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AGRICULTURAL RESEARCH 2011

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SOUTHEAST AGRICULTURAL RESEARCH CENTER

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Effects of Various Grazing Systems on Grazing and Subsequent Finishing Performance

L.W. Lomas and J.L. Moyer

Summary
Forty mixed black steers (633 lb) 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. Daily gains of steers that grazed 'MaxQ' tall fescue, wheat-bermudagrass, or wheat-crabgrass were similar ($P>0.05$). However, total grazing gain was greater ($P<0.05$) for 'MaxQ' tall fescue than for wheat-bermudagrass and wheat-crabrass because cattle grazed these pastures for a longer period of time. Finishing gains were similar ($P>0.05$) among forage systems. Cattle that grazed 'MaxQ' tall fescue had greater ($P<0.05$) ending weight, greater ($P<0.05$) hot carcass weight, greater ($P<0.05$) dry matter intake, and greater ($P<0.05$) overall gain than those that had previously grazed wheat-bermudagrass or wheat-crabgrass.

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. However, these systems have never been directly compared in the same study. The objective of this study was to compare grazing and subsequent finishing performance of stocker steers that grazed the three systems.

Experimental Procedures
Forty mixed black steers (633 lb) were weighed on 2 consecutive days (April 5 and 6, 2010) and allotted to three four-acre pastures of 'Midland 99 ' bermudagrass and three four-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 Sept. 30, 2009, and four four-acre established pastures of 'MaxQ' tall fescue (four steers/pasture). All pastures were fertilized with 80-40-40 lb/a of N-P_2O_5-K_2O on Mar. 3, 2010. Fescue pastures received an additional 46 lb/a of N on Aug. 31, 2010.

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 Sept. 14, 2010 (161 days), and fescue pastures were grazed continuously until Nov. 9, 2010 (217 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, 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). 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 Table 1. Grazing daily gain of steers that grazed 'MaxQ' fescue, wheat-bermudagrass, or wheat-crabgrass were similar ($P>0.05$). However, 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-bermudagrss, 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 than wheat-bermudagrass or wheat-crabgrass.

Grazing treatment had no effect on finishing gains or feed efficiency. Steers that grazed 'MaxQ' fescue had greater ($P<0.05$) ending weight, feed intake, and hot carcass weight than those that grazed wheat-bermudagrass or wheat-crabgrass. However, this was due primarily to those steers being heavier at the end of the grazing phase. Steers that grazed 'MaxQ' fescue had greater ($P<0.05$) overall gain, but lower ($P<0.05$) overall daily gain than those that grazed wheat-bermudagrass or wheat-crabgrass because of grazing 56 more days and being fed six more days in the finishing phase.

Although grazing daily gains were similar among steers that grazed 'MaxQ' fescue, wheat-bermudagrass, or wheat-crabgrass, 'MaxQ' tall fescue produced more ($P<0.05$) available forage, provided for a longer grazing season, and produced greater ($P<0.05$) gain/a.

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

	Forage system		
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	1456a	1349b	1327b
Gain, lb	462	430	436
Daily gain, lb	4.62	4.57	4.64
Daily dry matter intake, lb	27.3a	24.6b	25.2b
Feed:gain	5.92	5.38	5.43
Hot carcass weight, lb	847a	794b	790b
Dressing percentage	58.2	58.9	59.5
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[1]	649	590	592
Percentage USDA grade Choice	100	92	83
Overall performance (grazing plus finishing)			
No. of days	317	255	255
Gain, lb	823a	716b	694b
Daily gain, lb	2.60a	2.80b	2.72b

[1] 500 = small, 600 = modest, 700 = moderate.
Means within a row followed by the same letter do not differ ($P<0.05$).

