:gain than those that had grazed low-endophyte 'Kentucky 31' or 'HM4' and lower ($P < 0.05$) hot carcass weight and smaller ($P < 0.05$) ribeye area than those that grazed 'MaxQ' (Table 3). Hot carcass weight, ribeye area, and overall gain and daily gain were similar ($P < 0.05$) between steers that grazed low-endophyte 'Kentucky 31,' 'HM4,' or 'MaxQ.' Steers that previously grazed high-endophyte 'Kentucky 31' had lower ($P < 0.05$) overall gain and daily gain than steers that grazed 'HM4' or 'MaxQ.'

In 2012, subsequent finishing gains were similar ($P > 0.05$) among fescue cultivars (Table 4), but steers that previously grazed high-endophyte 'Kentucky 31' had lower ($P < 0.05$) feed intake, lower ($P < 0.05$) feed:gain, lower (P < 0.05) hot carcass weight, lower ($P < 0.05$) overall gain, and lower ($P < 0.05$) overall daily gain than those that had grazed low-endophyte 'Kentucky 31,' 'HM4,' or 'MaxQ' (Table 4).

Steers supplemented with DDG gained significantly more ($P < 0.05$) and produced more ($P < 0.05$) gain/a than those that received no supplement while grazing (Tables 5, 6, 7, and 8). Grazing gains and gain/a of steers that received no supplement and those that were supplemented with DDG were 1.71 and 2.61 lb/head daily and 343 and 525 lb/a, respectively, in 2009; 1.62 and 2.12 lb/head daily and 363 and 475 lb/a, respectively, in 2010; 1.46 and 2.23 lb/head daily and 246 and 469 lb/a, respectively, in 2011; and 1.31 and 2.20 lb/head daily and 160 and 334 lb/a, respectively, in 2012. Supplemented steers consumed an average of 7.8, 6.0, 5.9, and 5.5 lb of DDG/head daily during the grazing phase in 2009, 2010, 2011, and 2012, respectively. Each additional pound of gain obtained from pastures with supplemented steers required 6.5, 7.2, 5.6, and 4.8 lb of DDG in 2009, 2010, 2011, and 2012, respectively. Steers that were supplemented during the grazing phase had greater ($P < 0.05$) final finishing weights, hot carcass weights, overall gain, and overall daily gain than those that received no supplement while grazing during all four years. Daily gain, feed efficiency, yield grade, marbling score, and percentage of carcasses grading choice or higher were similar ($P > 0.05$) between supplementation treatments in 2009; however, in 2010, 2011, and 2012, steers supplemented with DDG while grazing had lower ($P < 0.05$) finishing gains than those that received no supplement while grazing.

Average available forage dry matter (DM) is presented for each fescue cultivar and supplementation treatment combination for 2009, 2010, 2011, and 2012 in Tables 9, 10, 11, and 12, respectively. A significant interaction occurred ($P < 0.05$) between cultivar and supplementation treatment during all four years. Within each variety, there was no difference ($P > 0.05$) in average available forage DM between pastures stocked with 0.8 steer/a that received no supplement and those stocked with 1.0 steer/a and supplemented with DDG at 1.0% body weight per head daily in 2009 (Table 9). Average available forage DM was similar ($P > 0.05$) between supplementation treatments and pastures with supplemented steers stocked at a heavier rate, which indicates that pastures were responding to the N that was being returned to the soil from steers consuming DDG, or cattle supplemented with DDG were consuming less forage, or both. High-endophyte 'Kentucky 31' pastures with or without DDG supplementation had greater ($P < 0.05$) average available forage DM than 'MaxQ' pastures without supplementation. No other differences in average available forage DM were observed.

In 2010, no difference occurred ($P > 0.05$) in average available forage DM within variety for high-endophyte 'Kentucky 31,' low-endophyte 'Kentucky 31,' or 'HM4' pastures stocked with 0.8 steer/a that received no supplement and those stocked with 1.0 steer/a and supplemented with DDG at 0.75% body weight per head daily (Table 10); however, 'MaxQ' pastures that were stocked at the heavier rate and grazed by steers supplemented with DDG had greater ($P < 0.05$) average available forage DM than those stocked at a lighter rate and grazed by steers that received no supplement. High-endophyte 'Kentucky 31' pastures had greater ($P < 0.05$) average available DM than low-endophyte 'Kentucky 31,' 'HM4,' or 'MaxQ' pastures stocked with 0.8 steer/a that received no supplement.

In 2011, no difference occurred ($P > 0.05$) in average available forage DM within variety for low-endophyte 'Kentucky 31' or 'HM4' pastures stocked with 0.8 steer/a that received no supplement and those stocked with 1.0 steer/a and supplemented with DDG at 0.75% body weight per head daily (Table 11), but 'MaxQ' pastures that were stocked at the heavier rate and grazed by steers supplemented with DDG had greater ($P < 0.05$) average available forage DM than those stocked at a lighter rate and grazed by steers that received no supplement. High-endophyte 'Kentucky 31' pastures that were stocked at the heavier rate and grazed by steers supplemented with DDG had lower ($P < 0.05$) average available forage DM than those stocked at a lighter rate. High-endophyte 'Kentucky 31' pastures had greater ($P < 0.05$) average available DM than low-endophyte 'Kentucky 31,' 'HM4,' or 'MaxQ' pastures stocked with 0.8 steer/a that received no supplement.

In 2012, a cultivar × date interaction occurred, with similar peak available DM on April 18 ($P > 0.05$) but lower available DM for 'MaxQ' and 'HM4' ($P < 0.05$) at the end of the grazing phase on August 17. No difference occurred ($P > 0.05$) in average available forage DM within variety for low-endophyte 'Kentucky 31,' 'HM4,' or 'MaxQ' pastures stocked with 0.8 steer/a that received no supplement and those stocked with 1.0 steer/a and supplemented with DDG at 0.75% body weight per head daily (Table 12); however, high-endophyte 'Kentucky 31' pastures that were stocked at the heavier rate and grazed by steers supplemented with DDG had lower ($P < 0.05$) average available forage DM than those stocked at a lighter rate in both 2011 and 2012. This result suggests that supplementation with DDG increased forage intake and utilization by cattle grazing these pastures. High-endophyte 'Kentucky 31' pastures had greater ($P < 0.05$) average available DM than low-endophyte 'Kentucky 31,' 'HM4,' or 'MaxQ' pastures within each stocking rate and supplementation level in 2012.

Grazing gains and overall gains of steers that grazed low-endophyte 'Kentucky 31,' 'HM4,' or 'MaxQ' were similar ($P > 0.05$) and significantly greater ($P < 0.05$) than those of steers that grazed high-endophyte 'Kentucky 31.' Supplementation of grazing steers with DDG resulted in greater ($P < 0.05$) grazing gains, supported a higher stocking rate, resulted in greater ($P < 0.05$) gain/a, and reduced the amount of fertilizer needed by providing approximately 30 to 60 lb of N/a. Producers seeking to maximize production from fescue pastures should consider using one of the new fescue varieties with the non-toxic endophyte in combination with DDG supplementation.

Table 1. Effects of cultivar on grazing and subsequent performance of steers grazing tall fescue pastures, Southeast Agricultural Research Center, 2009

	Tall fescue cultivar[1]			
Item	High-endophyte Kentucky 31	Low-endophyte Kentucky 31	HM4	MaxQ
Grazing phase (201 days)				
No. of head	17	18	17	18
Initial weight, lb	571	569	566	569
Ending weight, lb	913a	1042b	1019b	1038b
Gain, lb	342a	473b	453b	468b
Daily gain, lb	1.70a	2.35b	2.25b	2.33b
Gain/a, lb	318a	438b	415b	428b
Finishing phase (109 days)				
Beginning weight, lb	913a	1,042b	1,019b	1,038b
Ending weight, lb	1,285a	1,381b	1,366b	1,376b
Gain, lb	372	339	347	338
Daily gain, lb	3.41	3.11	3.20	3.10
Daily dry matter intake, lb	24.4	24.1	24.1	24.9
Feed:gain	7.18	7.81	7.57	8.11
Hot carcass weight, lb	759a	820b	810b	811b
Backfat, in.	0.43	0.43	0.44	0.47
Ribeye area, sq. in.	11.9a	11.9a	12.5b	11.7a
Yield grade[2]	2.6a	3.0b	2.8a	3.0b
Marbling score[3]	601a	646ab	672bc	717c
Percentage USDA grade choice	95	100	95	100
Overall performance (grazing plus finishing) (310 days)				
Gain, lb	714a	812b	800b	807b
Daily gain, lb	2.31a	2.63b	2.59b	2.61b

[1] Means within a row followed by the same letter do not differ ($P < 0.05$).

[2] USDA (1987).

[3] 600 = modest, 700 = moderate, 800 = slightly abundant.

Table 2. Effects of cultivar on grazing and subsequent performance of steers grazing tall fescue pastures, Southeast Agricultural Research Center, 2010

	Tall fescue cultivar[1]			
Item	High-endophyte Kentucky 31	Low-endophyte Kentucky 31	HM4	MaxQ
Grazing phase (224 days)				
No. of head	18	18	18	18
Initial weight, lb	550	550	550	550
Ending weight, lb	899a	978b	990b	1,007b
Gain, lb	349a	428b	441b	457b
Daily gain, lb	1.56a	1.91b	1.97b	2.04b
Gain/a, lb	322a	390b	400b	416b
Finishing phase (106 days)				
Beginning weight, lb	899a	978b	990b	1,007b
Ending weight, lb	1,386a	1,432b	1,419b	1,449b
Gain, lb	486a	454ab	429b	442b
Daily gain, lb	4.59a	4.28ab	4.04b	4.17b
Daily dry matter intake, lb	25.8	26.0	25.7	26.0
Feed:gain	5.63	6.10	6.37	6.24
Hot carcass weight, lb	812a	849ab	840ab	861b
Dressing percentage	58.6	59.3	59.2	59.4
Backfat, in.	0.37a	0.48b	0.44b	0.45b
Ribeye area, sq. in.	12.0	12.2	12.2	12.4
Yield grade[2]	2.7	2.9	2.8	2.8
Marbling score[3]	660ab	676a	630b	648ab
Percentage USDA grade choice	100	94	94	100
Overall performance (grazing plus finishing) (330 days)				
Gain, lb	836a	882b	869ab	899b
Daily gain, lb	2.53a	2.67b	2.63ab	2.72b

[1] Means within a row followed by the same letter do not differ ($P < 0.05$).

[2] USDA (1987).

[3] 600 = modest, 700 = moderate.

Table 3. Effects of cultivar on grazing and subsequent performance of steers grazing tall fescue pastures, Southeast Agricultural Research Center, 2011

	Tall fescue cultivar[1]			
Item	High-endophyte Kentucky 31	Low-endophyte Kentucky 31	HM4	MaxQ
Grazing phase (210 days)				
No. of head	18	18	18	18
Initial weight, lb	536	536	536	536
Ending weight, lb	845a	956b	947b	946b
Gain, lb	310a	420b	411b	410b
Daily gain, lb	1.47a	2.00b	1.96b	1.95b
Gain/a, lb	288a	385b	377b	378b
Finishing phase (105 days)				
Beginning weight, lb	845a	956b	947b	946b
Ending weight, lb	1,310a	1,369ab	1,374ab	1,401b
Gain, lb	465a	412b	427bc	455ac
Daily gain, lb	4.42a	3.93b	4.05bc	4.33ac
Daily dry matter intake, lb	27.0ab	27.2ab	26.7a	27.8b
Feed:gain	6.12a	6.94b	6.62bc	6.43ac
Hot carcass weight, lb	812a	849ab	852ab	869b
Dressing percentage	59.9ab	59.5b	60.4a	60.5a
Backfat, in.	0.39a	0.46ab	0.45ab	0.50b
Ribeye area, sq. in.	12.7a	13.0ab	13.1ab	13.3b
Yield grade[2]	2.5	2.8	2.8	2.8
Marbling score[3]	646ab	620a	687b	654ab
Percentage USDA grade choice	100	100	100	100
Overall performance (grazing plus finishing) (315 days)				
Gain, lb	774a	833ab	839b	865b
Daily gain, lb	2.46a	2.65ab	2.66b	2.75b

[1] Means within a row followed by the same letter do not differ ($P < 0.05$).

[2] USDA (1987).

[3] 600 = modest, 700 = moderate.

Table 4. Effects of cultivar on grazing and subsequent performance of steers grazing tall fescue pastures, Southeast Agricultural Research Center, 2012

	Tall fescue cultivar[1]			
Item	High-endophyte Kentucky 31	Low-endophyte Kentucky 31	HM4	MaxQ
Grazing phase (152 days)				
No. of head	18	18	17	18
Initial weight, lb	550	550	548	550
Ending weight, lb	702a	843b	861b	859b
Gain, lb	152a	293b	313b	310b
Daily gain, lb	1.00a	1.93b	2.06b	2.04b
Gain/a, lb	145a	271b	288b	286b
Finishing phase (113 days)				
Beginning weight, lb	702a	843b	861b	859b
Ending weight, lb	1,249a	1,384b	1,408b	1,415b
Gain, lb	547	541	547	556
Daily gain, lb	4.84	4.79	4.84	4.92
Daily dry matter intake, lb	24.8a	27.2b	28.0b	28.6b
Feed:gain	5.13a	5.67b	5.79b	5.85b
Hot carcass weight, lb	774a	858b	873b	877b
Backfat, in.	0.45a	0.52b	0.49ab	0.48ab
Ribeye area, sq. in.	12.2a	12.9ab	13.4b	13.1b
Yield grade[2]	2.7	3.0	2.8	2.9
Marbling score[3]	577a	591a	657b	619ab
Percentage USDA grade choice	95	88	100	100
Overall performance (grazing plus finishing) (265 days)				
Gain, lb	699a	835b	860b	865b
Daily gain, lb	2.64a	3.15b	3.25b	3.27b

[1] Means within a row followed by the same letter do not differ ($P < 0.05$).

[2] USDA (1987).

[3] 500 = small, 600 = modest, 700 = moderate.

Table 5. Effects of dried distillers grains (DDG) supplementation on grazing and subsequent performance of steers grazing tall fescue pastures, Southeast Agricultural Research Center, 2009

	DDG level (% body weight/head per day)[1]	
Item	0	1.0
Grazing phase (201 days)		
No. of head	30	40
Initial weight, lb	569	569
Ending weight, lb	911a	1,095b
Gain, lb	343a	525b
Daily gain, lb	1.71a	2.61b
Gain/a, lb	274a	525b
Total DDG consumption, lb/head	---	1628
Average DDG consumption, lb/head per day	---	7.8
DDG, lb/additional gain, lb	---	6.5
Finishing phase		
No. of days	119	99
Beginning weight, lb	911a	1,095b
Ending weight, lb	1,289a	1,415b
Gain, lb	378a	320b
Daily gain, lb	3.17	3.23
Daily dry matter intake, lb	24.6	24.2
Feed:gain	7.80	7.54
Hot carcass weight, lb	768a	832b
Dressing percentage	59.6	58.8
Backfat, in.	0.43	0.45
Ribeye area, sq. in.	11.7a	12.3b
Yield grade	2.8	2.9
Marbling score[2]	638	680
Percentage USDA grade choice	100	95
Overall performance (grazing plus finishing)		
No. of days	320	300
Gain, lb	721a	846b
Daily gain, lb	2.25a	2.82b

[1] Means within a row followed by the same letter do not differ ($P < 0.05$).

[2] 600 = modest, 700 = moderate.

Table 6. Effects of dried distillers grains (DDG) supplementation on grazing and subsequent performance of steers grazing tall fescue pastures, Southeast Agricultural Research Center, 2010

	DDG level (% body weight/head per day)[1]	
Item	0	0.75
Grazing phase (224 days)		
No. of head	32	40
Initial weight, lb	550	550
Ending weight, lb	912a	1,025b
Gain, lb	363a	475b
Daily gain, lb	1.62a	2.12b
Gain/a, lb	290a	475b
Total DDG consumption, lb/head	---	1,335
Average DDG consumption, lb/head per day	---	6.0
DDG, lb/additional gain, lb	---	7.2
Finishing phase (106 days)		
Beginning weight, lb	912a	1,025b
Ending weight, lb	1,378a	1,464b
Gain, lb	466a	439b
Daily gain, lb	4.40a	4.15b
Daily dry matter intake, lb	26.2	25.6
Feed:gain	5.99	6.18
Hot carcass weight, lb	806a	875b
Dressing percentage	58.5a	59.7b
Backfat, in.	0.39a	0.47b
Ribeye area, sq. in.	12.1	12.2
Yield grade	2.6	3.0
Marbling score[2]	638a	669b
Percentage USDA grade choice	94	100
Overall performance (grazing plus finishing) (330 days)		
Gain, lb	829a	914b
Daily gain, lb	2.51a	2.77b

[1] Means within a row followed by the same letter do not differ ($P < 0.05$).

[2] 600 = modest, 700 = moderate.

Table 7. Effects of dried distillers grains (DDG) supplementation on grazing and subsequent performance of steers grazing tall fescue pastures, Southeast Agricultural Research Center, 2011

	DDG level (% body weight/head per day)[1]	
Item	0	0.75
Grazing phase (210 days)		
No. of head	32	40
Initial weight, lb	536	536
Ending weight, lb	843a	1,005b
Gain, lb	307a	469b
Daily gain, lb	1.46a	2.23b
Gain/a, lb	246a	469b
Total DDG consumption, lb/head	---	1,240
Average DDG consumption, lb/head per day	---	5.9
DDG, lb/additional gain, lb	---	5.6
Finishing phase		
No. of days	112	98
Beginning weight, lb	943a	1,005b
Ending weight, lb	1,324a	1,403b
Gain, lb	481a	498b
Daily gain, lb	4.30a	4.07b
Daily dry matter intake, lb	27.3	27.1
Feed:gain	6.38	6.68
Hot carcass weight, lb	821a	870b
Backfat, in.	0.46	0.44
Ribeye area, sq. in.	12.7a	13.3b
Yield grade	2.8	2.6
Marbling score[2]	644	659
Percentage USDA grade choice	100	100
Overall performance (grazing plus finishing)		
No. of days	322	308
Gain, lb	788a	867b
Daily gain, lb	2.45a	2.82b

[1] Means within a row followed by the same letter do not differ ($P < 0.05$).

[2] 600 = modest, 700 = moderate.

Table 8. Effects of dried distillers grains (DDG) supplementation on grazing and subsequent performance of steers grazing tall fescue pastures, Southeast Agricultural Research Center, 2012

	DDG level (% body weight/head per day)[1]	
Item	0	0.75
Grazing phase (152 days)		
No. of head	31	40
Initial weight, lb	549	550
Ending weight, lb	748a	884b
Gain, lb	200a	334b
Daily gain, lb	1.31a	2.20b
Gain/a, lb	160a	334b
Total DDG consumption, lb/head	---	829
Average DDG consumption, lb/head per day	---	5.5
DDG, lb/additional gain, lb	---	4.8
Finishing phase (113 days)		
Beginning weight, lb	748a	884b
Ending weight, lb	1,314a	1,414b
Gain, lb	566a	530b
Daily gain, lb	5.01a	4.69b
Daily dry matter intake, lb	26.8	27.5
Feed:gain	5.35a	5.87b
Hot carcass weight, lb	815a	877b
Backfat, in.	0.44a	0.53b
Ribeye area, sq. in.	12.6	13.2
Yield grade	2.7	3.0
Marbling score[2]	605	616
Percentage USDA grade choice	94	98
Overall performance (grazing plus finishing) (265 days)		
Gain, lb	765a	864b
Daily gain, lb	2.89a	3.26b

[1] Means within a row followed by the same letter do not differ ($P < 0.05$).

[2] 600 = modest, 700 = moderate.

Table 9. Effects of tall fescue cultivar and dried distillers grains (DDG) supplementation on average available forage dry matter, Southeast Agricultural Research Center, 2009

	DDG level (% body weight/head per day)[1]	
Tall fescue cultivar	0	1.0
	------------------ lb/a ------------------	
High-endophyte Kentucky 31	5,593a	5,564a
Low-endophyte Kentucky 31	5,135ab	5,052ab
HM4	5,193ab	5,146ab
MaxQ	4,762b	5,527ab

[1] Means followed by the same letter do not differ ($P < 0.05$).

Table 10. Effects of tall fescue cultivar and dried distillers grains (DDG) supplementation on average available forage dry matter, Southeast Agricultural Research Center, 2010

	DDG level (% body weight/head per day)[1]	
Tall fescue cultivar	0	0.75
	------------------ lb/a ------------------	
High-endophyte Kentucky 31	6,553a	6,253ab
Low-endophyte Kentucky 31	5,791cd	5,675cd
HM4	5,884cd	5,617d
MaxQ	5,668d	5,984bc

[1] Means followed by the same letter do not differ ($P < 0.05$).

Table 11. Effects of tall fescue cultivar and dried distillers grains (DDG) supplementation on average available forage dry matter, Southeast Agricultural Research Center, 2011

	DDG level (% body weight/head per day)[1]	
Tall fescue cultivar	0	0.75
	------------------ lb/a ------------------	
High-endophyte Kentucky 31	5,313a	4,861b
Low-endophyte Kentucky 31	4,426c	4,439c
HM4	4,535c	4,468c
MaxQ	4,486c	4,939b

[1] Means followed by the same letter do not differ ($P < 0.05$).

Table 12. Effects of tall fescue cultivar and dried distillers grains (DDG) supplementation on average available forage dry matter, Southeast Agricultural Research Center, 2012

	DDG level (% body weight/head per day)[1]	
Tall fescue cultivar	0	0.75
	------------------ lb/a ------------------	
High-endophyte Kentucky 31	6,203a	5,784d
Low-endophyte Kentucky 31	5,993bcd	6,024abc
HM4	5,837cd	6,004abc
MaxQ	5,837cd	6,004abc

[1] Means followed by the same letter do not differ ($P < 0.05$).

Effects of Frequency of Dried Distillers Grains Supplementation on Gains of Heifers Grazing Smooth Bromegrass Pastures

L.W. Lomas and J.L. Moyer

Summary

A total of 150 heifer calves grazing smooth bromegrass pastures were used to compare daily supplementation of dried distillers grains (DDG) with supplementation with an equivalent amount of DDG three days per week in 2009, 2010, 2011, 2012, and 2013. The rate of DDG fed was based on the equivalent of 0.5% of body weight per head daily. Daily gains and DDG intake of heifers fed daily or three days per week were similar ($P > 0.05$) during all five years.

Introduction

Distillers grains, a by-product of the ethanol industry, have tremendous potential as an economical and nutritious supplement for grazing cattle. Distillers grains contain a high concentration of protein (25% to 30%), with more than two-thirds escaping degradation in the rumen, which makes it an excellent supplement for younger cattle. Previous research at this location on DDG supplementation of stocker cattle grazing smooth bromegrass has shown DDG at 0.5% body weight per head daily to be the most efficacious level from the perspectives of both animal performance and economics. Many producers would prefer not to supplement their cattle on a daily basis, however, to save labor and reduce costs. This research was conducted to compare daily supplementation of grazing stocker cattle with DDG at 0.5% body weight with an equivalent amount of DDG supplemented three days per week.

Experimental Procedures

Thirty heifer calves were weighed on two consecutive days each year, stratified by weight, and randomly allotted to six 5-acre smooth bromegrass pastures on April 7, 2009 (420 lb); March 30, 2010 (422 lb); April 5, 2011 (406 lb); April 3, 2012 (447 lb); and April 16, 2013 (454 lb). Three pastures of heifers were randomly assigned to one of two supplementation treatments (three replicates per treatment) and grazed for 192 days, 168 days, 169 days, 127 days, and 141 days in 2009, 2010, 2011, 2012, and 2013, respectively. Supplementation treatments were DDG at 0.5% body weight per head daily or an equivalent amount of DDG fed three days per week (Monday, Wednesday, and Friday). Pastures were fertilized with 100 lb/a nitrogen and P_2O_5 and K_2O as required by soil test on February 10, 2009; February 19, 2010; April 6, 2011; February 1, 2012; and March 8, 2013. Pastures were stocked with 1 heifer/a and grazed continuously until October 16, 2009 (192 days); September 13, 2010 (168 days); September 21, 2011 (169 days); August 8, 2012 (127 days); and September 4, 2013 (141 days), when heifers were weighed on two consecutive days and grazing was terminated.

Cattle in each pasture were group-fed DDG in meal form in bunks on a daily basis, and pasture was the experimental unit. No implants or feed additives were used. Weight gain was the primary measurement. Cattle were weighed every 28 days; quantity of

DDG fed was adjusted at that time. Cattle were treated for internal and external parasites before being turned out to pasture and later vaccinated for protection from pinkeye. Heifers had free access to commercial mineral blocks that contained 12% calcium, 12% phosphorus, and 12% salt. One heifer was removed from the study in 2009, 2011, and 2012 for reasons unrelated to experimental treatment.

Results and Discussion

Cattle gains and DDG intake are presented in Tables 1, 2, 3, 4, and 5 for 2009, 2010, 2011, 2012, and 2013, respectively. Gains and DDG intake of heifers that were supplemented three times per week were similar ($P > 0.05$) to those of heifers that were supplemented daily all five years.

In 2009, daily gain and gain/a were 1.89 and 362 lb, respectively, for heifers supplemented daily and 1.87 and 359 lb, respectively, for heifers supplemented three times per week. Total DDG consumption and average daily DDG consumption were 561 and 2.9 lb, respectively, for heifers supplemented daily and 566 and 3.0 lb, respectively, for heifers supplemented three times per week. Heifers supplemented three times per week were fed an average of 6.9 lb per feeding.

In 2010, daily gain and gain/a were 1.75 and 294 lb, respectively, for heifers supplemented daily and 1.76 and 295 lb, respectively, for heifers supplemented three times per week. Total DDG consumption and average daily DDG consumption were 485 and 2.9 lb, respectively, for heifers supplemented daily and 478 and 2.8 lb, respectively, for heifers supplemented three times per week. Heifers supplemented three times per week were fed an average of 6.5 lb per feeding.

In 2011, daily gain and gain/a were 1.84 and 311 lb, respectively, for heifers supplemented daily and 1.82 and 307 lb, respectively, for heifers supplemented three times per week. Total DDG consumption and average daily DDG consumption were 477 and 2.8 lb, respectively, for heifers supplemented daily and 470 and 2.8 lb, respectively, for heifers supplemented three times per week. Heifers supplemented three times per week were fed an average of 6.5 lb per feeding.

In 2012, daily gain and gain/a were 1.86 and 237 lb, respectively, for heifers supplemented daily and 1.74 and 220 lb, respectively, for heifers supplemented three times per week. Total DDG consumption and average daily DDG consumption were 349 and 2.1 lb, respectively, for heifers supplemented daily and 351 and 2.1 lb, respectively, for heifers supplemented three times per week. Heifers supplemented three times per week were fed an average of 4.9 lb per feeding.

In 2013, daily gain and gain/a were 1.83 and 259 lb, respectively, for heifers supplemented daily and 1.73 and 244 lb, respectively, for heifers supplemented three times per week. Total DDG consumption and average daily DDG consumption were 418 and 3.0 lb, respectively, for heifers supplemented daily and 415 and 2.9 lb, respectively, for heifers supplemented three times per week. Heifers supplemented three times per week were fed an average of 6.8 lb per feeding.

Stocker cattle can be fed DDG three times per week rather than daily without any adverse effects on performance. Caution should be used, however, when feeding greater than the equivalent of 0.5% per head daily fewer than seven days per week to avoid potential sulfur toxicity problems.

Table 1. Effects of frequency of dried distillers grains (DDG) supplementation on gains of heifer calves grazing smooth bromegrass pastures, Southeast Agricultural Research Center, 2009

	Supplementation frequency	
Item	Daily	Three times per week
No. of days	192	192
No. of head	14	15
Initial weight, lb	420	420
Final weight, lb	782	779
Gain, lb	362	359
Daily gain, lb	1.89	1.87
Gain/a, lb	362	359
Total DDG consumption, lb/head	561	566
Average DDG consumption, lb/head per day	2.9	3.0

Table 2. Effects of frequency of dried distillers grains (DDG) supplementation on gains of heifer calves grazing smooth bromegrass pastures, Southeast Agricultural Research Center, 2010

	Supplementation frequency	
Item	Daily	Three times per week
No. of days	168	168
No. of head	15	15
Initial weight, lb	422	422
Final weight, lb	716	717
Gain, lb	294	295
Daily gain, lb	1.75	1.76
Gain/a, lb	294	295
Total DDG consumption, lb/head	485	478
Average DDG consumption, lb/head per day	2.9	2.8

Table 3. Effects of frequency of dried distillers grains (DDG) supplementation on gains of heifer calves grazing smooth bromegrass pastures, Southeast Agricultural Research Center, 2011

	Supplementation frequency	
Item	Daily	Three times per week
No. of days	169	169
No. of head	14	15
Initial weight, lb	409	403
Final weight, lb	720	710
Gain, lb	311	307
Daily gain, lb	1.84	1.82
Gain/a, lb	311	307
Total DDG consumption, lb/head	477	470
Average DDG consumption, lb/head per day	2.8	2.8

Table 4. Effects of frequency of dried distillers grains (DDG) supplementation on gains of heifer calves grazing smooth bromegrass pastures, Southeast Agricultural Research Center, 2012

	Supplementation frequency	
Item	Daily	Three times per week
No. of days	127	127
No. of head	14	15
Initial weight, lb	451	443
Final weight, lb	688	663
Gain, lb	237	220
Daily gain, lb	1.86	1.74
Gain/a, lb	237	220
Total DDG consumption, lb/head	349	351
Average DDG consumption, lb/head per day	2.1	2.1

Table 5. Effects of frequency of dried distillers grains (DDG) supplementation on gains of heifer calves grazing smooth bromegrass pastures, Southeast Agricultural Research Center, 2013

	Supplementation frequency	
Item	Daily	Three times per week
No. of days	141	141
No. of head	15	15
Initial weight, lb	454	454
Final weight, lb	713	698
Gain, lb	259	244
Daily gain, lb	1.83	1.73
Gain/a, lb	259	244
Total DDG consumption, lb/head	418	415
Average DDG consumption, lb/head per day	3.0	2.9

Distillers Grains Supplementation Strategy for Grazing Stocker Cattle

L.W. Lomas and J.L. Moyer

Summary

A total of 216 steers grazing smooth bromegrass pastures were used to evaluate the effects of distillers grains supplementation strategy on available forage, grazing gains, subsequent finishing gains, and carcass characteristics in 2008, 2009, 2010, 2011, 2012, and 2013. Supplementation treatments evaluated were no supplement, dried distillers grains (DDG) at 0.5% of body weight per head daily during the entire grazing phase, and no supplementation during the first 56 days and DDG at 0.5% of body weight per head daily during the remainder of the grazing phase.

Supplementation with DDG during the entire grazing phase or only during the latter part of the grazing phase resulted in higher ($P < 0.05$) grazing gains than feeding no supplement. Steers on the delayed supplementation treatment consumed less DDG, but had gains ($P > 0.05$) similar to those supplemented during the entire grazing phase. Supplementation during the grazing phase had no effect ($P > 0.05$) on finishing performance in 2008, 2010, 2011, 2012, or 2013. In 2009, steers that received no supplementation during the grazing phase had greater ($P < 0.05$) finishing gains than those supplemented during the entire grazing phase and lower ($P < 0.05$) feed:gain ratios than steers that were supplemented with DDG while grazing. Steers supplemented with DDG in 2010 and 2013 had greater ($P > 0.05$) overall gains than those that received no supplement during the grazing phase.

Introduction

Distillers grains are a by-product of the ethanol industry and have tremendous potential as an economical and nutritious supplement for grazing cattle. Because the co-products generally have high concentrations of protein and phosphorus, their nutrient composition complements that of mature forages, which are typically deficient in these nutrients. Previous research at this location evaluating DDG supplementation of stocker cattle grazing smooth bromegrass has shown DDG at 0.5% of body weight per head daily to be the most efficacious level from both an animal performance and economic perspective. This research was conducted to evaluate DDG supplementation strategies that might increase the efficiency of supplement conversion by delaying supplementation until later in the grazing season, when forage quality starts to decline.

Experimental Procedures

Thirty-six steers of predominately Angus breeding were weighed on two consecutive days, stratified by weight, and randomly allotted to nine 5-acre smooth bromegrass pastures on April 9, 2008 (450 lb); April 3, 2009 (467 lb); March 30, 2010 (448 lb); April 5, 2011 (468 lb); April 3, 2012 (489 lb); and April 16, 2013 (502 lb). Three pastures of steers were randomly assigned to 1 of 3 supplementation treatments (3 replicates per treatment) and were grazed for 196 days, 221 days, 224 days, 199 days, 142 days, and 195 days in 2008, 2009, 2010, 2011, 2012, and 2013, respectively.

Supplementation treatments were no supplement, DDG at 0.5% of body weight per head daily, and no DDG during the first 56 days of grazing then DDG at 0.5% of body weight per head daily for the remainder of the grazing phase (140 days, 165 days, 168 days, 143 days, 86 days, and 139 days in 2008, 2009, 2010, 2011, 2012, and 2013, respectively). Pastures were fertilized with 100 lb/a nitrogen (N) on February 29, 2008; February 10, 2009; February 18, 2010; April 6, 2011; February 1, 2012; and March 8, 2013. Pastures were stocked with 0.8 steers/a and grazed continuously until October 22, 2008; November 10, 2009; November 9, 2010; October 21, 2011; August 23, 2012; and October 28, 2013, when steers were weighed on two consecutive days and grazing was terminated.

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

Forage availability was measured approximately every 28 days with a disk meter calibrated for smooth bromegrass.

After the grazing period, cattle were shipped to a finishing facility, implanted with Synovex-S (Zoetis, Madison, NJ), and fed a diet of 80% whole-shelled corn, 15% corn silage, and 5% supplement (dry matter basis) for 112 days in 2008 and 2009, for 100 days in 2010, for 110 days in 2011, for 127 days in 2012, and for 112 days in 2013. All cattle were slaughtered in a commercial facility at the end of the finishing period, and carcass data were collected.

Results and Discussion

Average available forage for the smooth bromegrass pastures during the grazing phase and grazing and subsequent finishing performance of grazing steers are presented by supplementation treatment in Tables 1, 2, 3, 4, 5, and 6 for 2008, 2009, 2010, 2011, 2012, and 2013, respectively. Supplementation with DDG had no effect ($P > 0.05$) on quantity of forage available for grazing in the first five years; however, in 2013, pastures grazed by steers supplemented with DDG had greater ($P < 0.05$) available DM than pastures grazed by unsupplemented control steers. Pastures grazed by supplemented steers would be expected to have greater available forage DM because consumption of DDG by steers grazing these pastures would likely reduce forage intake, thereby resulting in more residual forage. Average available forage was higher for all treatments in 2008 than in any of the other years.

Steers supplemented with 0.5% DDG during the entire grazing season or only during the latter part of the grazing season had greater ($P < 0.05$) weight gain, daily gain, and steer gain/a during each year than those that received no supplement. Supplementation with either system resulted in an average of 0.5 lb greater average daily gain over those that received no supplement. Grazing weight gain, daily gain, and gain/a were not different ($P > 0.05$) between steers that were supplemented with 0.5% DDG during the entire grazing season or only during the latter part of the season. Steers supplemented with DDG at 0.5% of body weight per head daily during the entire grazing season consumed 155, 142, 128, 132, 151, and 173 lb more DDG in 2008, 2009, 2010, 2011, 2012, and 2013, respectively, than those that were supplemented only during the latter part of the grazing season. In general, steers supplemented with DDG only during the latter part of the grazing season consumed approximately 20% less DDG but had grazing gains similar to ($P > 0.05$) those supplemented during the entire grazing season. In 2008, supplementation during the grazing phase had no effect ($P > 0.05$) on finishing weight gain, feed intake, feed:gain, hot carcass weight, backfat, ribeye area, yield grade, or marbling score. Overall performance (grazing plus finishing) did not differ ($P > 0.05$) between supplementation treatments.

In 2009, steers that received no supplement during the grazing phase had greater ($P < 0.05$) finishing gains than those that were supplemented with DDG during the entire grazing season; lower ($P < 0.05$) final live weight, hot carcass weight, and overall gain than those that received DDG only during the latter part of the grazing season; and lower ($P < 0.05$) feed:gain ratios, dressing percentage, and ribeye areas than steers that received either DDG supplementation treatment. Feed intake, backfat, yield grade, marbling score, and percentage of carcasses grading choice or higher did not differ ($P > 0.05$) between supplementation treatments.

In 2010, supplementation during the grazing phase had no effect ($P > 0.05$) on finishing gains, dry matter intake, or feed:gain, but steers supplemented with DDG during the grazing phase had greater ($P < 0.05$) final live weight, hot carcass weight, and overall daily gain than those that received no supplement during the grazing phase.

In 2011, supplementation during the grazing phase had no effect ($P > 0.05$) on finishing gains, feed:gain, or carcass characteristics. Steers that received no supplementation during the grazing phase had lower ($P < 0.05$) final live weight, hot carcass weight, finishing feed intake, and overall live weight gain than those that were supplemented during the grazing phase.

In 2012, supplementation during the grazing phase had no effect ($P > 0.05$) on finishing gains or feed:gain. Steers that were supplemented during the entire grazing phase had greater ($P < 0.05$) ribeye area than those that received no supplement. No other differences in carcass characteristics were observed.

In 2013, supplementation during the grazing phase had no effect ($P > 0.05$) on finishing gains, dry matter intake, or feed:gain, but steers supplemented with DDG during the grazing phase had greater ($P < 0.05$) final live weight, hot carcass weight, overall gain, and overall daily gain than those that received no supplement during the grazing phase.

Under the conditions of this study, supplementation of stocker cattle grazing smooth bromegrass pasture with DDG at 0.5% of body weight only during the latter part of the grazing season would likely have been the most profitable treatment if the cattle had been marketed as feeder cattle at the end of the grazing phase. Delaying supplementation until early June reduced labor requirements for the first 56 days of the grazing phase, when cattle received no supplement, but resulted in grazing gains similar to those supplemented during the entire grazing phase. In 2008 and 2012, DDG supplementation during the grazing phase carried no advantage if ownership of the cattle was retained through slaughter. In 2009, 2010, 2011, and 2013, however, stocker cattle that were supplemented with DDG during the grazing phase maintained their weight advantage through slaughter. Cattle grazed for a shorter duration in 2012 than in other years due to forage availability being limited due to below normal precipitation; therefore, weight gain from grazing represented a smaller percentage and weight gain from finishing a greater percentage of overall gain than in other years.

Table 1. Effects of dried distillers grains (DDG) supplementation strategy on available smooth bromegrass forage and grazing and subsequent finishing performance of steers grazing smooth bromegrass pastures, Southeast Agricultural Research Center, 2008

	Level of DDG (% body weight/head per day)		
Item	0	0.5	0.5 delayed[1, 2]
Grazing phase (196 days)			
No. of head	12	12	12
Initial weight, lb	450	450	450
Final weight, lb	772a	871b	846b
Gain, lb	321a	421b	396b
Daily gain, lb	1.64a	2.15b	2.02b
Gain/a, lb	257a	337b	317b
Total DDG consumption, lb/head	0	651	496
Average DDG consumption, lb/head per day	0	3.3	3.5
DDG, lb/additional gain	---	6.5	6.6
Average available smooth bromegrass forage, lb of dry matter/a	9,264	9,020	9,240
Finishing phase (112 days)			
Beginning weight, lb	772a	871b	846b
Ending weight, lb	1,306	1,369	1,357
Gain, lb	535	498	511
Daily gain, lb	4.77	4.44	4.56
Daily dry matter intake, lb	26.0	25.8	25.7
Feed:gain	5.46	5.83	5.64
Hot carcass weight, lb	764	821	813
Dressing percentage	58	60	60
Backfat, in.	0.43	0.45	0.41
Ribeye area, sq. in.	11.1	11.6	11.5
Yield grade	3.2	2.9	2.8
Marbling score[3]	675	645	640
Percentage USDA grade choice	100	100	100
Overall performance (grazing plus finishing; 308 days)			
Gain, lb	856	918	907
Daily gain, lb	2.78	2.98	2.94

[1] Steers were supplemented with DDG only during the last 140 days of the grazing phase.

[2] Means within a row followed by the same letter are not significantly different ($P < 0.05$).

[3] 600 = modest, 700 = moderate.

Table 2. Effects of dried distillers grains (DDG) supplementation strategy on available smooth bromegrass forage and grazing and subsequent finishing performance of steers grazing smooth bromegrass pastures, Southeast Agricultural Research Center, 2009

	Level of DDG (% body weight/head per day)		
Item	0	0.5	0.5 delayed[1, 2]
Grazing phase (221 days)			
No. of head	12	12	12
Initial weight, lb	467	467	467
Final weight, lb	792a	927b	922b
Gain, lb	325a	460b	454b
Daily gain, lb	1.47a	2.08b	2.06b
Gain/a, lb	260a	368b	364b
Total DDG consumption, lb/head	0	773	631
Average DDG consumption, lb/head per day	0	3.5	2.9
DDG, lb/additional gain	---	5.7	4.9
Average available smooth bromegrass forage, lb of dry matter/a	5,109	5,110	5,212
Finishing phase (112 days)			
Beginning weight, lb	792a	927b	922b
Ending weight, lb	1,230a	1,280ab	1,304b
Gain, lb	438a	353b	383ab
Daily gain, lb	3.91a	3.15b	3.42ab
Daily dry matter intake, lb	23.9	23.7	24.7
Feed:gain	6.13a	7.56b	7.25b
Hot carcass weight, lb	734a	781ab	799b
Dressing percentage	60a	61b	61b
Backfat, in.	0.36	0.36	0.41
Ribeye area, sq. in.	10.8a	11.9b	11.8b
Yield grade	2.8	2.7	2.9
Marbling score[3]	629	638	670
Percentage USDA grade choice	92	92	100
Overall performance (grazing plus finishing; 333 days)			
Gain, lb	763a	813ab	838b
Daily gain, lb	2.29a	2.44ab	2.52b

[1] Steers were supplemented with DDG only during the last 165 days of the grazing phase.

[2] Means within a row followed by the same letter are not significantly different ($P < 0.05$).

[3] 600 = modest, 700 = moderate.

Table 3. Effects of dried distillers grains (DDG) supplementation strategy on available smooth bromegrass forage and grazing and subsequent finishing performance of steers grazing smooth bromegrass pastures, Southeast Agricultural Research Center, 2010

	Level of DDG (% body weight/head per day)		
Item	0	0.5	0.5 delayed[1, 2]
Grazing phase (224 days)			
No. of head	12	12	12
Initial weight, lb	448	448	448
Final weight, lb	791a	880b	894b
Gain, lb	343a	431b	446b
Daily gain, lb	1.53a	1.93b	1.99b
Gain/a, lb	275a	345b	357b
Total DDG consumption, lb/head	0	758	630
Average DDG consumption, lb/head per day	0	3.4	2.8
DDG, lb/additional gain	---	8.6	6.1
Average available smooth bromegrass forage, lb of dry matter/a	6,382	6,364	6,477
Finishing phase (100 days)			
Beginning weight, lb	791a	880b	894b
Ending weight, lb	1,228a	1,319b	1,318b
Gain, lb	436	439	424
Daily gain, lb	4.36	4.39	4.24
Daily dry matter intake, lb	23.6	26.1	24.7
Feed:gain	5.41	5.94	5.82
Hot carcass weight, lb	725a	772b	779b
Dressing percentage	59.1	58.5	59.1
Backfat, in.	0.34	0.35	0.41
Ribeye area, sq. in.	11.0	11.3	11.7
Yield grade	2.7	2.8	2.9
Marbling score[3]	565	600	610
Percentage USDA grade choice	100	92	100
Overall performance (grazing plus finishing; 324 days)			
Gain, lb	780a	871b	870b
Daily gain, lb	2.41a	2.69b	2.69b

[1] Steers were supplemented with DDG only during the last 168 days of the grazing phase.

[2] Means within a row followed by the same letter are not significantly different ($P < 0.05$).

[3] 500 = small, 600 = modest, 700 = moderate.