Effect 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
One hundred forty-four 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,' low-endophyte 'Kentucky 31,' 'HM4,' and 'MaxQ.' Steers were either fed no supplement or supplemented with DDG at 1.0% or 0.75% of body weight per head daily while grazing in 2009 and 2010, respectively. 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. However, in 2010, steers that previously grazed high-endophyte 'Kentucky 31' had greater ($P>0.05$) finishing gains that those that had grazed 'HM4' or 'MaxQ.' Supplementation of grazing steers with DDG supported a higher stocking rate and resulted in greater ($P<0.05$) grazing gains, gain/a, hot carcass weights, ribeye area, and overall gains and reduced the amount of fertilizer needed by providing approximately 60 lb/a and 50 lb/a of nitrogen in 2009 and 2010, respectively, from feces and 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 "novel" endophyte that provides vigor to the fescue plant but does not have the negative effect on performance of grazing livestock.

Growth in the ethanol industry has resulted in increased availability of distillers grains, which, because of their high protein and phosphorus content, have been shown to be an excellent feedstuff for supplementing grazing cattle. Dried distillers grains (DDG) contain approximately 4% to 5% N, and cattle consuming them excrete a high percentage of this nitrogen in their urine and feces. Therefore, feeding DDG to grazing cattle will provide nitrogen 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 steers were weighed on two consecutive days and allotted to 16 five-acre established pastures of high-endophyte 'Kentucky 31,' low-endophyte 'Kentucky 31,' 'HM4,' or 'MaxQ' tall fescue (four replications per cultivar) on March 26, 2009 (569 lb), and March 24, 2010 (550 lb). 'HM4' and 'MaxQ' have the novel 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 and 2010, respectively. All pastures were fertilized with 80 lb/a nitrogen and P_2O_5 and K_2O as required by soil test on February 5, 2009, and February 10, 2010. Pastures with steers that received no supplement were fertilized with 60 lb/a nitrogen on September 16, 2009, and 46 lb/a nitrogen on August 30, 2010. This was calculated to be approximately the same amount of nitrogen 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. In 2009, two steers were removed from the study for reasons unrelated to experimental treatment. Pastures were grazed continuously until October 13, 2009 (201 days), and Nov. 3, 2010 (224 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, 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, respectively, in 2009 and for 106 days in 2010. 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 and 2 for 2009 and 2010, respectively, and by supplementation treatment in Tables 3 and 4 for 2009 and 2010, respectively.

During both 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 and 2). 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, and 1.56, 1.91, 1.97, and 2.04 lb/head, respectively, in 2010. 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, and 322, 390, 400, and 416 lb/a, respectively, in 2010.

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 grading 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,' similar (P>0.05) finishing gains as those that grazed low-endophyte 'Kentucky 31,' lower (P<0.05) hot carcass weight than those that grazed 'MaxQ,' similar (P>0.05) hot carcass weight as 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.' 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.'

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 3 and 4). 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, and 1.62 and 2.12 lb/head daily and 363 and 475 lb/a, respectively, in 2010. Supplemented steers consumed an average of 7.8 and 6.0 lb of DDG/head daily during the grazing phase in 2009 and 2010, respectively. Each additional pound of gain obtained from pastures with supplemented steers required 6.5 and 7.2 lb of DDG in 2009 and 2010, 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 both 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, steers supplemented with DDG while grazing had lower (P<0.05) finishing gains and greater (P<0.05) fat thickness and marbling score than those that received no supplement while grazing.

Average available forage dry matter is presented for each fescue cultivar and supplementation treatment combination for 2009 and 2010 in Tables 5 and 6, respectively. A significant interaction occurred (P<0.05) between cultivar and supplementation treatment during both years. Within each variety, there was no difference (P>0.05) in average available forage dry matter 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 5). Average available forage dry matter was similar (P>0.05) between supplementation treatments and pastures with supplemented steers were stocked at a heavier rate, which indicates that pastures were responding to the nitrogen 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 dry matter than 'MaxQ' pastures without supplementation. No other differences in average available forage dry matter were observed.