Table 4. Effects of dried distillers grains (DDG) supplementation strategy on available smooth bromegrass forage and grazing and subsequent finishing performance of steers grazing smooth bromegrass pastures, Southeast Agricultural Research Center, 2011

	Level of DDG (% body weight/head per day)		
Item	0	0.5	0.5 delayed[1,2]
Grazing phase (199 days)			
No. of head	12	12	12
Initial weight, lb	468	468	468
Final weight, lb	725a	814b	833b
Gain, lb	257a	346b	365b
Daily gain, lb	1.29a	1.74b	1.83b
Gain/a, lb	206a	277b	292b
Total DDG consumption, lb/head	0	658	526
Average DDG consumption, lb/head per day	0	3.3	2.6
DDG, lb/additional gain	---	7.4	4.9
Average available smooth bromegrass forage, lb of dry matter/a	5,203	5,273	5,236
Finishing phase (110 days)			
Beginning weight, lb	725a	814b	833b
Ending weight, lb	1,250a	1,325b	1,349b
Gain, lb	525	511	516
Daily gain, lb	4.77	4.64	4.69
Daily dry matter intake, lb	25.2a	26.7b	26.6b
Feed:gain	5.28	5.76	5.67
Hot carcass weight, lb	731a	780ab	788b
Dressing percentage	58.5	58.9	58.5
Backfat, in.	0.39	0.41	0.40
Ribeye area, sq. in.	11.6	11.7	12.4
Yield grade	2.8	2.8	2.5
Marbling score[3]	653	605	636
Percentage USDA grade choice	100	92	92
Overall performance (grazing plus finishing; 309 days)			
Gain, lb	782a	857ab	881b
Daily gain, lb	2.53a	2.77ab	2.85b

[1] Steers were supplemented with DDG only during the last 143 days of the grazing phase.

[2] Means within a row followed by the same letter are not significantly different ($P < 0.05$).

[3] 600 = modest, 700 = moderate.

Table 5. Effects of dried distillers grains (DDG) supplementation strategy on available smooth bromegrass forage and grazing and subsequent finishing performance of steers grazing smooth bromegrass pastures, Southeast Agricultural Research Center, 2012

	Level of DDG (% body weight/head per day)		
Item	0	0.5	0.5 delayed[1, 2]
Grazing phase (142 days)			
No. of head	12	12	12
Initial weight, lb	489	489	490
Final weight, lb	671a	753b	749b
Gain, lb	182a	264b	260b
Daily gain, lb	1.28a	1.86b	1.83b
Gain/a, lb	145a	211b	208b
Total DDG consumption, lb/head	0	441	290
Average DDG consumption, lb/head per day	0	3.1	2.0
DDG, lb/additional gain	---	5.4	3.7
Average available smooth bromegrass forage, lb of dry matter/a	6,437	6,575	6,519
Finishing phase (127 days)			
Beginning weight, lb	671a	753b	749b
Ending weight, lb	1,217	1,294	1,291
Gain, lb	546	541	541
Daily gain, lb	4.30	4.26	4.26
Daily dry matter intake, lb	25.9	26.1	25.4
Feed:gain	6.03	6.14	5.95
Hot carcass weight, lb	755	802	800
Backfat, in.	0.38	0.40	0.42
Ribeye area, sq. in.	11.8a	12.6b	12.3ab
Yield grade	2.5	2.4	2.7
Marbling score[3]	537	582	553
Percentage USDA grade choice	83	69	92
Overall performance (grazing plus finishing; 269 days)			
Gain, lb	728	804	801
Daily gain, lb	2.71	2.99	2.98

[1] Steers were supplemented with DDG only during the last 86 days of the grazing phase.

[2] Means within a row followed by the same letter are not significantly different ($P < 0.05$).

[3] 500 = small, 600 = modest.

Table 6. Effects of dried distillers grains (DDG) supplementation strategy on available smooth bromegrass forage and grazing and subsequent finishing performance of steers grazing smooth bromegrass pastures, Southeast Agricultural Research Center, 2013

	Level of DDG (% body weight/head per day)		
Item	0	0.5	0.5 delayed[1, 2]
Grazing phase (195 days)			
No. of head	12	12	12
Initial weight, lb	502	503	502
Final weight, lb	796a	882b	864b
Gain, lb	294a	379b	362b
Daily gain, lb	1.50a	1.93b	1.85b
Gain/a, lb	235a	303b	289b
Total DDG consumption, lb/head	0	686	513
Average DDG consumption, lb/head per day	0	3.5	2.6
DDG, lb/additional gain	---	8.1	7.5
Average available smooth bromegrass forage, lb of dry matter/a	6,270a	6,390b	6,496c
Finishing phase (112 days)			
Beginning weight, lb	796a	882b	864b
Ending weight, lb	1,318a	1,373b	1,354b
Gain, lb	521	491	490
Daily gain, lb	4.66	4.38	4.37
Daily dry matter intake, lb	26.7	24.9	24.9
Feed:gain	5.74	5.69	5.70
Hot carcass weight, lb	817a	851b	839b
Backfat, in.	0.42	0.36	0.44
Ribeye area, sq. in.	12.3a	13.1b	12.3a
Yield grade	2.7	2.5	2.8
Marbling score[3]	675a	600b	638ab
Percentage USDA grade choice	100	100	100
Overall performance (grazing plus finishing; 307 days)			
Gain, lb	815a	870b	851b
Daily gain, lb	2.65a	2.83b	2.76b

[1] Steers were supplemented with DDG only during the last 140 days of the grazing phase.

[2] Means within a row followed by the same letter are not significantly different ($P < 0.05$).

[3] 600 = modest, 700 = moderate.

Use of Legumes in Wheat-Bermudagrass Pastures

J.L. Moyer and L.W. Lomas

Summary

Using legumes in lieu of 100 lb/a of nitrogen (N) for wheat-bermudagrass pastures has previously maintained spring and summer cow gains. A winter legume could further increase N available for summer bermudagrass production, so Austrian winter fieldpea as well as wheat were interseeded in fall to supplement summer clover production in bermudagrass. Forage production and estimated forage crude protein (CP) during the wheat phase of 2013 pasture production were higher where more N was applied. Later in the season, legumes in the pasture maintained similar production as the other pastures but resulted in higher CP concentration. Cow performance over the season was increased 20% where legumes were used in lieu of higher N fertilization.

Introduction

Bermudagrass is a productive forage species when intensively managed; however, it has periods of dormancy and requires proper management to maintain forage quality. Bermudagrass also requires adequate N fertilizer to optimize forage yield and quality. Interseeding wheat or other small grains can lengthen the grazing season, but this requires additional N fertilization. Legumes in the bermudagrass sward could improve forage quality and reduce fertilizer usage, but legumes are difficult to establish and maintain with the competitive grass. Clovers can maintain summer survival once established in bermudagrass sod and may be productive enough to substitute for some N fertilization. Including a winter annual legume with wheat could produce more N and forage CP. This study was designed to compare dry cow performance on a wheat-bermudagrass pasture system that included spring and summer legume with a single 50 lb/a N application (Legumes) vs. wheat-bermudagrass with additional N applications of 100 lb/a and no legumes (Nitrogen).

Experimental Procedures

Eight 5-acre 'Hardie' bermudagrass pastures that were interseeded with wheat at the Mound Valley Unit of the Southeast Agricultural Research Center (Parsons silt loam soil) were assigned to Legume or Nitrogen treatments in a completely randomized design with four replications.

All pastures were interseeded (no-till) with 'Everest' wheat (90 lb/a) into the bermudagrass sod on September 19, 2012, and the four designated pastures were interseeded with Austrian winter fieldpeas (40 lb/a) on September 20. Legume pastures received additional red clover (8 lb/a) and ladino clover (3 lb/a) by broadcast on March 7, 2013. Pastures that received no legumes (Nitrogen) were fertilized with 46 lb/a N as urea each on February 5, and 50 lb/a N on May 14, 2013. All pastures received 45-26-27 of N-P_2O_5-K_2O on July 2.

Thirty-two pregnant fall-calving cows of predominantly Angus breeding were weighed on consecutive days and assigned randomly by weight to pastures on April 10. On July 23, cows were weighed again on consecutive days and removed from the pastures.

Available forage and forage CP, as estimated by the normalized difference vegetation index (NDVI) and available forage, were monitored monthly during grazing with an automated rising plate meter and GreenSeeker (Trimble, Sunnyvale, CA) instrument.

Results and Discussion

Available forage is plotted by date (Figure 1). Means of available forage were different ($P < 0.05$) for the Legume and the Nitrogen systems overall as well as at each sampling time. However, there was an interaction between system and time of sampling, because the Nitrogen system had more forage through early June, but the systems had similar amounts of forage from July 1 through the end of grazing. Much of the advantage of the Nitrogen treatment occurred in April when the primary forage was wheat, but by the early June sampling, the forage was primarily bermudagrass. By July 1, the amount of available forage had declined in both treatments, largely because of summer drought.

Estimated CP concentration followed a trend similar to that of available forage in the first two samplings, likely as a result of the effect of Nitrogen on the wheat (Figure 1). By early June, however, the Legume system showed higher NDVI readings than the Nitrogen system, likely because of the presence of legumes that contain more protein.

Data for cow performance are in Table 1. Gains during the 2013 season were greater for the Legume than the Nitrogen system (Table 1, $P = 0.05$), increasing gain by an average 20%.

Table 1. Performance of cows grazing wheat-bermudagrass pastures interseeded with wheat and fertilized with nitrogen or interseeded with legumes, Mound Valley Unit, Southeast Agricultural Research Center, 2013

	Management system	
Item	Nitrogen[1]	Legumes
No. of cows	16	16
No. of days	104	104
Stocking rate, cows/a	0.8	0.8
Cow initial weight, lb	1,261	1,261
Cow final weight, lb	1,468a[2]	1,510b
Cow gain, lb	207a	249b
Cow daily gain, lb	1.99a	2.40b
Cow gain, lb/a	259	312

[1] Fertilized with ~50 lb/a of N in February and May; both treatments received 45 lb N/a, along with P and K, on July 2.

[2] Means within a row followed by a different letter were significantly different at $P = 0.05$.

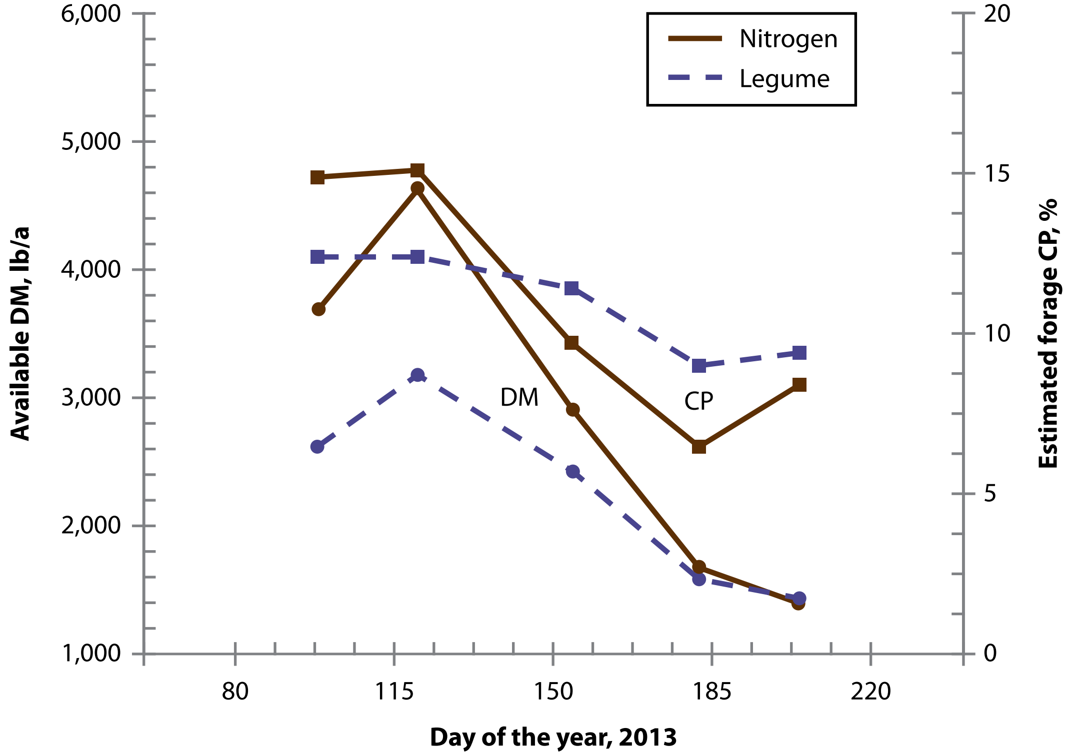

Figure 1. Available forage dry matter (DM) and estimated crude protein (CP) concentration during the grazing season in wheat-bermudagrass pastures fertilized with nitrogen or interseeded with legumes, Mound Valley Unit, Southeast Agricultural Research Center, 2013.

Alfalfa Variety Performance in Southeastern Kansas[1]

J.L. Moyer

Summary

A 16-line alfalfa test was seeded in 2010 and cut twice in 2013 before much of the plot area "drowned out." Yield from those two cuts of 'Vernal' totaled less than that from 10 higher-yielding entries, but there was no real difference among the other 15 entries. Four-year total yield was greater from 'FSG639ST' than from the eight below-average cultivars. Conversely, total yield from 'DKA50-18' was less than the eight cultivars that yielded above the average.

Introduction

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

Experimental Procedures

A 16-line alfalfa test with four replications was seeded (15 lb/a) on April 12, 2010, at the Mound Valley Unit of the Southeast Agricultural Research Center (Parsons silt loam). Plots were fertilized with 20-50-200 lb/a N-P_2O_5-K_2O each year.

Weevil larvae appeared in early April, so plots were sprayed with 1.5 pt/a of Lorsban on April 9. Blister beetle swarms that occurred in midsummer prompted spraying with Warrior (Syngenta Crop Protection, Inc., Greensboro, NC) on July 2 and Stallion (FMC Corp., Philadelphia, PA) on August 2 in plots and the surrounding area.

Cool, wet weather in May delayed the first cutting. After the second cutting, we suffered a period of drought (see annual weather summary, pages 95 and 96). Heavy rains that occurred in late July and early August caused saturated soil conditions that killed most plants in the less-elevated fourth and third replications and one end of the second replication, such that yields taken August 20 were not reported.

Results and Discussion

First-cut yields (at 10% bloom) were significantly greater ($P < 0.05$) for 'AmeriStand 403T+' than for three other entries (Table 1). Second-cut yields were greater for 'Archer III' and 'DG 4210' than for 'Vernal' and 'Kanza.'

Yields from the two cuttings obtained in 2013 for 'Vernal' totaled less than that from 10 higher-yielding entries. Total yield for three years was higher for 'FSG639ST' and 'Ameristand 407TQ' than for five other entries.

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[1] Statewide alfalfa performance test results can be found at http://www.agronomy.k-state.edu/services/crop-performance-tests/alfalfa/index.html

Total yield from the shortened four years was greater from 'FSG639ST' than from the eight below-average cultivars. Conversely, total yield from 'DKA50-18' was less than that of the eight cultivars that yielded above the average. The five best-yielding entries, including 'Perry,' yielded more than the five lowest-yielding entries.

Table 1. Forage yields (tons/a at 12% moisture) for 2013, and four-year total for the alfalfa variety test seeded in 2010, Mound Valley Unit

		2013						4-yr.
Source	Entry	May 17	June 19	Total	2010	2011	2012	total
		-------------------- Tons/a, 12% moisture --------------------						
America's Alfalfa	AmeriStand 403T+	2.25	1.84	4.09	3.86	5.65	4.27	17.87
America's Alfalfa	AmeriStand 407TQ	2.06	1.93	3.99	4.04	5.58	4.34	17.95
America's Alfalfa	Archer III	2.09	2.01	4.11	3.72	5.03	3.75	16.60
Allied	FSG505 Bt	2.14	1.95	4.08	3.84	5.52	4.18	17.62
Allied	FSG408DP Bt	2.23	1.91	4.14	4.18	5.29	4.34	17.94
Allied	FSG639ST Bt	2.13	1.94	4.07	4.25	5.67	4.31	18.29
CPS	DG 4210	2.14	2.00	4.15	3.50	5.00	3.77	16.44
Farm Science Genetics	FSG 528SF	2.14	1.82	3.96	3.65	5.48	3.88	16.97
Garst Seed	6552	2.04	1.93	3.97	3.63	5.00	3.93	16.52
Monsanto Seed	DKA50-18	2.08	1.93	4.01	3.35	4.90	3.98	16.23
Syngenta	6422Q	2.10	1.97	4.06	3.76	5.24	3.95	17.00
W-L Research	WL 343 HQ	2.19	1.89	4.08	3.36	5.25	4.04	16.72
W-L Research	WL 363 HQ	2.02	1.89	3.90	3.97	5.13	4.18	17.18
Kansas AES[1] and USDA	Kanza	2.14	1.80	3.93	4.18	5.50	3.99	17.61
Nebraska AES and USDA	Perry	2.12	1.85	3.97	4.08	5.50	4.31	17.86
Wisconsin AES and USDA	Vernal	1.98	1.70	3.68	3.87	5.63	4.21	17.39
Average		2.11	1.90	4.01	3.83	5.33	4.09	17.26
LSD (0.05)		0.21	0.16	0.26	0.41	0.49	0.36	1.07

[1] Agricultural Experiment Station.

Evaluation of Tall Fescue Cultivars

J.L. Moyer

Summary

Spring 2013 yield was higher for 'Texoma MaxQ II' than for seven of the 17 other entries. Fall production was greater for 'AGRFA-111' and 'AGRFA-179' than for 11 other entries. Total 2013 production was higher for 'Texoma MaxQ II' than for 'AGRFA-179'. Total 3-year forage production was greater for 'Texoma MaxQ II' and 'Martin 2 647' than for the seven entries that were below average.

Introduction

Tall fescue (*Lolium arundinacium* Schreb.) is the most widely grown forage grass in southeastern Kansas. Its tolerance to extremes in climate and soils of the region is partly attributable to its association with a fungal endophyte, *Neotyphodium coenophialum*; however, most ubiquitous endophytes are also responsible for production of substances toxic to some herbivores, including cattle, sheep, and horses. Endophytes that purportedly lack toxins but augment plant vigor have been identified and inserted into tall fescue cultivars adapted to the United States. These cultivars, and others that are fungus-free or contain a ubiquitous endophyte, are included in this test.

Experimental Procedures

The trial was seeded at the Mound Valley Unit of the Southeast Agricultural Research Center in 10-in. rows on Parsons silt loam soil. Plots were 50 ft × 5 ft and were arranged in four randomized complete blocks. They were fertilized preplant with 20-50-60 lb/a of N-P_2O_5-K_2O and seeded with 20 lb/a of pure, live seed on September 22, 2010. Spring fertilizer (120-60-60 lb/a of N-P_2O_5-K_2O) was applied on February 20, 2013. Fall growth was supplemented with 55 lb/a of nitrogen on September 26.

Date of heading for the majority of each plot was noted, and harvest was performed on a 3-ft-wide and 15- to 20-ft-long strip from each plot. A flail-type harvester was used to cut to a 3-in. height after bloom. After harvest, forage was removed from the rest of the plot at the same height. A forage subsample was collected from each plot and dried at 140°F for moisture determination. Regrowth that occurred in fall was harvested on December 2, 2013.

Results and Discussion

Heading dates in 2013 were similar to those in 2011, but about three weeks later than those in 2012. In 2013, 'Bar Elite,' 'Barianne,' and 'AGRFA-111' headed later ($P < 0.05$) than 12 of the other entries. In 2013, 'AU Triumph' and 'Drover' were earlier than all other entries except 'Jesup MaxQ' and 'Martin 2 647,' consistent with trends of previous years. Again this year, we found no correlation between heading date and any yield parameters but an expected negative correlation ($P < 0.01$) of forage yield and dry matter content of the first harvest (data not shown).

Spring forage yield was greater ($P < 0.05$) for 'Texoma MaxQ II' than for seven of the 17 other entries. It and 'Bardurum' yielded more than 'AGRFA 179,' 'AGRFA 111,' and 'BarOptima PLUS E34.' Forage production during the rest of the season (June 10 through December 2), primarily late fall production, was greater for 'AGRFA 111' than for 14 other entries. It and 'AGRFA-179' yielded more than 11 other entries. 'Bariane' yielded less in fall than all but four other low-yielding entries. Total 2013 production was higher for 'Texoma MaxQ II' than for 'AGRFA-179.'

Total three-year forage production was greater for 'Texoma MaxQ II' and 'Martin 2 647' than for the seven entries that were below-average. Yields of 'Bariane' and 'AGRFA-179' were less than those of the five highest-yielding entries.

Table 1. 2013 heading date, and forage yields of tall fescue cultivars seeded in 2010, Mound Valley Unit

		Forage yield					
Cultivar	Heading date[1]	June 10, 2013	Dec. 2, 2013	2013 total	2012 total	2011 total	3-yr. total
	(Julian)	---------------- Tons/a, 12% moisture ----------------					
BarOptima PLUS E34	138	3.92	1.20	5.11	3.80	4.33	13.24
Bar Elite	141	4.14	1.04	5.18	3.93	4.08	13.19
Bardurum	137	4.52	1.18	5.70	3.99	4.26	13.95
Drover	127	4.06	1.24	5.30	4.52	4.12	13.94
BAR FA 70DH	133	4.20	1.19	5.39	4.20	4.39	13.98
BAR FA 80DH	132	4.32	1.40	5.72	4.22	4.22	14.17
Bariane	139	4.39	0.91	5.29	3.70	3.97	12.96
DuraMax GOLD	132	4.13	1.08	5.21	4.22	4.68	14.11
Martin 2 647	130	4.37	1.28	5.65	4.64	4.86	15.15
AGRFA 111	139	3.89	1.56	5.44	3.95	3.91	13.31
AGRFA 177	137	4.37	1.29	5.66	4.29	4.43	14.37
AGRFA 178	138	4.02	1.19	5.21	4.12	4.32	13.66
AGRFA 179	137	3.47	1.52	4.99	3.83	4.18	12.99
Jesup MaxQ	130	4.33	1.14	5.47	4.53	4.56	14.56
Texoma MaxQ II	131	4.67	1.18	5.85	4.66	4.79	15.30
AU Triumph	124	4.19	1.25	5.44	4.54	4.27	14.26
Ky 31 HE	138	4.18	1.18	5.35	4.01	4.74	14.10
Ky 31 LE	136	4.15	1.10	5.25	4.07	4.37	13.69
Average	134	4.18	1.22	5.40	4.18	4.36	13.94
LSD (0.05)	3.2	0.52	0.27	0.75	0.54	0.43	1.25

[1] Average heading date; Julian day 134 was May 14.

Burning Dormant Alfalfa for Pest Control[1]

J.L. Moyer, R.J. Whitworth[2], and H. Davis[3]

Summary

The production of alfalfa is hampered by pests, particularly the alfalfa weevil. Using propane burners on dormant alfalfa can control some pests. Burning in late fall or early spring was performed at three intensities and compared with pesticide or no treatment to determine effects on weevil damage and weed density for four site-years. Alfalfa weevil damage was generally reduced by burning at high intensity. Winter annual broadleaf weeds' density was reduced by burning. Burning in early spring often gave better results than in late fall.

Introduction

Alfalfa is an important crop, particularly for types of livestock that require high-quality forage. It is also one of the more profitable dryland crops in Kansas and is useful for soil improvement in long-term rotations, particularly because of its ability to "fix" nitrogen.

Numerous pests infest alfalfa, but alfalfa weevil is one of the most damaging in Kansas. Its ability to defoliate early growth depletes energy reserves needed to maintain the plant, so it can reduce stand life if left unchecked. Insecticides usually provide the most economical control, but their use can eliminate natural control agents, sometimes allowing secondary pest outbreaks. Also, organic alfalfa production prohibits use of most effective insecticides.

Weevils primarily damage the first cutting, which often yields the most. Larvae hatched from eggs deposited in fall and warm winter periods are responsible for damage soon after growth has begun. Removing fall residue could reduce the number of larvae in the earliest hatches, delaying major damage until the first cutting can be taken. Late cutting or grazing sometimes reduced spring infestations, but results depend on timing and the height of the remaining stubble.

Burning alfalfa residue during dormancy has been listed as a pest control alternative for decades, but an external source for combustion is usually needed for clean stands. Burning has also been known to affect other pests, such as aphids, other insects, diseases, and weeds. One benefit to burning might be to replace separate treatments for weeds and/or other insects.

In this study, late fall or early spring burning was performed at three intensities using LP-gas, and compared with pesticide or no treatment. We determined treatment effects on weevil damage and weed density for four site-years.

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[1] The comprehensive report of this work was published in the American Journal of Plant Sciences at http://dx.doi.org/10.4236/ajps.2014.57104.

[2] Associate professor, Kansas State University Department of Entomology.

[3] Diagnostician, Kansas State University Department of Entomology.

Experimental Procedures

2011–2012

One of the two sets of plots used was near Mound Valley, KS, in a 5 year-old alfalfa stand on land operated by Steve Black. The same design was used in an established field near Emporia, KS. Treatments included three burning intensities, each performed in either late fall or early spring, comprising a 3 × 2 factorial. A positive, pesticide-treated check and an untreated (negative) check were included, for a total of eight treatments in each four replications, arranged as a randomized complete block with individual plots of 20 × 10 ft. We used four Model LT 2 x 8 burners from Flame Engineering (LaCrosse, KS), spaced at 1 ft and operated at 50 psi with burner tips about 3 in. off the ground.

Burned plots were fall treated on November 29 at Mound Valley and on November 15 at Emporia. In spring, burned plots were treated on February 27 at Mound Valley and on March 6 at Emporia. Intensity was varied by operating the burner at 2.1 mph for "low," 1.3 mph for "medium," and 1.1 mph for "high" intensity. The dry residue was removed at all intensities, but temperatures at the soil surface varied with intensity, as affected by air and crop conditions. On November 29 at Mound Valley, the air was still, with a temperature of 36°F, temperature at the soil surface reached about 50°, 130°, and 196°F for low, medium, and high intensity, respectively, measured with an Omega Type K high-temperature probe (Omega Engineering, Inc., Stamford, CT). At Emporia, soil surface temperatures were similar for the fall burning, despite warmer ambient air, because the air was also still. The next spring at Emporia, air temperature on March 6 was above 60°F, but winds of 30 mph with gusts over 35 mph kept soil surface temperatures lower. Soil temperature at the low burning intensity was about 77°F, but at the higher burning intensities, temperatures hardly exceeded 100°F.

Application of a dormant herbicide amounting to 2.5 lb/a of AlfaMax (54% diuron and 46% hexazinone; DuPont, Wilmington, DE) was made to the pesticide-treated check on January 4 at Mound Valley and on March 6 at Emporia. The treated checks were also sprayed at both locations on March 28 with 0.75 lb/a a.i. of chlorpyrifos, although the plots at Emporia were inadvertently sprayed by a custom applicator with insecticide more than a week earlier.

In 2012, weevil emergence began earlier than usual in eastern Kansas because of warmer than usual temperatures. At our Mound Valley Unit, average air temperatures were 5.4°, 3.1°, and 9.9°F above the 30-year average for January, February, and March 2012, respectively. Weevil larvae hatched one to two weeks earlier than average, and adults emerged to lay more eggs, causing a long period of infestation that forced many producers to spray more than once.

Visual ratings were made at both locations for weevil damage on a 0 to 5 scale, based on leaf damage, and weed density was similarly evaluated on March 28 at Emporia and April 3 at Mound Valley. The Mound Valley plots were cut for yield with a flail-type plot harvester on May 23 and subsampled for total forage dry matter and N concentration. No further data were collected at Emporia because all plots were sprayed with insecticide again in April.

Pure weed and alfalfa samples were collected at the Mound Valley harvest by replication and assayed along with each plot's total forage subsample. Dry matter and nitrogen (N) contents of weeds and alfalfa varied enough to calculate proportion of alfalfa in each plot using ratios of each (see Cooper et al., 1957, J. Agric. Sci. 49:190–193).

2012–2013

Both sets of plots were located in Labette County, KS, using the same location as the previous year for one set, with the same design for both. The other location was near Dennis, KS, on property owned by Brad Boss. Fall burning was performed on December 12 and spring burning on March 13 at both locations. Speeds were similar for the previous low and medium intensity burning, but for high intensity, a lower speed of 0.7 mph was used to increase the treatment's temperature. For the fall burning, soil surface temperatures were about 117°, 129°, and 208°F for low, medium, and high intensities, respectively. Air temperature approached 50°F in fall, but in spring daily maximum was 79°F. Then temperatures at the soil surface reached 156°, 183°, and 264°F for low, medium, and high intensities, respectively.

Pesticide-treated check plots were sprayed at Dennis for weed control with 1.0 lb/a a.i. of 2,4-DB and 0.3 lb/a a.i. of sethoxydim, with 0.5% non-ionic surfactant on March 20. At Dennis, the positive checks were sprayed for weevil control with 0.125 lb/a of Baythroid XL (Bayer CropScience, Research Triangle Park, NC) insecticide on April 9. At Mound Valley, the positive checks were sprayed with 0.45 lb/a a.i. of chlorpyrifos and 0.11kg/ha zeta-cypermethrin on April 9 for weevil control, then with 0.75 lb/a a.i. of glyphosate with 0.5% non-ionic surfactant for weed control, because it was a Roundup-Ready variety.

At the Mound Valley location, plots were evaluated for leaf damage as before on April 9 and 17 (see Tables 1, 2, and 3), and weevil larvae counts from 10 stems were taken on the latter date. Plots were harvested for yield on May 13 and subsampled for dry matter content because there were few green weeds. At Dennis, visual assessment was difficult because of large differences in weed infestation and weevil that appeared later, so plots were harvested on May 11 for forage yield and subsampled for dry matter, N, and phosphorus (P) contents. Subsamples of pure weed and alfalfa were collected as before, and N/P ratios (on a fresh weight basis) were used for calculation of alfalfa percentage in forage (see Table 4).

Results and Discussion

2011–2012

Total forage yields were lower in the pesticide-treated plots than in any of the burned treatments except for those spring-burned at medium intensity, where yields were similar to the untreated check (Table 1). The yield difference was due to weed production, as shown by the difference between total yield and the percentage of alfalfa in the treatments. The herbicide-treated plots were practically weed-free, so there was more alfalfa in the pesticide-treated and high-intensity spring burning treatments than for the untreated and low-intensity fall burning treatments.

A few annual broadleaf weeds were present at Mound Valley, mostly shepherdspurse and henbit. Weed density was lower where AlfaMax was applied than in the other treatments (Table 1). More weeds were also found with no treatment compared with fall burning at medium and high intensity and spring burning at high intensity. Average weed density was lower with high- than low-intensity burning, and the medium intensity treatment was intermediate. There was no difference between fall and spring burning in average weed density.

Weevil damage at Mound Valley on April 3 was greater with no treatment than with pesticide treatment, high-intensity fall burning, or spring burning at low or high intensity (Table 1). Average weevil damage for burning intensities showed no significant ($P < 0.05$) difference, although the high-intensity treatments appeared to have less weevil damage. There was no difference in average weevil damage ratings between fall and spring burning treatments.

At Emporia, average weevil damage on March 28 was less in spring compared with fall burning, and in high-intensity compared with burning at medium or low intensity (Table 2). The high-intensity burning treatments, whether in fall or spring, had less weevil damage than all other treatments, except for the medium-intensity, spring-burned treatment and the untreated check (data not shown); however, there was more weevil damage in the herbicide treatment than in all other treatments.

Weed density, mostly from shepherdspurse and common chickweed, was lower in the spring-burned than the fall treatments, particularly at the higher intensities (Table 2).

2012–2013

Weevil damage at the Mound Valley location on April 3 was effectively reduced as burning intensity was increased (Table 3). There was more weevil damage for the checks than for medium- or high-intensity burned treatments, regardless of time (means not shown), which was reflected by weevil numbers on April 17 (Table 3). Weevil damage on that date, however, was affected by an interaction between burning intensity and time (Figure 1). Average weevil damage from fall and spring burning were no different, but there was more weevil damage at low burning intensities than at high intensities, regardless of when they were burned. Spring burning at medium intensity was more effective than fall burning. High-intensity burning at either time resulted in less weevil damage than fall burning at medium intensity.

Forage yield at the Mound Valley location did not differ among treatments (data not shown), so alfalfa apparently recovered enough after April 17 to overcome most previous damage.

At Dennis, plots were harvested for forage yield and subsampled for weed density determinations because weevils appeared primarily after treatment and common chickweed infestation made visual assessment difficult. Total yield and alfalfa percentage were greater in high-intensity burning treatments than in the others (Table 4). Medium-intensity burning treatments yielded more total forage than the check and pesticide treatments, and more alfalfa than the latter. Medium-intensity treatments burned in spring also yielded more total forage with higher percentage of alfalfa than the check. The more intense burning treatment apparently provided better control of chickweed than the 2,4-DB applied at the time of pesticide treatment.

In general, burning alfalfa during dormancy provided some weevil control, along with reducing the amount of broadleaf weeds. In the former case, removal of residue was not sufficient to reduce larval population. Low-intensity burning adequately removed dried litter but did not likely supply sufficient heat to deter weevil infestation.

If the benefits of insect control were combined with weed control, an efficient burner could be cost-effective for organic, and perhaps conventional, producers. However, grassy weeds have been reported to be more difficult to control with burning than broadleaf weeds, which limits the method's usefulness. Disadvantages of burning could be cost of fuel and equipment, lower speed of treatment, and lack of residual control. Another would be its lack of flexibility, because treatment would be required without knowing whether an infestation might meet economic thresholds.

Table 1. Effects of burning treatments in 2011–2012 on forage yield, percentage of alfalfa in forage, weed density, and weevil damage, Mound Valley, KS

Burning treatment					
Time[1]	Intensity[2]	Forage yield[3]	Alfalfa in forage[4]	Weed density[5]	Weevil damage[6]
		Tons/a	%		
Fall	Low	1.62ab[7]	38c	3.8a	3.8a
	Medium	1.65ab	77ab	2.3bc	3.1ab
	High	1.68a	61bc	2.0c	2.7ab
Spring	Low	1.71a	54bc	3.7a	2.7ab
	Medium	1.54ab	71abc	3.4ab	3.8a
	High	1.70a	78ab	2.0c	2.8ab
	Pesticides[8]	1.35b	100a	0.0d	1.8b
	Check	1.52ab	42bc	3.9a	4.1a
Treatment means					
	Low	1.66a	46a	3.7a	3.2a
	Medium	1.59a	74a	2.8ab	3.4a
	High	1.69a	69a	2.0b	2.7a

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[1] Fall burning was on November 29, 2011; spring on February 27, 2012.

[2] Burning intensity was varied by ground speed (see Experimental Procedures).

[3] Total forage, expressed on 12% moisture basis.

[4] Calculated from nitrogen concentrations in pure alfalfa vs. weeds (see Experimental Procedures).

[5] Visual rating where 0 = no weeds and 5 = weed coverage over entire plot.

[6] Rating where 0 = no damage and 5 = all leaves damaged.

[7] Means of a group within a column followed by the same letter do not differ ($P < 0.05$).

[8] Sprayed with AlfaMax (DuPont, Wilmington, DE) on January 4, and with chlorpyrifos on March 28, 2012.

Table 2. Effects of burning treatments in 2011–2012 on weevil damage and weed density, Emporia, KS

Burning treatment means			
Time[1]	Intensity[2]	Weevil damage[3]	Weed density[4]
		0 to 5 scale	0 to 5 scale
Fall burning		2.3a[5]	3.6a
Spring burning		1.7b	2.4b
	Low	2.7a	3.3a
	Medium	2.2a	2.9a
	High	1.2b	2.7a

[1] Fall burning was on November 15, 2011; spring on March 6, 2012.

[2] Burning intensity was varied by ground speed (see Experimental Procedures).

[3] Visual rating where 0 = no damage and 5 =all leaves damaged.

[4] Rating where 0 = no weeds and 5 = weed coverage over entire plot.

[5] Means of a group within a column followed by the same letter do not differ ($P < 0.05$).

Table 3. Effects of burning intensity on weevil damage (April 3) and on larvae numbers on April 17, 2013, Mound Valley, KS

	Alfalfa weevil	
Burning intensity[1]	Damage[2]	Larvae
	0 to 5 scale[3]	No./10 stems
Low	3.2a	31a
Medium	2.2b	17b
High	1.0c	10b
LSD $_{(0.05)}$	0.7	12

[1] Burning intensity was varied by ground speed (see Experimental Procedures).

[2] Visual rating taken on April 3 where 0 = no damage and 5 = all leaves damaged.

[3] Means within a column followed by the same letter do not differ ($P < 0.05$).

Table 4. Effects of alfalfa treatments in 2012–2013 on total forage production and percentage of alfalfa on May 11, Dennis, KS

Timing[1]	Intensity[2]	Forage yield	Alfalfa in forage[4]
		Tons/a[3]	%
Fall	Low	1.83	18
	Medium	1.92	30
	High	2.42	47
Spring	Low	1.82	32
	Medium	2.07	34
	High	2.56	45
	Pesticides[5]	1.62	11
	No treatment	1.77	12
	LSD $_{(0.05)}$	0.26	15
Burning treatment means			
Fall burning		2.05	31
Spring burning		2.15	37
LSD $_{(0.05)}$		NS	NS
	Low	1.82	25
	Medium	1.99	31
	High	2.49	46
	LSD $_{(0.05)}$	0.18	11

[1] Fall = November 29, 2012; Spring = February 27, 2013.

[2] Burning intensity was varied by ground speed (see Experimental Procedures).

[3] Total forage, expressed on 12% moisture basis.

[4] Calculated from N/P ratios of pure alfalfa versus weeds (see Experimental Procedures).

[5] Sprayed March 20 with herbicides (see Experimental Procedures), and April 9, 2013, with 2 oz/a of Baythroid (Bayer CropScience, Research Triangle Park, NC) insecticide.

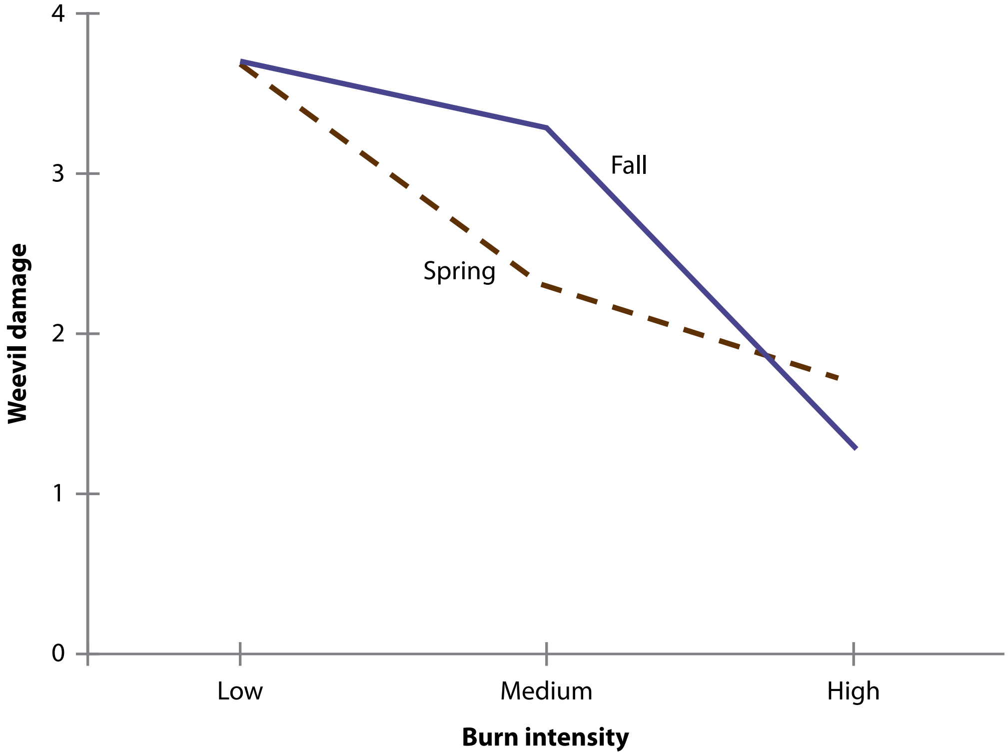

Figure 1. Alfalfa weevil damage rating (0 to 5 scale) at Mound Valley on April 17, 2013, as affected by the time and intensity of burning.

Tillage and Nitrogen Placement Effects on Yields in a Short-Season Corn/Wheat/Double-Crop Soybean Rotation

D.W. Sweeney

Summary

In 2013, late planting resulted in corn yields that were less than 100 bu/a. Nitrogen (N) placement did not affect yields in the higher-yielding conventional tillage system, but knifing tended to result in greater yield in reduced and no-till systems.

Introduction

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

Experimental Procedures

A split-plot design with four replications was initiated in 1983 with tillage system as the whole plot and N treatment as the subplot. In 2005, the rotation was changed to begin a short-season corn/wheat/double-crop soybean sequence. Use of three tillage systems (conventional, reduced, and no-till) continued in the same areas used during the previous 22 years. The conventional system consisted of chiseling, disking, and field cultivation. Chisel operations occurred in the fall preceding corn or wheat crops. The reduced-tillage system consists of disking and field cultivation prior to planting. Glyphosate (Roundup; Monsanto, St. Louis, MO) was applied to the no-till areas. The four N treatments for the crop were: no N (control), broadcast urea-ammonium nitrate (UAN; 28% N) solution, dribble UAN solution, and knife UAN solution at 4 in. deep. The N rate for the corn crop grown in odd years was 125 lb/a. Corn was planted on May 15, 2013.

Results and Discussion

In 2013, wet field conditions delayed planting until mid-May. The lack of rain for more than four weeks prior to silking resulted in low corn yields that were less than 100 bu/a in any treatment (Figure 1). Overall yields were greatest with conventional tillage, with no difference between N placements. In the lower-yielding reduced and no-tillage treatments, knife application tended to result in greater yields than with dribble, broadcast, or the no-N control. In no-till, however, the trend was significant only for the comparison of the knife vs. no-N control treatments.

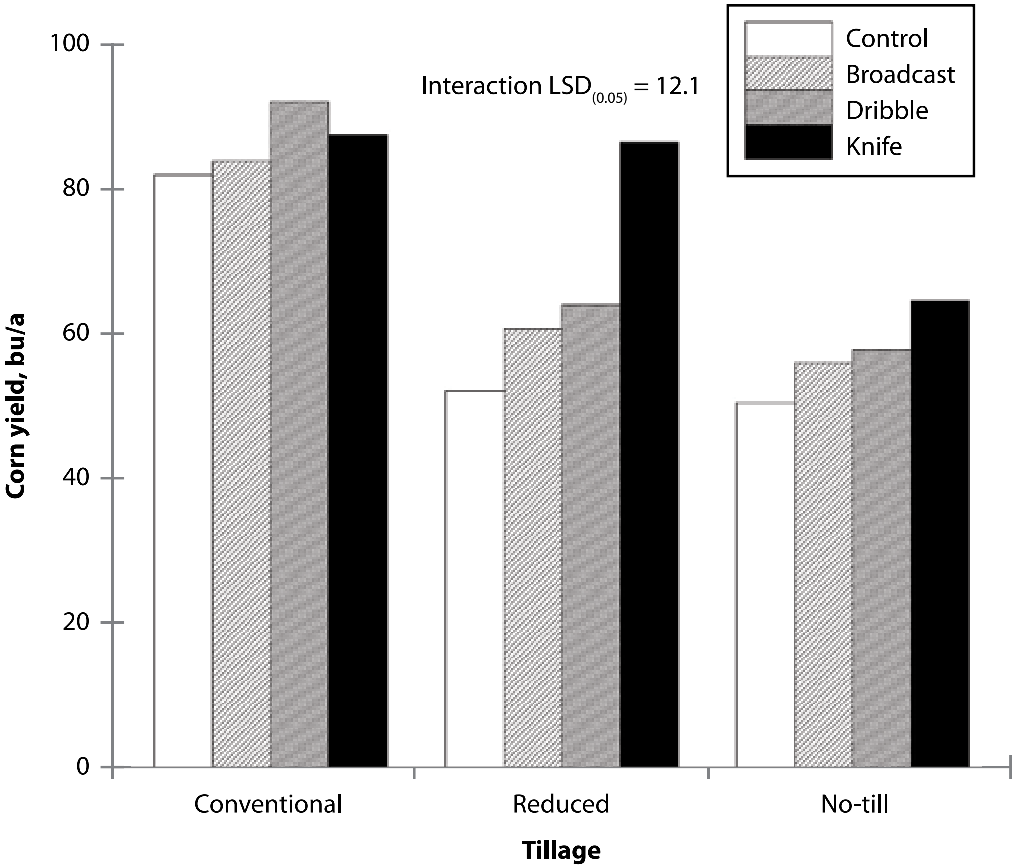

Figure 1. Effects of tillage and nitrogen placement on short-season corn yield in 2013.