In 2010, no difference occurred (P>0.05) in average available forage dry matter 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 6). 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 dry matter 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 dry matter than low-endophyte 'Kentucky 31,' 'HM4,' or 'MaxQ' pastures stocked with 0.8 steer/a that received no supplelment.

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 50 to 60 lb of nitrogen/a. Producers seeking to maximize production from fescue pastures should consider using one of the new fescue varieties with the novel endophyte in combination with DDG supplementation.

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

	Tall fescue cultivar			
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	1042b	1019b	1038b
Ending weight, lb	1285a	1381b	1366b	1376b
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
Dressing percentage	59.1	59.4	59.3	58.9
Backfat, in.	0.43	0.43	0.44	0.47
Ribeye area, sq. in.	11.9a	11.9a	12.5b	11.7a
Yield grade[1]	2.6a	3.0b	2.8a	3.0b
Marbling score[2]	601a	646ab	672bc	717c
Percent 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] USDA (1987).
[2] 600 = modest, 700 = moderate.
Means within a row followed by the same letter do not differ (P<0.05).

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

	Tall fescue cultivar			
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	1007b
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	1007b
Ending weight, lb	1386a	1432b	1419b	1449b
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[1]	2.7	2.9	2.8	2.8
Marbling score[2]	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] USDA (1987).
[2] 600 = modest, 700 = moderate.
Means within a row followed by the same letter do not differ (P<0.05).

Table 3. Effect 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)	
Item	0	1.0
Grazing phase (201 days)		
No. of head	30	40
Initial weight, lb	569	569
Ending weight, lb	911a	1095b
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	1095b
Ending weight, lb	1289a	1415b
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[1]	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] 600 = modest, 700 = moderate.

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

Table 4. Effect 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)	
Item	0	0.75
Grazing phase (224 days)		
No. of head	32	40
Initial weight, lb	550	550
Ending weight, lb	912a	1025b
Gain, lb	363a	475b
Daily gain, lb	1.62a	2.12b
Gain/a, lb	290a	475b
Total DDG consumption, lb/head	---	1335
Average DDG consumption, lb/head per day	---	6.0
DDG, lb/additional gain, lb	---	7.2
Finishing phase (106 days)		
Beginning weight, lb	912a	1025b
Ending weight, lb	1378a	1464b
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[1]	638a	669b
Percent USDA grade choice	94	100
Overall performance (grazing plus finishing) (330 days)		
Gain, lb	829a	914b
Daily gain, lb	2.51a	2.77b

[1] 600 = modest, 700 = moderate.
Means within a row followed by the same letter do not differ (P<0.05).

Table 5. Effect 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)	
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

Means followed by the same letter do not differ (P<0.05).

Table 6. Effect 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)	
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

Means followed by the same letter do not differ (P<0.05).

Distillers Grains Supplementation Strategy for Grazing Stocker Cattle

L.W. Lomas and J.L. Moyer

Summary
A total of 108 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, and 2010. 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. Supplementation treatment had no effect (P>0.05) on available forage during the grazing phase. Grazing performance and supplement conversion efficiency were not different (P>0.05). However, compared with steers supplemented during the entire grazing phase, those on the delayed supplementation treatment consumed 155, 142, and 128 lb less DDG in 2008, 2009, and 2010, respectively, but had similar gains. Supplementation during the grazing phase had no effect (P>0.05) on finishing performance in 2008 or 2010. In 2009, steers that received no supplementation during the grazing phase had greater (P<0.05) finishing gains than those that were 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 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 coproducts 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 five-acre smooth bromegrass pastures on April 9, 2008 (450 lb); April 3, 2009 (467 lb); and March 30, 2010 (448 lb). Three pastures of steers were randomly assigned to one of three supplementation treatments (three replicates per treatment) and were grazed for 196 days, 221 days, and 224 days in 2008, 2009, and 2010, respectively. Supplementation treatments were

no DDG, 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, and 168 days in 2008, 2009, and 2010, respectively). Pastures were fertilized with 100 lb/a N on February 29, 2008; February 10, 2009; and February 18, 2010). Pastures were stocked with 0.8 steers/a and grazed continuously until October 22, 2008; November 10, 2009; and November 9, 2010, 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 distillers grains 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, 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, and for 100 days in 2010. 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, and 3 for 2008, 2009, and 2010, respectively. Supplementation with DDG had no effect ($P>0.05$) on quantity of forage available for grazing in either year. However, average available forage for all treatments was higher in 2008 than in 2009 and 2010.