Seeding Rates and Fertilizer Placement to Improve Strip-Till and No-Till Corn[1]

D.W. Sweeney

Summary

In 2013, late planting resulted in corn yields that were less than 110 bu/a. Yields were not increased with seeding rates above 26,000/a, but a small increase in yield was obtained with knife applications of fertilizer nitrogen (N) compared with dribble.

Introduction

Use of conservation tillage systems is promoted because of environmental concerns. In the claypan soils of southeastern Kansas, crops grown with no-till may yield less than crops grown in systems involving some tillage operation, often because of reduced plant emergence. Strip tillage provides a tilled seed-bed zone in which early spring soil temperatures might be greater than those in no-till soils. Like no-till, strip tillage leaves residues intact between the rows as a conservation measure. Optimizing seeding rates for different tillage systems should improve corn stands and yields.

Experimental Procedures

In 2013, the experiment was conducted at the Parsons Unit of the Southeast Agricultural Research Center. The experimental design was a split-plot arrangement of a randomized complete block with three replications. The whole plots were three tillage systems: conventional, strip tillage, and no-till. Conventional tillage consisted of chisel and disk operations in the spring. Strip tillage was done with a Redball (Benson, MN) strip-till unit in the spring prior to planting. The subplots were a 5 × 2 factorial combination of five seed planting rates (18,000, 22,000, 26,000, 30,000, and 34,000 seeds/a) and two N fertilizer placement methods: surface band (dribble) on 30-in. centers near the row and subsurface band (knife) at 4 in. deep. Corn was planted at both sites on May 15, 2013.

Results and Discussion

In 2013, wet field conditions delayed planting until mid-May. The lack of rain for more than four weeks prior to silking resulted in low corn yields that were less than 110 bu/a for any treatment (data not shown). Tillage did not significantly affect corn yields. Although significant, the effect of seeding rate on corn yield was variable and tended to increase with seeding rates up to 26,000 seeds/a with no increase with higher seeding rates. Subsurface band (knife) application of fertilizer N increased yields by 6% above surface band (dribble) applications.

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[1] This research was partly funded by the Kansas Corn Commission and the Kansas Fertilizer Research Fund.

Surface Runoff Characteristics from Claypan Soil in Southeastern Kansas Receiving Different Plant Nutrient Sources and Tillage[1]

D.W. Sweeney, P. Barnes[2], and G. Pierzynski[3]

Summary

Preliminary results show that two-year average total nitrogen (N) runoff losses and ortho-phosphorus (P) and total P runoff losses in the second year were greater with N-based turkey litter/no-till applications than P-based turkey litter or fertilizer-only applications. Incorporation of turkey litter applied based on N requirements resulted in N and P losses that did not differ from losses from P-based or fertilizer-only treatments. Chemical and statistical analyses of third-year samples will allow for final results and interpretation.

Introduction

Surface runoff losses of nutrients and sediments are significant threats to surface water quality. In the southeastern part of Kansas, the lack of underground aquifers and the dependence on surface water sources emphasizes the importance of the quality of surface waters to citizens of Kansas and states downstream. Increased fertilizer prices in recent years, especially noticeable when the cost of P spiked in 2008, have led U.S. producers to consider other alternatives, such as manure sources. The use of poultry litter as an alternative to fertilizer is of particular interest in southeastern Kansas because large amounts of poultry litter are imported from nearby confined animal feeding operations in Arkansas, Oklahoma, and Missouri. Incomplete information is available comparing relative nutrient losses in surface runoff following poultry litter applications to crop ground compared with using only commercial fertilizers. This is especially true for tilled soil compared with no-till, because production of most annual cereal crops on the claypan soils of the region is often negatively affected and is rarely improved by planting with no-tillage. The objectives of this study were to compare surface runoff losses of N and P nutrients and sediment from fertilizer and poultry litter and to determine the influence of tillage on nutrient and sediment losses in surface runoff from the use of fertilizer and poultry litter.

Experimental Procedures

The experiment was conducted near Girard, KS, on the Greenbush Educational facility's grounds from spring 2011 through spring 2014. Individual plot size was 1 acre. A total of 10 plots comprising five treatments were replicated twice. The five treatments were:

1. Control – no N or P fertilizer or turkey litter – no tillage
2. Fertilizer only – commercial N and P fertilizer – chisel-disk tillage
3. Turkey litter, N-based – no extra N or P fertilizer – no tillage
4. Turkey litter, N-based – no extra N or P fertilizer – chisel-disk tillage

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[1] Partially funded by the Kansas Fertilizer Research Fund.

[2] Kansas State University Department of Biological and Agricultural Engineering.

[3] Kansas State University Department of Agronomy.

5. Turkey litter, P-based – supplemented with fertilizer N – chisel-disk tillage

Fertilizer and turkey litter were applied prior to planting grain sorghum each spring. Analyses were performed on the manure each season prior to application to obtain total N, NH_4-N, and NO_3-N. Organic N was assumed to be Total N – (NH_4-N + NO_3-N). Potentially available N is assumed to be (1) 50% of organic N plus (2) 80 % of NH_4-N (fraction that does not volatilize) plus (3) NO_3-N. Total P of the turkey litter was also determined and assumed to be all potentially available. Water flow was measured and samples were collected using a weir-water sampler (Teledyne Isco, Lincoln, NE). Composite samples were collected from each natural rainfall event that produced runoff from approximately early April to mid-November each year. In 2014, samples will be collected from early April to mid-June to determine carryover effects from the third year of application. All water samples were analyzed for sediment, total P, soluble P, ammonium, nitrate, and total N concentrations by standard methods.

Results and Discussion

Because of the highly variable nature of this field-scale project, final results will be presented after collection of three years of data so that flow-weighted concentrations and total losses as affected by treatments can be statistically analyzed and presented. However, two-year results for annual N and P losses from the period from litter and fertilizer application in June 2011 to just prior to application in June 2013 show preliminary observations. Average annual losses of NH_4-N, NO_3-N, and sediment were unaffected by treatment (Figure 1). Average annual total N losses were greater in the N-based turkey litter/no-till treatment with no differences in total N loss from the other treatments (Figure 2). Ortho-P losses (Figure 3) accounted for approximately 70% of the total P loss (Figure 4), and both were affected by a treatment × year interaction. Ortho- and total P losses were statistically unaffected by treatment in the first year, but P loss in the second year from the N-based turkey litter/no-till treatment was more than twice that from the other treatments. During the first two years of this study, incorporation of the high rate, N-based turkey litter resulted in annual N (Figures 1 and 2) or P losses (Figures 3 and 4) that did not differ from losses from treatments receiving a lower rate, P-based turkey litter application or only fertilizer.

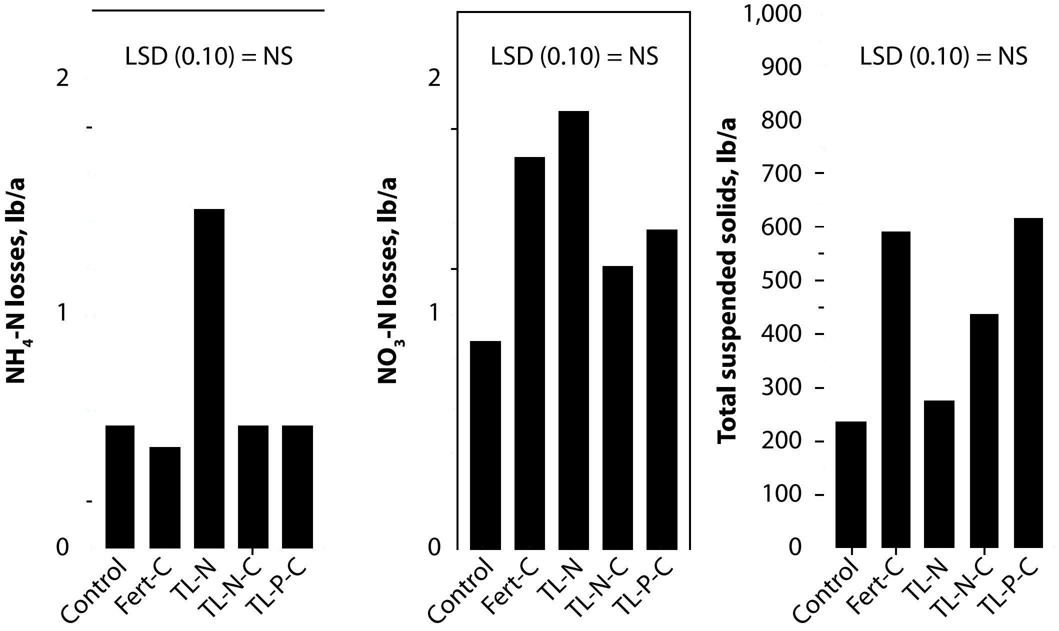

Figure 1. Two-year average NH_4-N, NO_3-N, and total suspended solids losses from claypan soil receiving turkey litter and/or fertilizer. Control: no fertilizer or turkey litter application with no tillage. Fert-C: commercial fertilizer only incorporated with conventional tillage. TL-N: Nitrogen-based turkey litter application with no tillage. TL-N-C: N-based turkey litter application incorporated with conventional tillage. TL-P-C: Phosphorus-based turkey litter and supplemental N application incorporated with conventional tillage.

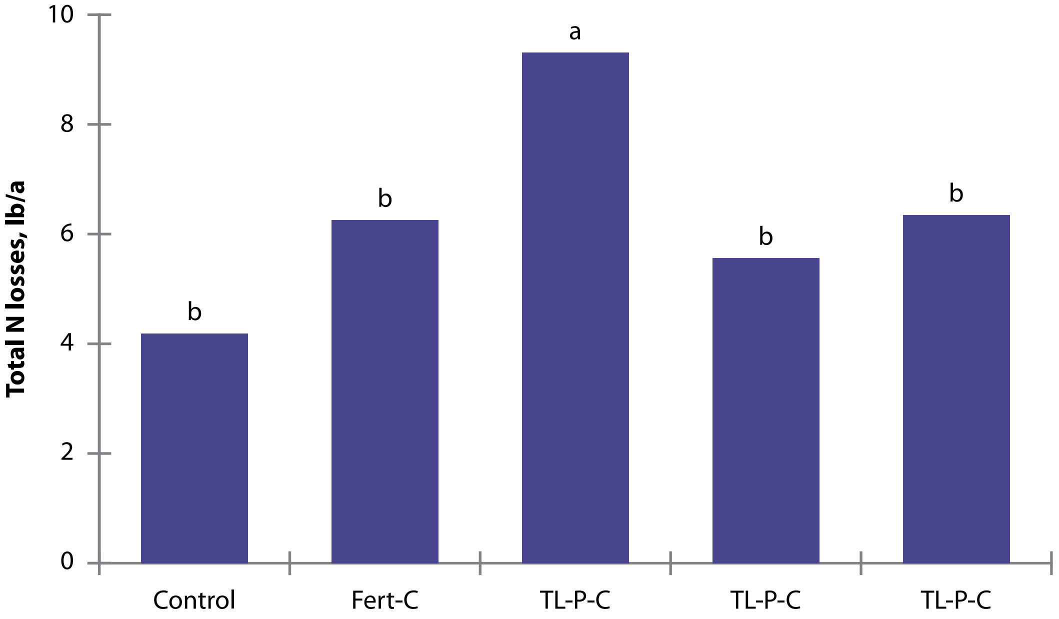

Figure 2. Two-year average total nitrogen (N) losses from claypan soil receiving turkey litter and/or fertilizer. Control: no fertilizer or turkey litter application with no tillage. Fert-C: commercial fertilizer only incorporated with conventional tillage. TL-N: N-based turkey litter application with no tillage. TL-N-C: N-based turkey litter application incorporated with conventional tillage. TL-P-C: P-based turkey litter and supplemental N application incorporated with conventional tillage. Bars with the same letter are not statistically different at *P* = 0.10 according to the LSD test.

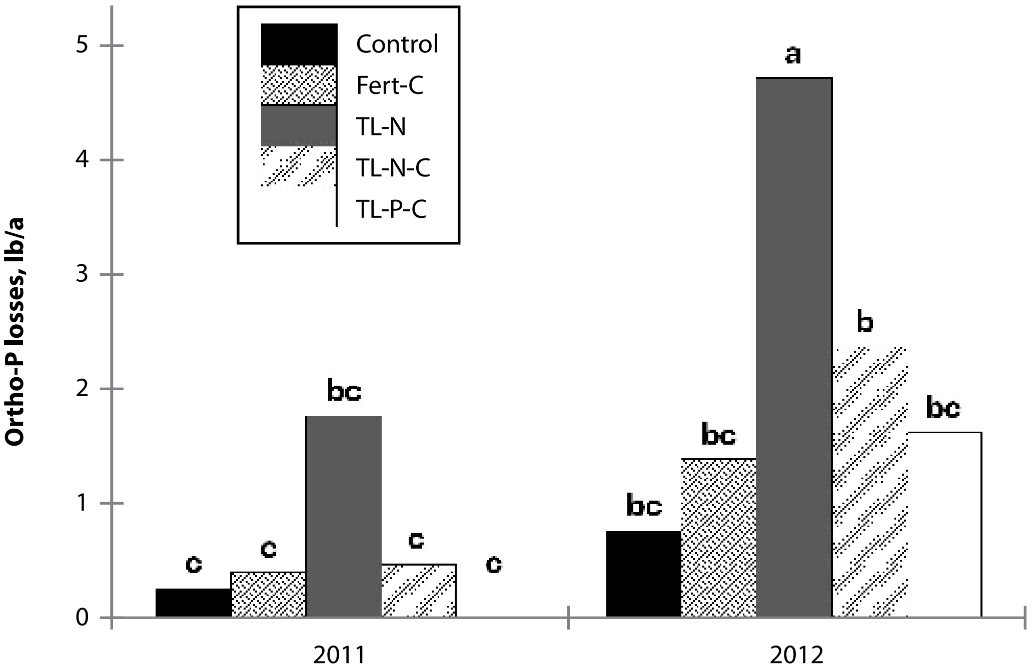

Figure 3. Ortho-phosphorus (P) losses from claypan soil receiving turkey litter and/or fertilizer in 2011 and 2012. Control: no fertilizer or turkey litter application with no tillage. Fert-C: commercial fertilizer only incorporated with conventional tillage. TL-N: N-based turkey litter application with no tillage. TL-N-C: N-based turkey litter application incorporated with conventional tillage. TL-P-C: P-based turkey litter and supplemental N application incorporated with conventional tillage. Bars with the same letter are not statistically different at *P* = 0.10 according to the LSD test.

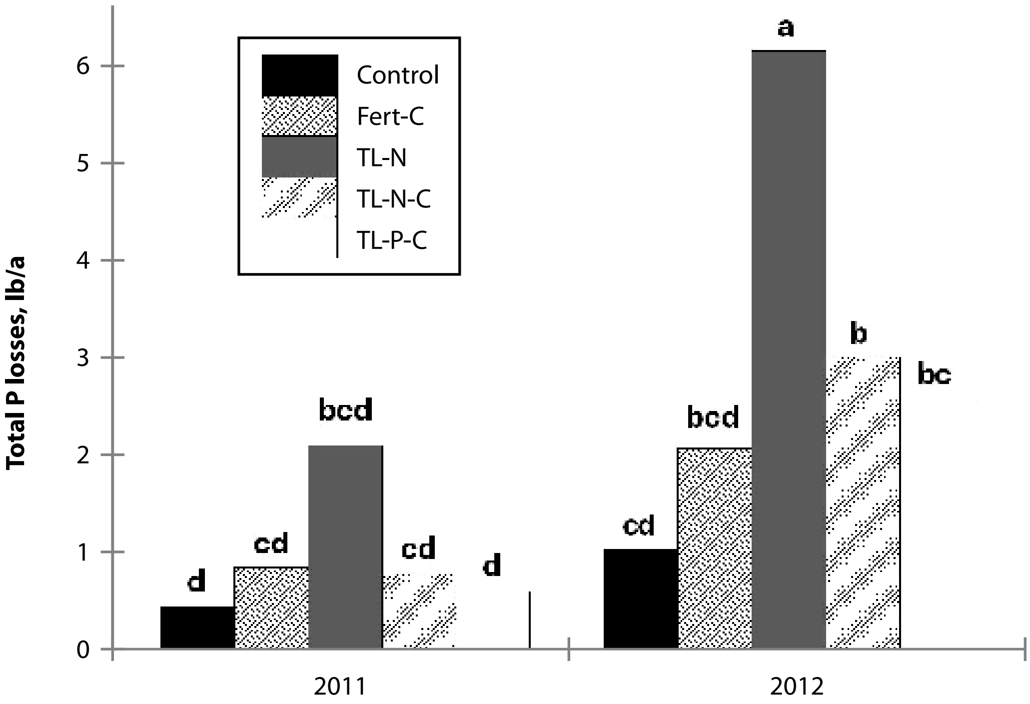

Figure 4. Total phosphorus (P) losses from claypan soil receiving turkey litter and/or fertilizer in 2011 and 2012. Control: no fertilizer or turkey litter application with no tillage. Fert-C: commercial fertilizer only incorporated with conventional tillage. TL-N: N-based turkey litter application with no tillage. TL-N-C: N-based turkey litter application incorporated with conventional tillage. TL-P-C: P-based turkey litter and supplemental N application incorporated with conventional tillage. Bars with the same letter are not statistically different at *P* = 0.10 according to the LSD test.

Response of Wheat to Residual Fertilizer Nitrogen Applied to Previous Failed Corn

D.W. Sweeney and D. Ruiz Diaz[1]

Summary

When drought conditions result in poor corn growth and yield, the potential exists for carryover of fertilizer nitrogen (N) to wheat. Soil sampling at the wheat jointing stage showed that NO_3-N levels increased slightly as previous N rate increased up to 240 lb/a N, but did not appear sufficient for the wheat yield increase to previous N rate. The relationship between wheat normalized difference vegetative index (NDVI) measurements at jointing and wheat yield was linear. The use of crop active sensors such as the GreenSeeker (Trimble Navigation Ltd., Sunnyvale, CA) may provide plant response data to supplement soil sampling to more adequately determine residual effects on a following wheat crop.

Introduction

In 2012, extreme hot and dry conditions reduced corn crop yields. These drought-induced, low-yielding conditions likely resulted in low N uptake by corn. As a result, the potential exists for unused fertilizer N left in the soil, but the potential carryover of unused N fertilizer is uncertain because of the dynamics of N cycling. The objective of this study was to determine the effect of residual N that had been applied to a previous, drought-failed corn on the following wheat crop.

Experimental Procedures

A study was started in 2012 to determine the effect of N rates and nitrification inhibitors on short-season corn grown with no tillage. The experimental design was a split-plot arrangement of a randomized complete block with four replications. Nitrogen fertilizer rates were the whole plots and nitrification inhibitors were the subplots. An untreated control was included in each replication. Because of replanting and hot, dry weather, corn yields were less than 30 bu/a with no response to nitrification inhibitors and a slight decline in yields as N rate increased (data not shown).

Because many farmers rotate winter wheat after corn and the 2012 experiment would not be repeated, 'Everest' wheat was drilled on October 12, 2012, with no added fertilizer and no tillage. The same plots with the same experimental design were used to study the residual effect of the N treatments. Wheat was harvested on June 25, 2013. In early April when the wheat was beginning to joint (Feekes 6), soil samples were taken from each plot to a 12-in. depth and analyzed for NH_4-N and NO_3-N. At the same time, a GreenSeeker handheld crop sensor was used to take NDVI readings.

Results and Discussion

The use of nitrification inhibitors on the previous corn crop had no residual effect on soil inorganic N levels and wheat NDVI readings taken in early April or wheat yield in June (data not shown), but residual from the previous N rate treatments did show

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[1] Kansas State University Department of Agronomy.

carryover effects on soil NO_3-N and NDVI readings at jointing and on wheat yields (Table 1). However, previous N rate treatments had no effect on soil NH_4-N levels in the top 12 in., which were less than 20 lb/a N. The residual soil NO_3-N levels in the top 12 in. increased from 5 to 20 lb/a N as the previous N rate increased from 0 (control) to 240 lb/a N. This small increase found at jointing from the control to the highest previous N rate was consequently expected to have minimal effect on wheat yield. Even though NDVI values were less than 0.70, the NDVI values increased with initial increments in previous N rate, but little change was measured at previous N rates above 120 lb/a N. Wheat yield increased more than 17 bu/a as N rate increased from the control to the previous 120 lb/a N fertilizer rate, but with no statistical increase with greater previous N rates.

To assess fields, producers should first sample for available N in the soil. In this situation, because NH_4-N levels were constant, a change in soil NO_3-N of only 5 lb/a appeared to result in improving yield from 60% of the maximum to more than 90%, but there was little change as soil NO_3-N increased another 10 lb/a (Figure 1A). In contrast, the relationship between NDVI at jointing and relative wheat yield was linear (Figure 1B).

The potential for carryover of fertilizer N when the corn crop fails because of drought exists for a following wheat crop. A producer's first step to determine potential fertilizer N residual is to soil sample; however, with the dynamics of N processes, those results may not always be a reliable indicator of the residual effect of previous N fertilization. The use of crop active sensors, such as the GreenSeeker, may provide plant response data to supplement soil sampling to more adequately determine residual effects on a following wheat crop.

Table 1. Effect of previous fertilizer N rate applied to failed corn in 2012 on soil NO_3-N at the 0–12-in. depth and wheat normalized difference vegetative index (NDVI) readings taken at jointing and wheat yield in 2013.

Previous N rate	NO_3-N	Wheat NDVI	Wheat yield
lb/a	lb/a		bu/a
0	5.3	0.46	30.1
60	7.8	0.52	35.0
120	10.5	0.63	47.2
180	15.6	0.64	50.0
240	19.5	0.67	48.9
LSD (0.05)	5.0	0.04	3.6

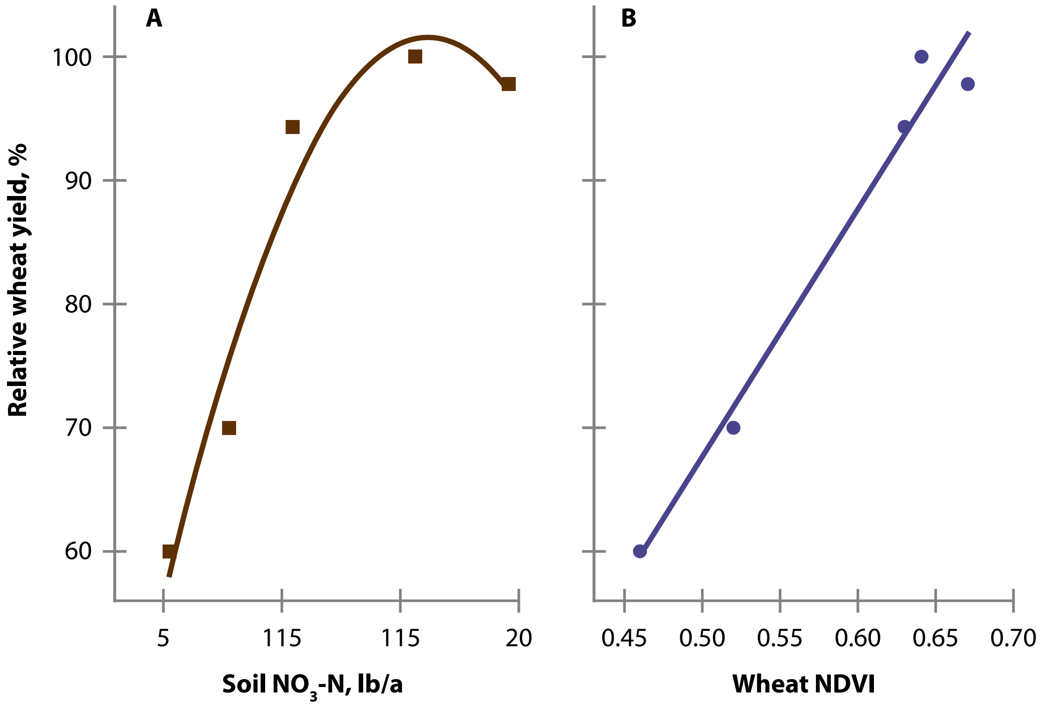

Figure 1. Effect of soil NO_3-N levels in the 0–12-in. depth and wheat normalized difference vegetative index (NDVI) readings taken at jointing (Feekes 6) on relative wheat yield in 2013.

Nitrogen, Phosphorus, and Potassium Fertilization for Newly Established Tall Fescue

D.W. Sweeney and J.L. Moyer

Summary

First-year spring yields of tall fescue in 2013 responded to phosphorus (P) fertilization, but lodging at the R5 growth stage in the spring with higher P fertilization rates may have influenced subsequent fall harvest yields, which declined with increasing P rates. As N rates increased, R5 yields declined but fall harvest yields increased.

Introduction

Tall fescue is the major cool-season grass in southeastern Kansas. Perennial grass crops, as with annual row crops, rely on proper fertilization for optimum production. Meadows and pastures are often under-fertilized and produce low quantities of low-quality forage. This is often true even when new stands are established. The objective of this study was to determine whether nitrogen (N), P, and potassium (K) fertilization improves yields during the early years of the stand. Potassium fertilization had no effect on fescue yield measured at the spring E2 and R5 growth stages or in the fall.

Experimental Procedures

The experiment was established on a Parsons silt loam at the Parsons unit of the Kansas State University Southeast Agricultural Research Center in the fall of 2012. Initial soil test values averaged 6.9 pH, 2.8% organic matter, 4.2 ppm P, 70 ppm K, 3.9 ppm NH_4-N, and 37.9 ppm NO_3-N in the top 6 in. The experimental design was a split-plot arrangement of a randomized complete block. The six whole plots were combinations of P_2O_5 and K_2O fertilizer levels allowing for two separate analyses where (1) four levels of P_2O_5 consisting of 0, 25, 50, and 100 lb/a and (2) a 2 × 2 factorial combination of two levels of P_2O_5 (0, 50 lb/a) and two levels of K_2O (0, 40 lb/a). Subplots were four levels of N fertilization consisting of 0, 50, 100, and 150 lb/a. P and K fertilizers were broadcast applied in the fall as 0-46-0 (N-P-K; triple superphosphate) and 0-0-60 (potassium chloride). Nitrogen was broadcast-applied in late winter as 46-0-0 (urea) solid. Early growth yield was taken at E2 (jointing) growth stage on May 1, 2013. Spring yield was measured at R5 (post-bloom) on June 7, 2013. Fall harvest was taken on September 10, 2013.

Results and Discussion

In 2013, fescue yield at E2 increased with P rates up to 100 lb/a P_2O_5 (Table 1). By R5, P fertilization increased yield above that with no P, but there were no differences between P rates. At fall harvest, yield declined with increasing P rate. This may be a result of plant damage from the extensive lodging at the spring R5 harvest. Nitrogen fertilization rate did not affect early E2 fescue yield; however, N effect on fescue yield at R5 and in the fall appeared to be opposite that seen for P fertilization. At R5, yield tended to decline with increasing N rate, but in the fall yield increased with increasing N rate. Potassium fertilization had no effect on fescue yield measured at the spring E2 and R5 growth stages or in the fall.

Table 1. Tall fescue yield in the spring and fall 2013 and R5 lodging visual estimates as affected by P_2O_5 and N fertilization rates

	Yield			
	Spring			
P_2O_5	E2 (jointing)	R5 (post-bloom)	Fall harvest	R5 lodging
---- lb/a ----	---------------------------- ton/a		----------------------------	- % -
0	0.26	3.41	2.05	1
25	0.64	4.32	1.99	53
50	0.88	4.51	1.74	97
100	1.50	4.47	1.48	100
LSD (0.05)	0.28	0.63	0.29	19
Nitrogen				
---- lb/a ----				
0	0.76	4.48	1.61	58
50	0.84	4.16	1.70	61
100	0.83	4.17	1.91	67
150	0.84	3.89	2.04	65
LSD (0.05)	NS[1]	0.33	0.15	NS

[1] Not significant.

Crop Yield Trends in Kansas

G.F. Sassenrath, X. Lin[1], and D. Shoup[2]

Summary

Crop production throughout Kansas has intensified in response to changing economics of production. These shifts have altered the crops produced and the crop rotations. Statewide average yields of corn, sorghum, soybean, and winter wheat have increased steadily for both rainfed and irrigated production.

Introduction

Competition among the food, feed, and biofuel industries has intensified agricultural production systems, but much of the yield enhancement gained through improvements in genetics, production technologies, and management protocols is being eroded and lost through yield stagnation and decline and increases in year-to-year variability. This difference between the yield potential of a cultivar as measured under optimal conditions and the actual yield harvested by farmers represents an inefficient conversion of inputs. A variety of factors control crop yield, including climate, soil quality, genetic potential, and management. The inability to capture the genetic yield potential of crops hinders agronomic production capacity and economic return and threatens the long-term sustainability of agricultural production.

This research is designed to identify potential factors contributing to the yield gap through an examination of historical production records and reports. Our goal is to improve the long-term sustainability of integrated crop and animal production systems in the Great Plains by identifying limitations to sustainable production and developing realistic management production methods that break through the yield barriers currently experienced in rainfed crop production in Kansas.

Experimental Procedures

Yearly crop production data, including acres planted, acres harvested, and yield per acre, were downloaded from the National Agricultural Statistics Service Quick Stats (http://www.nass.usda.gov/Quick_Stats/). Statewide survey data for irrigated and rainfed crops and statewide total values from 1970 through 2009 were used. To explore factors contributing to crop growth and performance, detailed measurements of crop growth were collected for county-level data from the NASS database based on availability of county-level weather data.

Climatological data were downloaded from the Kansas State University Weather Data Library (http://www.ksre.ksu.edu/wdl/Climate/Climate%20Records%201.htm) for counties throughout Kansas. Daily measurements of maximum and minimum temperature, total rainfall, and total sunlight were collected; growing degree days were calculated from maximum and minimum daily temperatures. Daily data were summarized based on a water-year, from October 1 through September 30, from 1986 through 2009. Climatological conditions for each growing season were determined for each crop

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[1] Kansas State University Department of Agronomy.

[2] Kansas State University Southeast Area Extension.

based on average planting dates for the region in Kansas as given in the Kansas Crop Planting Guide (http://www.ksre.ksu.edu/bookstore/pubs/l818.pdf).

For clarity of presentation, the results reported here focus on Labette County in southeast Kansas. Planting dates used to calculate weather conditions during each crop growing season are: corn, April 9; sorghum, May 7; soybean, June 14; and winter wheat, October 1.

Results and Discussion

Shifts in planting decisions result from changes in economic, political, and other factors that affect the agronomic system. Emerging interest in biofuel production enhanced the production of crops for use as biofuel feedstocks, particularly corn (Figure 1A). Since the late 1990s, corn acreage has increased sharply, particularly for rainfed production. Irrigated corn production has remained nearly steady since peaking in the late 1990s. Acreage planted to sorghum in Kansas has decreased slightly, with a greater drop in irrigated production (Figure 1C). Rainfed soybean production has more than doubled, with a more moderate increase seen in irrigated soybean acres (Figure 1E). Rainfed winter wheat acreage has declined steadily, whereas irrigated production has remained steady (Figure 1G).

Acreage for summer season crops is currently almost equally planted to corn, sorghum, and soybean, at approximately 3 million acres for each crop. Intensification of crop production has increased the corn/winter wheat/soybean rotation, resulting in three crops harvested in two years, and expanded the “apparent” crop acreage in Kansas. Growing concerns for groundwater resources, particularly of the Ogallala Aquifer, may account for the decline in irrigated acres.

Improvements in yield are seen for all crops over the 40-year period (Figure 1B, D, F, and H). The slope of the regression line indicates the extent of yield enhancement. As expected, irrigated yields are greater than rainfed yields for all crops. The difference between irrigated and rainfed crop production is greatest for corn and soybean. Corn yield is particularly limited by rainfed production and shows the least significant advancement over the 40-year period (Figure 1B). Winter wheat yield advancement is nearly identical for rainfed and irrigated production, although irrigated production does yield about 10 bu/a more than rainfed. Interestingly, sorghum yield improvement for rainfed production, although still more than 20 bu/a less than irrigated production, shows a more rapid increase (greater slope) than irrigated production (Figure 1D).

Rainfed crop production shows greater year-to-year variability than irrigated production because crop performance is more susceptible to deleterious environmental conditions during the growing season in rainfed production. This is particularly apparent for corn and soybean (Figures 1B and 1F) and less so for sorghum (Figure 1D). Winter wheat yield, although increased with irrigation, still shows substantial year-to-year variability for both rainfed and irrigated production (Figure 1H), indicating sensitivity to an environmental parameter other than water availability.

To further delineate factors contributing to crop performance and yield, we examined crop yields as a function of weather conditions throughout the past 25 years for select counties in Kansas. Correlations between crop yields and weather parameters, including maximum temperature (Tmax), minimum temperature (Tmin), growing degree days (with various base temperatures), sunlight, and rainfall were calculated. Significant relationships are reported here for simplicity.

Corn and soybean yield declined as maximum temperature increased above a certain threshold. Corn yield decreased as the number of days that Tmax was above 90°F increased, whereas soybean yield decreased as the number of days that Tmax exceeded 95°F increased (Figure 2A, B). Sorghum yield was not nearly as sensitive to temperature, showing only a slight yield decline as the number of days Tmax exceeding 100°F increased (Figure 2C). None of the crops showed a particular yield sensitivity to high nighttime temperatures (data not shown), which has been suggested to interfere with respiration and impair yield.

Winter wheat has three environmental phases during the growth cycle: establishment stage from planting until frost, dormancy period during the winter, and rapid growth after frost until harvest. Winter wheat yield was not particularly sensitive to temperature during any growth period (data not shown). The greatest impact on winter wheat yield in southeast Kansas resulted from high rainfall during the maturation phase after dormancy and before harvest (Figure 2D). As total rainfall after April 10 increased, wheat yield decreased. This result is particularly problematic for southeast Kansas because this is the period of the year with highest rainfall.

Examination of historical production records and yields gives insight into changes in the cropping systems and reveals opportunities to improve current production systems. Although corn and soybean acreage has increased recently, these crops are more sensitive to high temperatures and rainfed production than sorghum.

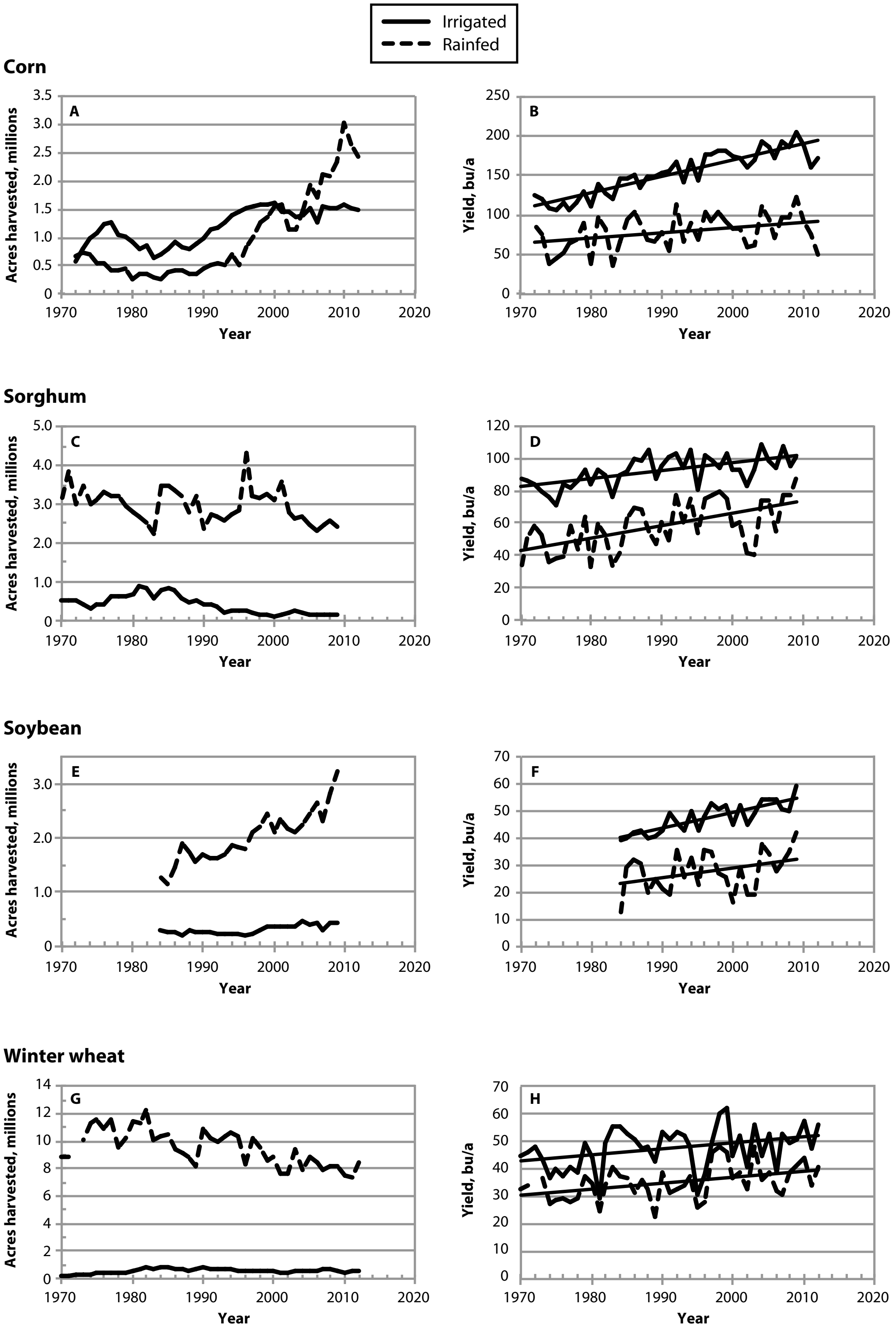


Figure 1. Historical trends in harvested acres and yield for principal crops of Kansas from state-level yield data for rainfed and irrigated production (NASS).

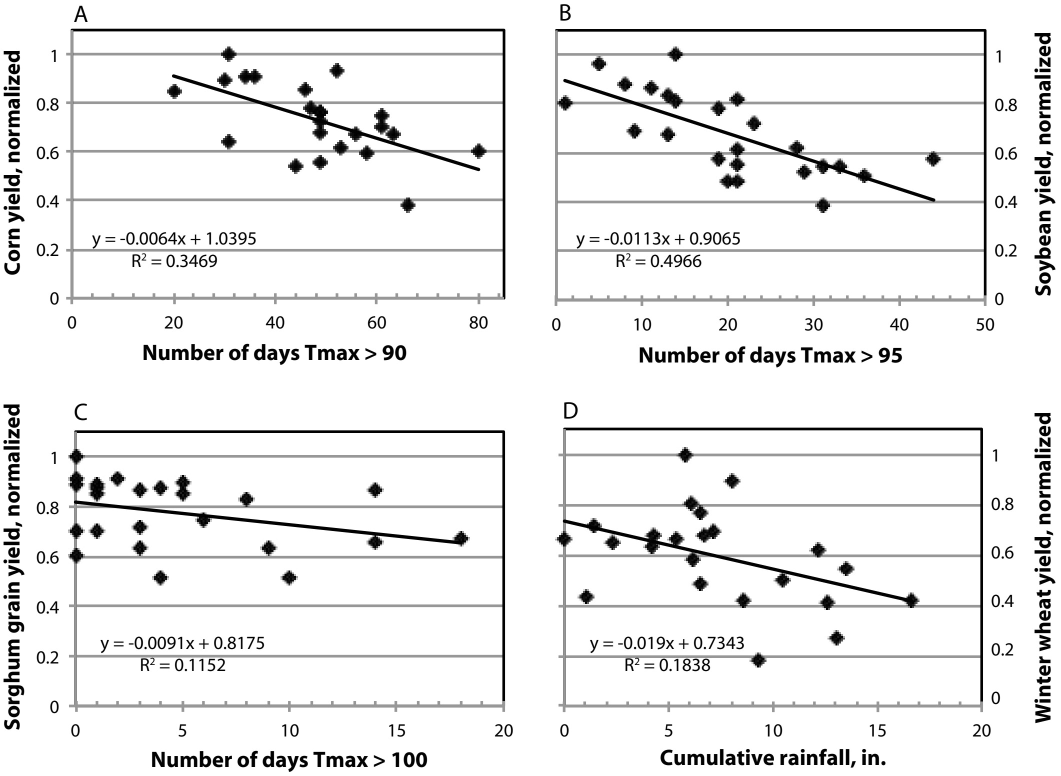


Figure 2. Correlations of crop yields to various weather parameters were calculated to better explore factors potentially affecting crop performance. Weather parameters included maximum and minimum temperature (Tmax and Tmin), rainfall, and sunlight. Cumulative rainfall was calculated over the growing season for each crop and for specific crop growth phases for winter wheat. Correlations are developed on a county level to better account for spatial variability in weather and soils. Crop yields and weather from Labette County in southeast Kansas are presented.

Identification of Yield-Limiting Factors in Southeast Kansas Cropping Systems

G.F. Sassenrath and K.R. Kusel

Summary

Variations in soils and environment contribute to inconsistencies in crop performance and yield within crop production fields. Yield-limiting factors in corn and soybean production were examined through on-farm measurements of soil pH, nutrients, and textural characteristics, and crop measurements and yield components in corn and soybean production in southeast Kansas. Some fields showed yield-limiting clay layers close to the soil surface. Wide variations in soil nutrient characteristics were observed, contributing to within-field variability of crop growth and yield performance. Corn yield was found to be most sensitive to environmental conditions. Soybean yield was dependent on management practices, as well as edaphic and biotic conditions.

Introduction

Advances in genetic yield potential of crops are not consistently realized by farmers. This yield gap — the difference between the yield potential of a cultivar as measured from controlled research fields and the actual yield harvested by farmers — represents an inefficient conversion of inputs to harvested crop and hence loss of return on investment. Many factors may play a role in exacerbating the yield gap, including growing environment (temperature, sunlight, and rainfall), poor soil quality, fertilizer inefficiency, and narrowed genetic diversity. This research is designed to delineate factors contributing to the yield gap by measuring on-farm crop performance, soil quality, and climate. The results of this research will be used to develop improved production methods to enhance the yield harvested by farmers in a consistent way.

Experimental Procedures

Plant and soil samples were collected from production fields in collaboration with cooperating farmers. Production fields were selected from three counties in southeast Kansas and for a variety of management practices (full-season and double-cropped soybean; row spacing, etc.) for corn and soybean. Ten corn fields and seven soybean fields were sampled. Soybean production systems included full-season and double-cropped, and rowed and drilled production methods.

Two-row-wide line-transects were established through the fields, and multiple sampling locations were established along each transect (Figure 1). At each sampling location, plants were hand-harvested from 3 ft^2 for determination of yield components (plants per area, pods or cobs per plant, seeds per pod or cob, average seed size, etc.). Soil samples were taken at each sampling site at four depths (0–3 in., 3–6 in., 6–12 in., and 12–18 in.) and analyzed for nutrients, pH, organic matter, and classification (percentage clay, silt, and sand content).

At each sampling location, 100 ft of row were harvested mechanically with a plot combine for total yield, and a seed sample was collected for analysis (average seed weight). Wet conditions during harvest limited the machine-harvesting of soybean. Potential factors contributing to the yield gap were identified through correlating climatic conditions, soil health, management, and yearly crop yields.

Results and Discussions

Soil Characteristics

Soils in southeast Kansas are predominantly nutrient-rich loams, silt loams, and clay, underlain by an unproductive clay layer. Determination of soil texture allowed determination of depth to claypan layer (Figure 2). In Field 1, heavy clay was detected at most locations by 12–18 in., and some sampling locations had a large percentage of clay in the surface samples (0–3 in. and 3–6 in.). Field 2, a river bottom soil, had deeper silty clay to silty clay loam soil.

Fields showed substantial variability in pH and nutrient levels at sampling locations across the fields. Optimal soil pH ranges from 6.4–7.2, with 5.8–6.4 being acceptable, depending on the crop. Below 5.8, lime is recommended. Maintaining the soil to a neutral pH (near 7) improves soil quality and can enhance the nutrients available to the crop. Field 1 showed spatial variability of soil pH (5.4 to 7.2 for the upper soil layer), with some sampling locations (#1 and #4) having limiting pH (<5.8). Field 2 had more consistent pH levels across the field, with most sampling locations in the acceptable range (5.8–6.4) or good (>6.4).