Steers supplemented with 0.5% DDG during the entire grazing season or only during the latter part of the grazing season had 31% or 23% greater ($P<0.05$) weight gain, daily gain, and steer gain/a in 2008; 42% or 40% greater ($P<0.05$) weight gain, daily gain, and steer gain/a in 2009; and 26% or 30% greater ($P<0.05$) weight gain, daily gain, and steer gain/a in 2010, respectively, than those that received no supplement. Steers supplemented with 0.5% DDG throughout the grazing season or only during the latter part in 2008 had 100 or 75 lb greater ($P<0.05$) total weight gain, 0.51 or 0.38 lb greater ($P<0.05$) daily gain, and 80 or 60 lb greater ($P<0.05$) gain/a, respectively, than those that received no supplementation. Steers supplemented with 0.5% DDG throughout the grazing season or only during the latter part in 2009 had 135 or 129 lb greater ($P<0.05$) total weight gain, 0.61 or 0.59 lb greater ($P<0.05$) daily gain, and 108 or 104 lb greater ($P<0.05$) gain/a, respectively, than those that received no supplementation. Steers supplemented with 0.5% DDG throughout the grazing season or only during the latter part in 2010 had 88 or 103 lb greater ($P<0.05$) total weight gain, 0.40 or 0.46 lb greater ($P<0.05$) daily gain, and 70 or 82 lb greater ($P<0.05$) gain/a, respectively, than those that received no supplementation. 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, and 128 lb more DDG in 2008, 2009, and 2010, respectively, than those that were supplemented only during the latter part of the grazing season. Steers supplemented with DDG during the entire grazing season or only during the latter part consumed 6.5 or 6.6 lb of DDG, 5.7 or 4.9 lb of DDG, and 8.6 or 6.1 lb of DDG for each additional pound of body weight gained during the grazing phase above steers that received no supplement in 2008, 2009, and 2010, respectively.

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) was not different (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 were not different (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. However, 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.

Under the conditions of this study, supplementation of stocker cattle grazing smooth bromegrass pasture with DDG at 0.5% of body weight during the entire grazing season or only during the latter part of the grazing season would likely have been most profitable 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 similar grazing gains. In 2008, DDG supplementation during the grazing phase carried no advantage if ownership of the cattle was retained through slaughter. In 2009 and 2010, however, stocker cattle that were supplemented with DDG during the grazing phase maintained their weight advantage through slaughter.

Table 1. Effect 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]
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	1306	1369	1357
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[2]	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] 600 = modest, 700 = moderate.

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

Table 2. Effect 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]
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	1230a	1280ab	1304b
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[2]	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] 600 = modest, 700 = moderate.
Means within a row followed by the same letter are not significantly different ($P<0.05$).

Table 3. Effect 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]
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	1228a	1319b	1318b
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[2]	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] 500 = small, 600 = modest, 700 = moderate.
Means within a row followed by the same letter are not significantly different ($P<0.05$).

Effect 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 sixty 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 (Monday, Wednesday, and Friday) in 2009 and 2010. 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 both years.

Introduction

Distillers grains, a byproduct 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. However, many producers would prefer to not supplement their cattle on a daily basis 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 (Monday, Wednesday, and Friday).