Phosphorus (P) showed a similar high degree of spatial variability across the fields, especially for the upper soil layers. Again, some fields had acceptable to moderately low levels of P. Given that samples were taken at the end of the growing season, amendments to soil P would be made for the next crop. In some cases, fields showed naturally high P levels, such as that measured in Field 2. This was a characteristic of the soil, and not the result of fertilizer application or use of manure.

Yield Components

Yield components and total yield are plotted in box-and-whiskers plots (Figures 3, 4, and 5). All harvested measurements are summarized in the grey area of each box, with median value given at the central line in each bar. The upper and lower edges of the box represent 25th and 75th percentiles, respectively. The upper and lower "whiskers" indicate the 90th and 10th percentiles of the data. Outliers are shown as individual points above or below the whiskers.

Of the yield components for corn, ear length, number of kernels around the cob, and average kernel weight showed the least variability across all fields and sites measured (Figure 3) as given by the coefficient of variation. This result indicated that the size of the cob (length and diameter) was fairly consistent across all growing environments, soil types, and cultivars. The yield component with the greatest variability was the number of kernels per cob. This was the primary factor impacting yield variability. Factors that contributed to number of kernels per cob included pollination, loss due to overripe ears (kernels on ground), and loss due to infection.

Soybean yield components of seed weight and number of seed per pod were the most consistent for both double-cropped and full-season soybean, whether planted by drill or rowed (data not shown). The single most variable factor for soybean yield was number of pods per plant, which was also dependent on planting configuration (rowed vs. drilled; Figure 4). The number of pods per plant decreased as the number of plants per acre increased, indicating soybean plants compensate to some degree for changes in plant population; however, the lowest yielding sampling sites were those with the lowest plant population. It is important to note that each field was planted to a consistent plant population based on the management system. The measured variability in plant population resulted from differences in plant stand establishment. The increased number of pods per plant at very low plant densities could not compensate for poor plant stands, indicating the importance of good plant stand establishment. The high plant population for drilled beans increased yield, but with diminishing returns (Figure 4). Some of the measured difference in soybean response to planting configuration may be due to cultivar differences.

Substantial in-field variability was observed for total yield in both corn and soybean (Figure 5). Although slight differences were observed between full-season and double-cropped soybean yield components, total yields per acre were fairly similar for the two cropping systems. More significant yield effects resulted from the planting configuration (Figure 5). Hand-harvested and machine-harvested values for corn yield were comparable, although highly variable.

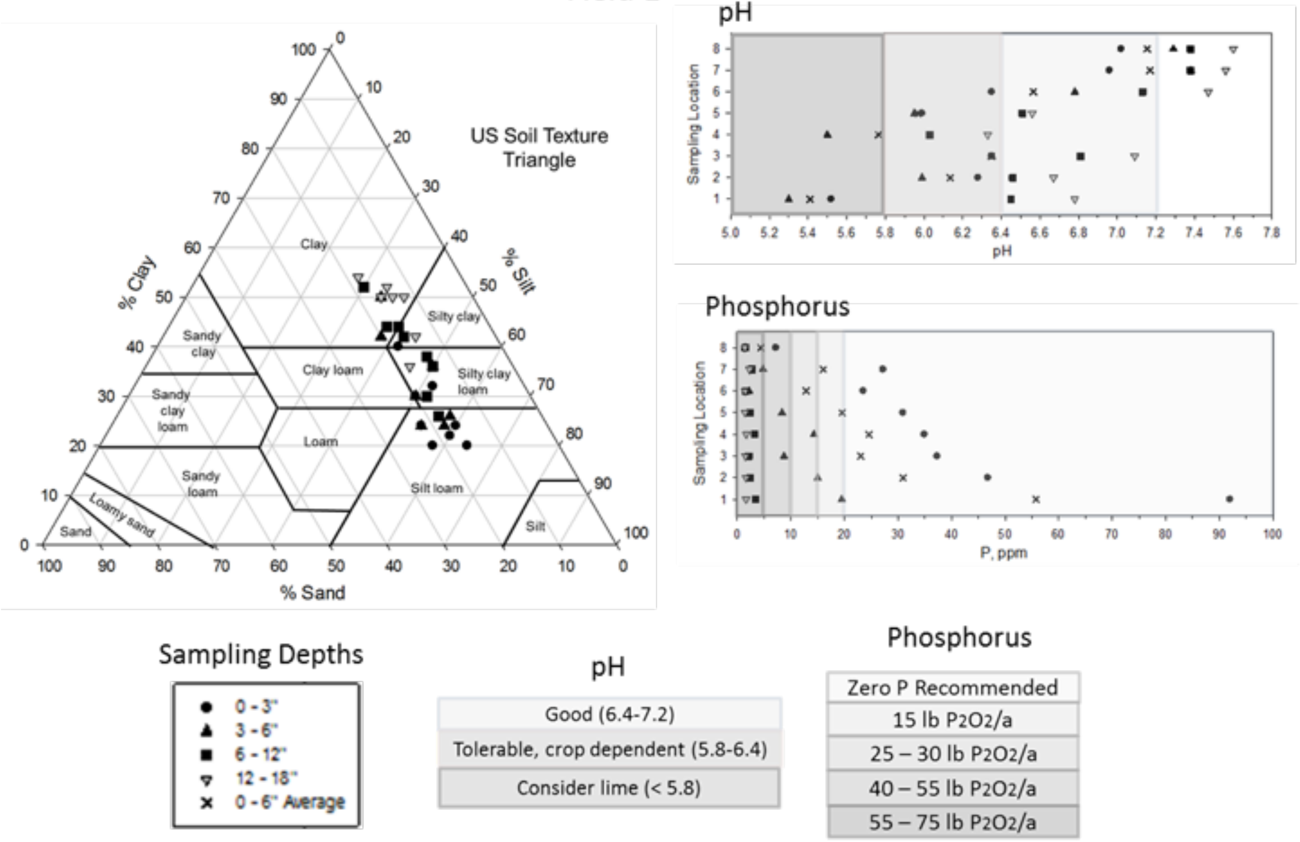
The results from this first year of study indicate the range of field conditions within production fields in southeast Kansas. The research will continue for a second year and expand to examine other crops in the region.

Acknowledgements

We would like to express our gratitude to the farmers who cooperated with this research.

Figure 1. Sampling protocol for on-farm determination of yield-limiting factors for crop production. Sampling protocol for on-farm determination of yield-limiting factors in production fields showing transects (white lines) through the field with sampling positions 1 through 8. Detailed measurements of soil and crop parameters were taken from within 3 ft^2 at each sampling position. Combine harvest of 100 ft of row was measured around each sampling position for total yield, seed size, and quality. Wet conditions during harvest prevented machine-harvested sampling of soybean.

Field 1



Field 2

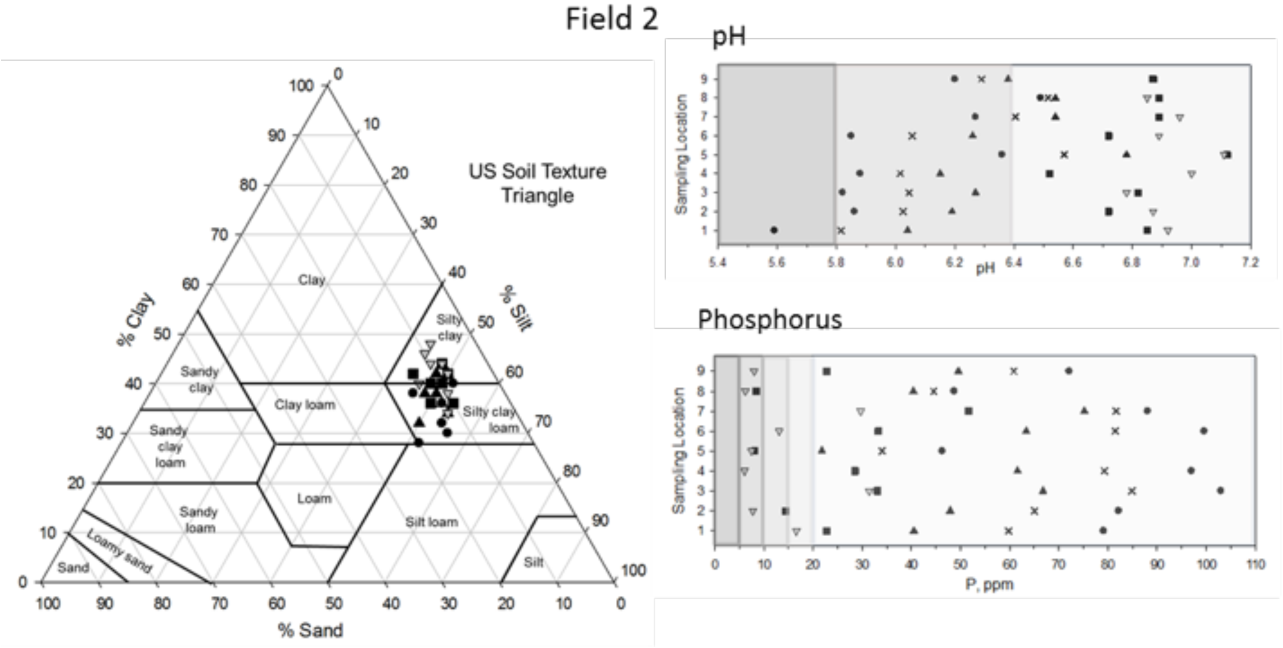


Figure 2. Soil parameters (texture, pH, and P) for two production fields in the study. Soil samples were taken at 0–3 in. (circle), 3–6 in. (up-triangle), 6–12 in. (square), and 12–18 in. (grey down triangle) depths within the soil profile at each of the selected sampling locations within the production fields and analyzed for soil texture (% sand, silt, and clay), pH, and soil nutrients (nitrogen, phosphorus, potassium, sulfur, and organic matter). For comparison to traditional on-farm soil nutrient results, measurements from 0–3 in. and 3–6 in. were combined (X's). Recommendations for optimal crop production are given by the shaded bars for pH and phosphorus.

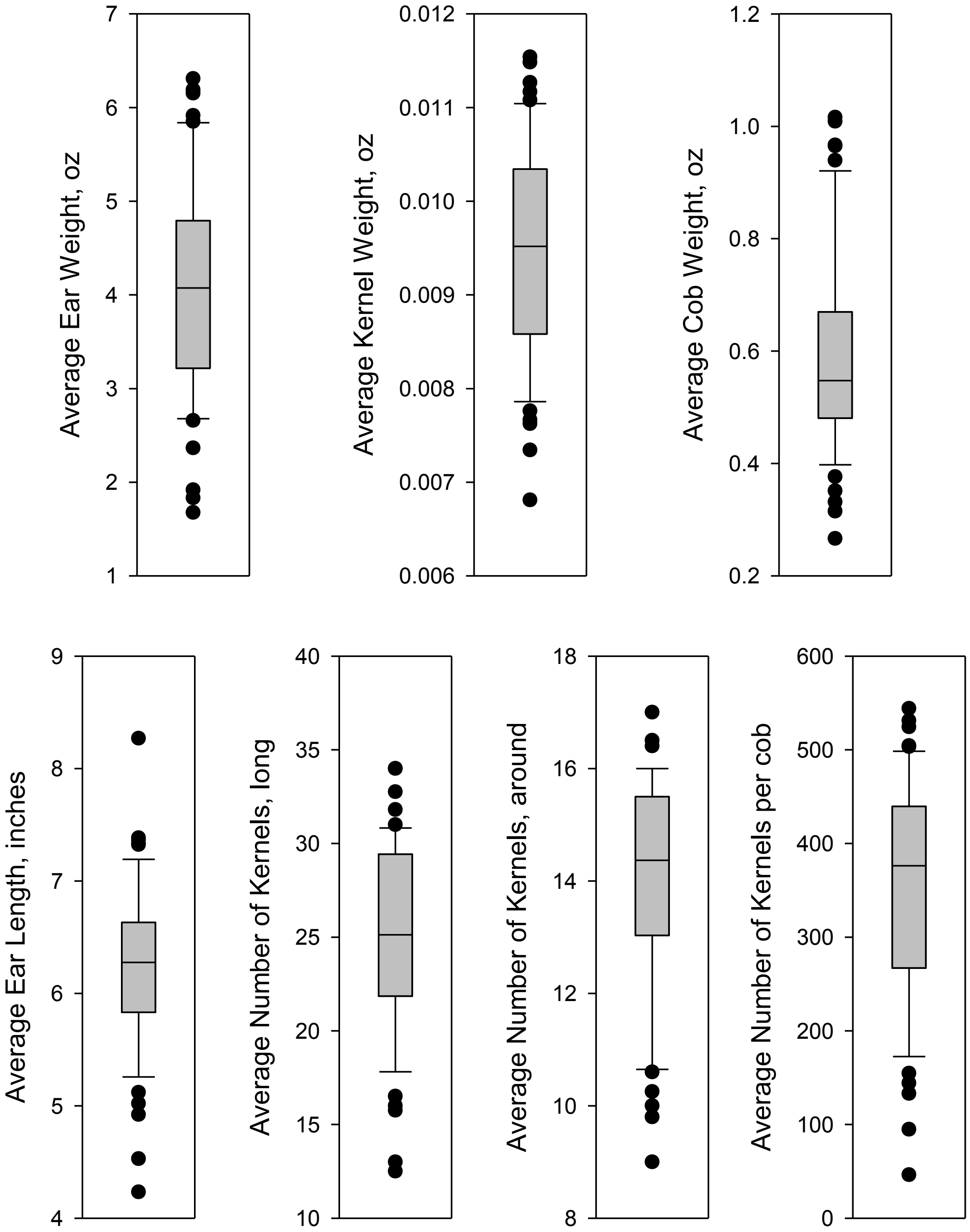
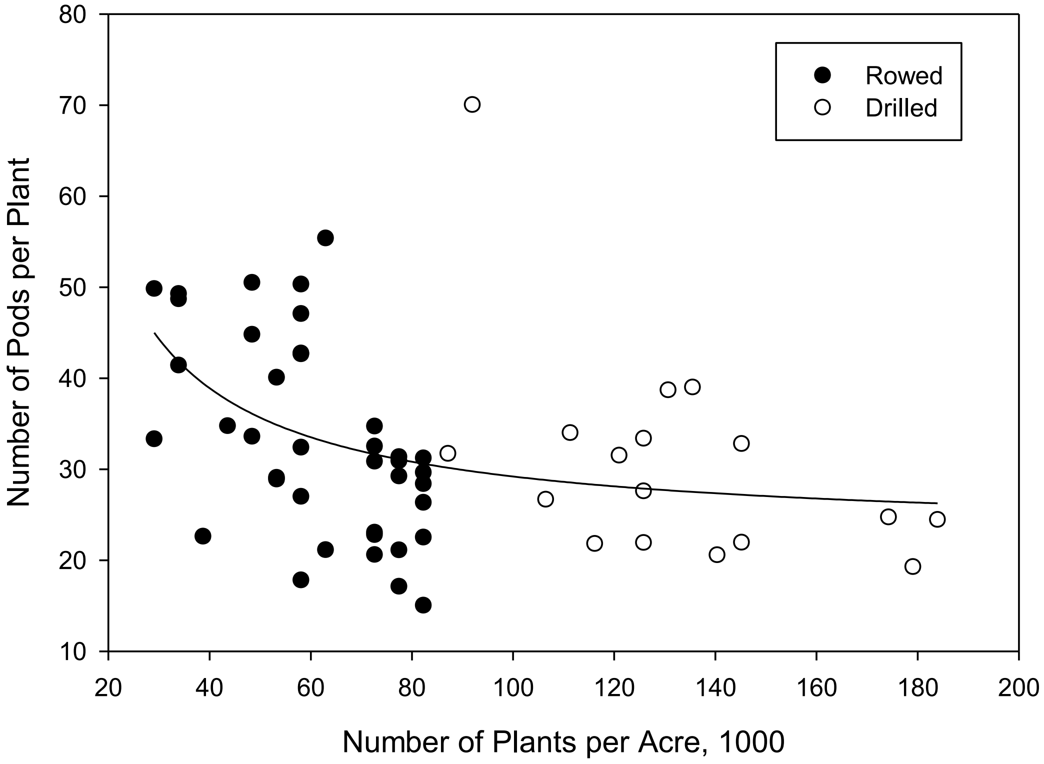


Figure 3. Harvest components for corn from each sampling location within production fields.



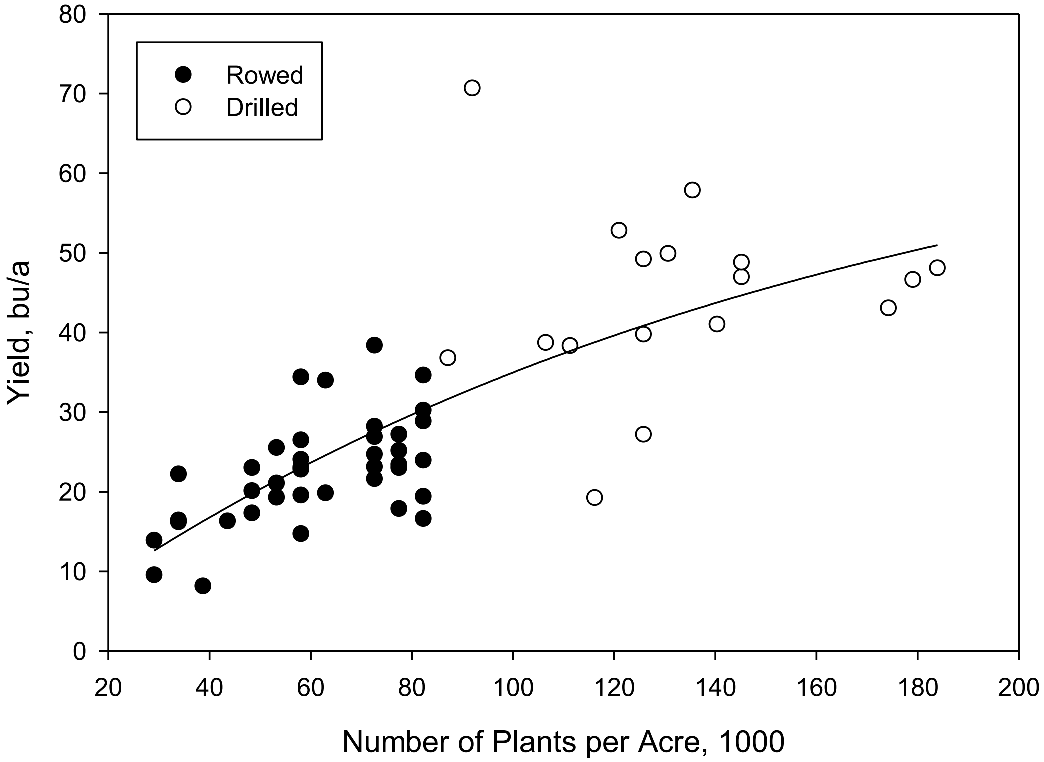


Figure 4. Response of soybean yield components to changes in plant density and planting configuration (row vs. drilled) for full-season and double-cropped soybean production fields.

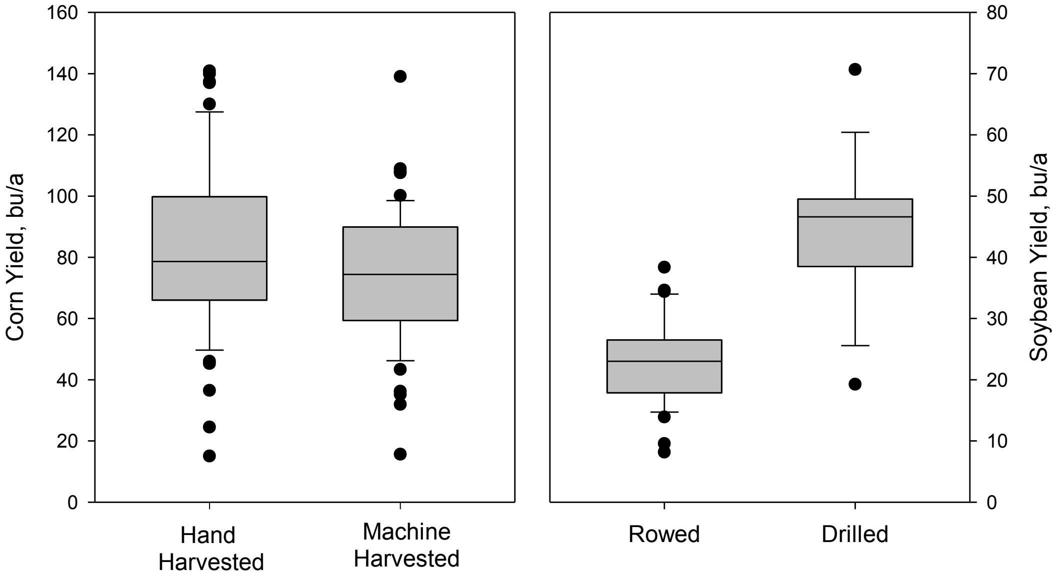


Figure 5. Yields for hand-harvested and machine-harvested corn from on-farm sampling (left) and hand-harvested soybean from rowed or drilled production fields (right).

Conservation Systems: Potential for Improving Yields in Southeast Kansas

G.F. Sassenrath and T. Mueller[1]

Summary

Concern for soil resources has increased the use of conservation tillage in southeast Kansas. Although this has improved soil and water quality, problems still exist in crop production fields prone to erosion. Publically available imagery and elevation data can be used to identify areas of vulnerability and develop alternative management practices to reduce soil loss and improve crop production.

Introduction

Southeast Kansas has nutrient-rich soils. One challenge for crop production is the shallow topsoil, underlain with a dense, unproductive clay layer. Concerns for topsoil loss have shifted production systems to reduced tillage or conservation management practices. Transitioning to conservation management practices such as reduced tillage and use of cover crops has been shown to improve the soil microenvironment and enhance the long-term sustainability of the agronomic production system.

To improve crop production and develop conservation practices, identification of vulnerable areas of fields is needed. Publicly available high-resolution imagery products and terrain maps can provide information on field conditions. This research explores within-field variability of farm production fields and uses online databases to collect information on vegetation and topography. The information is used to develop protocols for alternative management to protect vulnerable areas and reduce topsoil loss.