Experimental Procedures

Thirty heifer calves were weighed on two consecutive days each year, stratified by weight, and randomly allotted to six five-acre smooth bromegrass pastures on Aprril 7, 2009 (420 lb), and March 30, 2010 (422 lb). Three pastures of heifers were randomly assigned to one of two supplementation treatments (three replicates per treatment) and grazed for 192 days and 168 days in 2009 and 2010, 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, and February 19, 2010. Pastures were stocked with 1 heifer/a and grazed continuously until October 16, 2009 (192 days), and Sept. 13, 2010 (168 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 for reasons unrelated to experimental treatment.

Results and Discussion

Cattle gains and DDG intake are presented in Tables 1 and 2 for 2009 and 2010, 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 during both 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.

Stocker cattle can be fed DDG three times per week rather than daily without any adverse effects on performance. However, caution should be used 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. Effect 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	15	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. Effect 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

Use Of Legumes In Wheat-Bermudagrass Pastures

J.L. Moyer and L.W. Lomas

Summary
Use of legumes (clovers) in lieu of 100 lb/a of nitrogen (N) for wheat-bermudagrass pastures maintained spring and summer cow gains. Although forage availability was sometimes higher for pastures with only N fertilization compared to legume-containing pastures, an indicator of forage quality favored the latter in mid-season.

Introduction
Bermudagrass is a productive forage species when intensively managed; however, it has periods of dormancy and requires proper use 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. This study was designed to compare dry cow performance on a wheat-bermudagrass pasture system that included summer legumes with a single 50 lb/a N application (Legume) vs. wheat-bermudagrass with additional N applications of 100 lb/a and no legumes (Nitrogen).

Experimental Procedures
Eight five-acre 'Hardie' bermudagrass pastures 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.

'Fuller' wheat (90 lb/a) was interseeded (no-till) into bermudagrass sod on September 29, 2009. The next day, 10 lb/a medium red clover was interseeded into the four pastures assigned to the Legume treatment to supplement stands of white clover. Pastures that received no legumes (Nitrogen) were fertilized with 50 lb/a N as urea each on February 16 and May 12, 2010. All pastures received 50-30-30 of N-P_2O_5-K_2O on July 1.

Thirty-two pregnant fall-calving cows of predominantly Angus breeding were weighed on consecutive days and assigned randomly by weight to pastures on April 1. Cows grazed forage that was primarily wheat for the first six weeks, then bermudagrass, until August 20 (141 days), when they were weighed on consecutive days and removed to begin calving.

Available forage and forage crude protein (CP), as estimated by the normalized difference vegetation index (NDVI), were monitored monthly during grazing with an automated rising plate meter and Greenseeker (Trimble, Sunnyvale, CA) instrument, respectively. NDVI readings were correlated with hay CP in August 2009. Pastures were mowed on August 23, 2010, and excess forage was removed as hay.

Results and Discussion

Cow gains during the season were similar for the Legume and Nitrogen systems (Table 1, P>0.10), averaging 2.92 lb/head per day. Average available forage was higher (P<0.05) for the Nitrogen than the Legume system for three of the mid-season sampling times (Figure 1). However, CP was higher in pastures with Legume vs. Nitrogen treatments during the early part of the grazing season. Hay production was similar (P>0.10) for the systems, averaging 4,780 lb/a.

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, 2010

	Management system[1]	
Item	Nitrogen[2]	Legumes
No. of cows	16	16
No. of days	141	141
Stocking rate, cows/a	0.8	0.8
Cow initial weight, lb	1,169	1,163
Cow final weight, lb	1,553	1,601
Cow gain, lb	384	438
Cow daily gain, lb	2.72	3.11
Cow gain, lb/a	307	350
Hay removed, lb/a dry matter	3,714	3,446

[1] None of the means within a row were significantly different at P<0.05.

[2] Fertilized with 50 lb/a of N in February and May; both treatments received 50 lb N/a on July 1.