Experimental Procedures

High-resolution imagery is collected through the USDA National Agricultural Imagery Program (NAIP). Elevation data and orthoimagery for production fields were downloaded from the U.S. Geological Survey (USGS) (http://nationalmap.gov) and analyzed using ArcGIS with Spatial Analyst (ESRI, Redlands, CA). NAIP imagery for the production field presented here was collected from June 8 through July 24, 2012.

The NAIP 4-band imagery was used to calculate the normalized difference vegetation index (NDVI). NDVI is commonly used to indicate plant growth and is calculated as:

$$\text{NDVI} = \frac{(\text{NIR-Red})}{(\text{NIR + Red})}$$

where NIR and Red are the spectral bands for the near-infrared (~> 725 nm) and red (~600–725 nm) regions of the spectrum, respectively.

Digital elevation maps (DEMs) were used to perform terrain analysis of production fields using ArcGIS and Taudem (http://hydrology.usu.edu/taudem/taudem5/index.html).

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[1] John Deere & Company, Agronomic Data Researcher.

Analysis of the DEM allows determination of areas of the field that hold water and areas of high potential runoff.

Crop performance was determined as described previously from sampling sites within each production field. Two-row-wide line-transects were established through the fields, and multiple sampling locations were established along each transect (Figure 1). At each sampling location, plants were hand-harvested from 3 ft^2 for determination of yield components (plants per area, pods or cobs per plant, seeds per pod or cob, average seed size, etc.). Soil samples were taken at each sampling site at four depths (0–3 in., 3-6 in., 6–12 in., and 12–18 in.) and analyzed for nutrients, pH, organic matter, and classification (percentage clay, silt, and sand content).

Results and Discussion

The production field used in this study is 110 acres in Labette County, southeast Kansas (Figure 1). It is composed almost entirely of a Wagstaff silty clay loam soil with 1 to 3% slope and has been in a long-term corn/winter wheat/soybean rotation. Waterways drain the field to the south and north (arrows), and the deeper northern waterway is planted to grass.

The NDVI map indicates areas of thin vegetation, particularly in the western half of the field (Figure 2). The NAID imagery from which the NDVI was calculated was taken in 2012, when the field was planted to corn. Although the field has only a moderate slope (1–3%), calculation of surface curvature for the field indicates a higher ridge through the center of the field (lighter area in Figure 3). This area corresponds to the area of poor vegetative coverage. The following year, soybean yield was reduced in areas of low vegetation (Figure 4), indicating a persistent problem in those areas of the field.

To identify potential areas of erosion, we performed a terrain analysis of the field (Figure 5). Areas of high potential for soil loss are indicated by the black lines. These areas could benefit by altered management practices to slow water runoff from the field and preserve topsoil.

This study is being expanded to other production fields in southeast Kansas. Alternative production methods, such as cover crops, are being explored for their potential to retain topsoil and limit soil erosion.

Acknowledgements

We would like to express our gratitude to the producers who collaborated in this research project.

Figure 1. USDA National Agricultural Imagery Program remote image from early summer 2012 of a crop production field in southeast Kansas. Arrows indicate waterways draining the field.

Note: Color images of the figures are available in the online version of this publication at www.ksre.ksu.edu/bookstore. Type "SEARC Agricultural Research 2014" in the search box.

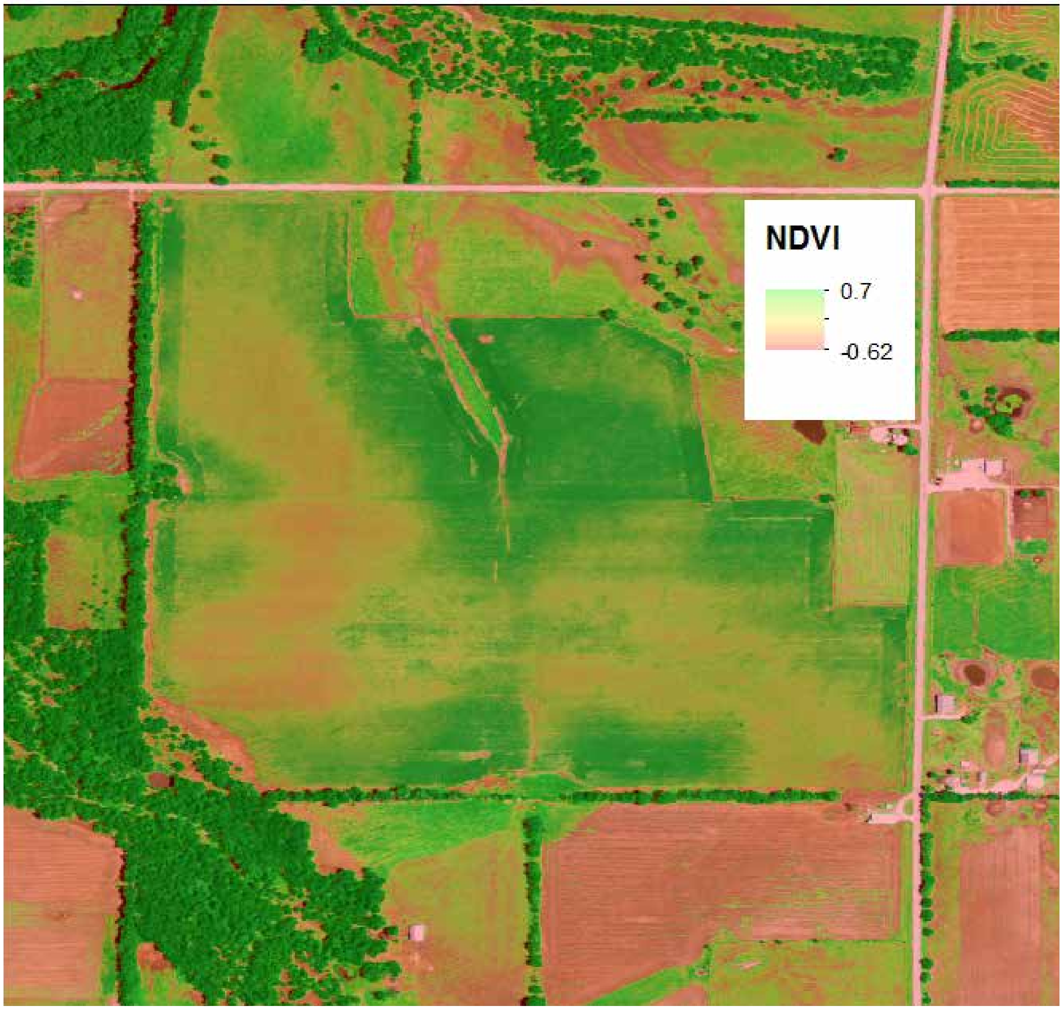

Figure 2. Calculation of normalized difference vegetation index (NDVI) from USDA National Agricultural Imagery Program imagery for the crop production field.
Note: Color images of the figures are available in the online version of this publication at www.ksre.ksu.edu/bookstore. Type "SEARC Agricultural Research 2014" in the search box.

Figure 3. Curvature of the field surface derived from USGS digital elevation map data.
Note: Color images of the figures are available in the online version of this publication at www.ksre.ksu.edu/bookstore. Type “SEARC Agricultural Research 2014” in the search box.

Figure 4. Soybean yield in 2013 from hand-harvested subplots within the field.
Note: Color images of the figures are available in the online version of this publication at www.ksre.ksu.edu/bookstore. Type “SEARC Agricultural Research 2014” in the search box.

Figure 5. Terrain analysis of the crop field showing areas of high runoff potential.
Note: Color images of the figures are available in the online version of this publication at www.ksre.ksu.edu/bookstore. Type “SEARC Agricultural Research 2014” in the search box.

Fungicide and Insecticide Use on Wheat in Southeast Kansas

K. Kusel, D. Shoup[1], and G. Sassenrath

Summary

Producers have increased management of wheat in recent years in response to higher commodity prices. Wheat response to fungicide and insecticide application was evaluated in 2012 and 2013. Treatments included an untreated check, Mustang Maxx (FMC, Philadelphia, PA) insecticide at 3.2 fl oz/a, Headline (BASF Research Triangle Park, NC) fungicide at 6.0 fl oz/a, and Headline at 6.0 fl oz/a + Mustang Maxx at 3.2 fl oz/a. Treatments were applied to Everest wheat at complete flag leaf emergence in 2012 and heading in 2013. No treatment × year interaction was detected, so data were combined across years. Good wheat yields were achieved, and the addition of any pesticide increased yield over the untreated check. The addition of insecticide, fungicide, and fungicide + insecticide increased wheat yields by 5.4, 9.0, and 12.1 bu/a, respectively.

Introduction

Wheat fungicide use across the state of Kansas historically has resulted in an approximate 10% yield increase when disease was present on a susceptible variety. Yield response of wheat to insecticides has not been well documented in southeast Kansas. With the change in economics of wheat production in recent years, producers are considering increased use of pesticides to improve wheat yield and quality. A two-year study was initiated to evaluate the yield response of wheat to fungicide and insecticide applications in southeast Kansas.

Experimental Procedures

The experimental site was located on a Parsons silt loam planted in tilled ground after corn harvest. The experiment utilized a randomized complete block design with four replications of four treatments. Everest wheat was planted on October 25, 2011, and October 3, 2012, at 75 lb/a in 7-in.-spaced rows. Plots were 8 ft × 275 ft in 2012 and 8 ft × 40 ft in 2013. Treatments included an untreated check, Mustang Maxx insecticide at 3.2 fl oz/a, Headline fungicide at 6.0 fl oz/a, and combined Mustang Maxx at 3.2 fl oz/a + Headline at 6.0 fl oz/a. Treatments were applied to wheat at the complete flag leaf emergence stage (Feekes 9) on March 3, 2012, and wheat at the heading stage (Feekes 10.1) on May 7, 2013. Wheat was harvested by plot combine on May 30, 2012, and June 24, 2013, and plot weights were adjusted to 13.5% moisture.

Results and Discussion

Favorable growing conditions resulted in above-average yields in both years. No year × treatment interaction was detected, so data were combined across years (Table 1). The untreated wheat averaged 61.6 bu/a. The addition of Mustang Maxx increased yield to 67.0 bu/a, and the addition of Headline increased yield to 70.6 bu/a. The fungicide treatment in this trial increased yield 9.0 bu/a, greater than the 10% yield increase response traditionally observed in Kansas. The highest-yielding treatment was

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[1] Kansas State University Southeast Area Extension.

the combined Headline + Mustang Maxx treatment at 73.7 bu/a. Disease and insect pressure were not recorded in this study, but common pests in the area during the years the trial was conducted were Septoria and stripe rust fungal pathogens and several aphid species, including bird cherry-oat aphid and English grain aphid. The enhanced response to fungicide and insecticide treatments observed in this study may indicate a greater pressure from these pathogens in these years.

Table 1. Wheat yield response to fungicide and/or insecticide in 2012 and 2013; data were combined across years

Treatment[1]	Rate	Yield[2]
	------- fl oz/a -------	------- bu/a -------
Untreated		61.6
MustangMax[3] insecticide	3.2	67.0
Headline[4] fungicide	6.0	70.6
MustangMax + Headline	3.2 + 6.0	73.7
LSD (0.05)		4.6

[1] Applications in 2012 were made to wheat at complete flag leaf emergence and in 2013 to wheat at heading.
[2] Yields adjusted to 13.5% moisture.
[3] FMC, Philadelphia, PA.
[4] BASF, Research Triangle Park, NC.

Wheat Response to Fungicides in Southeast Kansas

D. Shoup[1], K. Kusel, G. Sassenrath, and E. DeWolf[2]

Summary

Fungicide use on wheat has become a more common occurrence in recent years. To evaluate wheat response to fungicide applications under southeast Kansas conditions, three wheat varieties were planted following corn for two years (Everest, Endurance, and Overley in 2010 and Everest, Armour, and Fuller in 2012). Prosaro (Bayer CropScience, Research Triangle Park, NC) at 6.5 fl oz/a was applied at Feekes 10.5.1 in 2011, and Headline (BASF, Research Triangle Park, NC) at 6.0 fl oz/a was applied at Feekes 10.1 in 2013. Foliar disease was evaluated after application. No significant yield increase was observed in 2011; however, little to no disease was observed in 2011 following fungicide application. In 2013, heavier disease pressure was observed, and fungicide applications significantly increased yield across all three varieties. Fungicide application increased yield 10.3, 13.7, and 19.5 bu/a for Armour, Everest, and Fuller, respectively.

Introduction

Wheat fungicide use across the state of Kansas historically has resulted in approximately 10% yield increase when disease is present on a susceptible variety. With the change in economics of wheat production in recent years, producers are looking more intensively at the use of fungicides to improve wheat yield and quality. A two-year study was initiated to evaluate the yield response of fungicide applications to wheat varieties with varying levels of fungal disease resistance.

Experimental Procedures

The experimental site was located on a Parsons silt loam planted in tilled ground after corn harvest. The experiment utilized a randomized complete block design with four replications of six treatments consisting of three wheat varieties applied with and without fungicide. Varieties Everest, Endurance, and Overley were planted on October 7, 2010, and Everest, Armour, and Fuller were planted on October 19, 2012, at 75 lb/a in 7-in.-spaced rows. Prosaro 421 SC was applied at 6.5 fl oz/a on May 5, 2011 when wheat was at the Feekes 10.5.1 stage. Headline SC was applied on May 8, 2013, to wheat at the Feekes 10.1 stage. Wheat fungal diseases on the flag leaf were evaluated by visual inspection after applications. Wheat was harvested by plot combine on June 15, 2011, and June 24, 2013.

Results and Discussion

Wheat was planted in a timely manner both years and adequate fall tillering occurred, promoting average to above-average yields. Moisture was abundant in 2011, totaling 14.8 in. during the critical foliar disease months of March, April, and May; however, no significant fungal disease pressure was observed after fungicide application. Precipita-

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[1] Kansas State University Southeast Area Extension.

[2] Kansas State University Department of Plant Pathology.

tion in 2013 totaled 17.0 in. during March, April, and May and promoted the occurrence of stripe rust (*Puccinia striiformis* f. sp. *tritici*) and septoria tritici blotch (*Mycosphaerella graminicola*) (Table 2).

In 2011, yields ranged from 46.5 to 58.8 bu/a (Table 1). Although the highest-yielding treatment was 58.8 bu/a for Everest treated with a fungicide, no significant differences were observed between treated and untreated plots. In 2013, significant reductions in stripe rust and septoria were observed for plots treated with a fungicide (Table 2); consequently, yield differences between varieties and fungicide treatments were significant. Fungicide increased yield of all three varieties by 10.3, 13.7, and 19.5 bu/a for Armour, Everest, and Fuller, respectively. Yield increases with fungicide treatment were expected because of the high number of fungal lesions on the flag leaves of untreated plots, but yield increases of this magnitude are greater than typical responses to fungicides applied to wheat in Kansas.

Table 1. Wheat yield response to fungicide in 2011, when no significant fungal disease was present between application and harvest

Variety	Treatment[1]	Yield[2]
		------- bu/a -------
Endurance	Untreated	46.5
	Treated	49.4
Everest	Untreated	57.4
	Treated	58.8
Overley	Untreated	48.0
	Treated	51.6
LSD (0.05)		8.9
Main effect means:		
Endurance		48.0
Everest		58.1
Overley		49.8
LSD (0.05)		6.3
	Untreated	50.6
	Treated	53.2
	LSD (0.05)	NS

[1] Application of 6.5 fl oz/a Prosaro 421 SC (Bayer CropScience, Research Triangle Park, NC) to wheat at Feekes 10.5.1.

[2] Yields adjusted to 13.5% moisture.

Table 2. Wheat disease ratings and yield response to fungicide in 2013

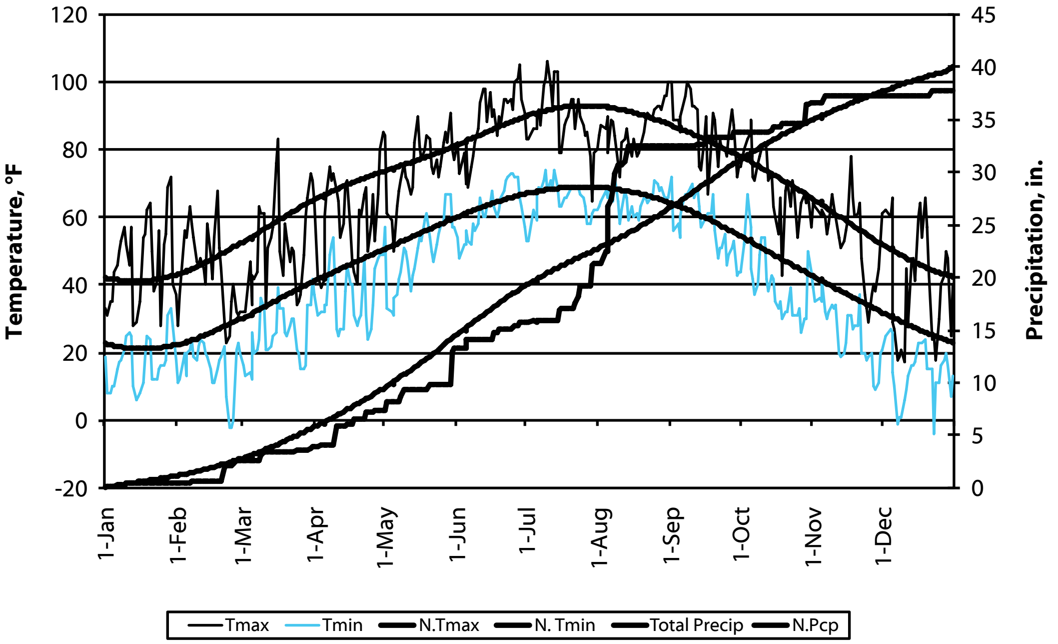
Variety	Treatment[1]	Stripe rust[2]	Septoria leaf blotch	Yield[3]
		------- % flag leaf infected -------		------- bu/a -------
Armour	Untreated	4.0	5.0	61.1
	Treated	0.0	1.0	71.4
Everest	Untreated	1.0	22.0	56.5
	Treated	0.0	7.0	70.2
Fuller	Untreated	0.0	11.0	48.4
	Treated	0.0	4.0	67.9
LSD (0.05)		1.9	4.9	6.7
Main effect means:				
Armour		2.0	2.9	66.2
Everest		0.4	14.5	63.3
Fuller		0.0	7.6	58.2
LSD (0.05)		1.4	3.5	4.8
	Untreated	1.5	12.8	55.3
	Treated	0.1	3.9	69.8
	LSD (0.05)	1.1	2.8	3.9

[1] Application of 6.0 fl oz/a Headline SC (BASF, Research Triangle Park, NC) to wheat at Feekes 10.1.

[2] Leaf ratings evaluated on May 22.

[3] Yields adjusted to 13.5% moisture.

Annual Summary of Weather Data for Parsons



2013 data

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Avg. max	46.3	44.5	51.3	60.9	74.5	88.6	88.9	86.3	85.8	69.5	54.5	41.2	66.0
Avg. min	16.9	15.9	24.9	36.7	50.1	61.9	65.3	65.3	58.2	40.3	26.433	14.4	39.7
Avg. mean	31.6	30.2	38.1	48.8	62.3	75.3	77.1	75.8	72.0	54.9	40.5	27.8	52.8
Precip.	0.55	2.13	1.17	3.6	5.77	2.49	5.59	11.23	1.34	2.80	0.59	0.42	37.68
Snow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Heat DD*	1036	976	834	489	160	14	2	0	21	338	736	1153	5757
Cool DD*	0	0	0	2	76	322	377	334	231	24	0	0	1364
Rain Days	4	6	6	11	7	7	8	10	5	6	1	2	73
Min < 10	5	4	0	0	0	0	0	0	0	0	1	7	17
Min < 32	30	28	23	12	1	0	0	0	0	7	19	31	151
Max > 90	0	0	0	0	1	15	12	8	10	0	0	0	46

Normal values (1981–2010)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Avg. max	42.0	47.6	57.1	67.1	75.7	84.4	90.0	90.3	81.3	69.6	56.6	44.2	67.2
Avg. min	21.8	26.0	35.0	44.5	55.0	64.1	68.5	66.6	57.6	45.5	35.3	24.6	45.5
Avg. mean	31.9	36.8	46.1	55.8	65.3	74.2	79.3	78.5	69.4	57.6	46	34.4	56.4
Precip	1.41	1.77	3.19	4.38	5.93	5.53	3.92	3.29	4.69	3.86	2.94	2.06	42.97
Snow	2.8	1.7	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	2.7	8.7
Heat DD	1026	790	590	299	85	8	1	1	52	260	574	948	4632
Cool DD	0	0	2	23	96	285	442	418	186	29	2	0	1483

Departure from normal

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Avg. max	4.3	-3.1	-5.8	-6.2	-1.2	4.2	-1.1	-4.0	4.5	-0.1	-2.1	-3.0	-1.1
Avg. min	-4.9	-10.1	-10.1	-7.8	-4.9	-2.2	-3.2	-1.3	0.6	-5.2	-8.9	-10.2	-5.7
Avg. mean	-0.3	-6.6	-8.0	-7.0	-3.0	1.0	-2.2	-2.7	2.6	-2.7	-5.5	-6.6	-3.4
Precip.	-0.86	0.36	-2.02	-0.78	-0.16	-3.04	1.67	7.94	-3.35	-1.06	-2.35	-1.64	-5.29
Snow	-2.8	-1.7	-1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.3	-2.7	-8.7
Heat DD	10	186	244	190	75	6	2	-1	-32	78	162	205	1123
Cool DD	0	0	-2	-21	-21	37	-65	-85	45	-5	-2	0	-119

* 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.

Research Center Personnel

Lyle Lomas, Research Center Head and Animal Scientist
  Larry Buffington, Custodial Specialist
  Jason Denton, Agricultural Technician Senior
  TaLana Erikson, Agricultural Technician Senior
  Terry Green, Agricultural Technician Senior
  Adam Harris, Agricultural Technician Senior
  Marla Sexton, Accountant I

Joseph Moyer, Forage Agronomist
  Mike Cramer, Agricultural Technician Senior
  Larry Sale, Agricultural Technician

Gretchen Sassenrath, Crop Production Agronomist
  Garth Blackburn, Agricultural Technician
  Kelly Kusel, Research Assistant
  Lonnie Mengarelli, Agricultural Technician

Daniel Sweeney, Soil and Water Management Agronomist
  Michael Dean, Agricultural Technician Senior
  David Kerley, Agricultural Technician Senior

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