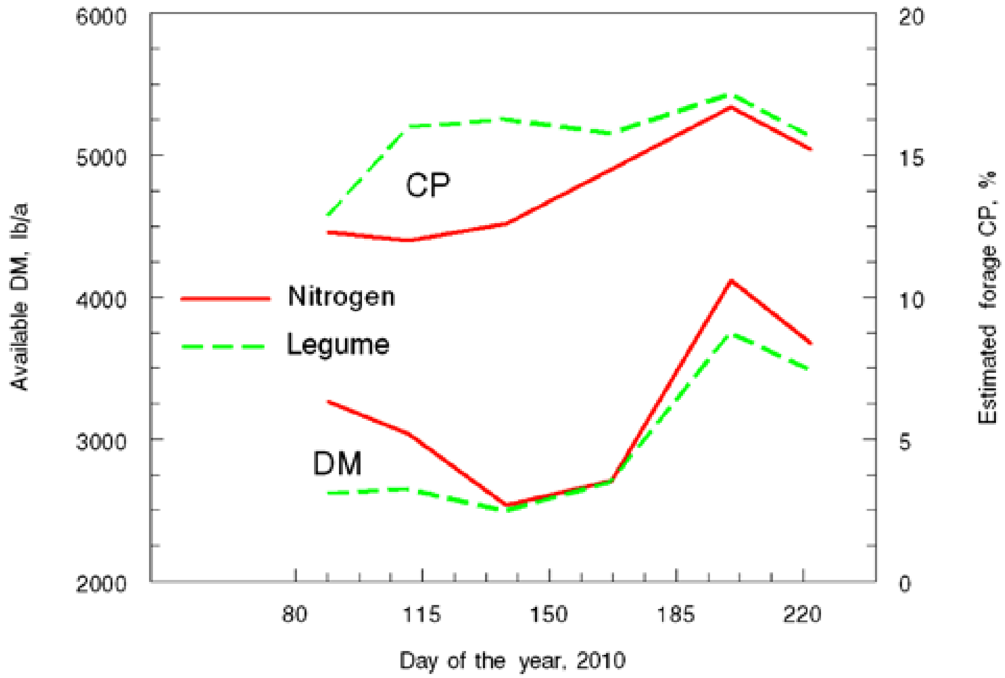

Figure 1. Available forage dry matter (DM) and estimated crude protein (CP) concentration during the grazing season in wheat-bermudagrass pastures fertilized with nitrogen or interseeded with legumes, Mound Valley Unit, Southeast Agricultural Research Center, 2010 .

Forage Production of Seeded Bermudagrass Cultivars

J.L. Moyer

Summary
Stands after the 2009-2010 winter were better (P<0.05) for 'Wrangler' and 'Cherokee' than for six of the other cultivars. Two seeded types that were previously the highest-yielding, 'SG 19' and 'Sungrazer,' had poorer stands than 'Wrangler,' but similar to 'Midland 99,' a sprigged cultivar. By August, stands remained better for 'Cherokee' than for six other cultivars, but stands of 'SG 19' and 'Sungrazer' were not significantly poorer than 'Cherokee.'

Introduction
Bermudagrass can be a high-producing, warm-season perennial forage for eastern Kansas when not affected by winterkill. Producers in southeastern Kansas have profited from the use of more winter-hardy varieties that produce more than common bermudagrasses. Seeded types may offer cost savings or other advantages in marginal areas, but some may not have the winter-hardiness necessary to adapt to this latitude. Further developments in bermudagrass breeding should be monitored to speed adoption of improved cold-hardy types.

Experimental Procedures
Thirteen bermudagrass entries were seeded at 8 lb/a of pure live seed for hulled seed or 5 lb/a of hulless seed at the Mound Valley Unit of the Southeast Agricultural Research Center on June 21, 2005, and 'Midland 99' plugs were planted 2 weeks later. In 2010, plots were clipped several times, visually rated for spring greenup on May 4, and for stand, based on plot coverage, on May 28 and August 8.

Results and Discussion
The winter of 2009-2010 was colder than the 30-year average. The average minimum temperatures for December through February were cooler than average by 3.8, 4.5, and 4.0°F. The temperature dipped below 10°F 12 days in December and January.

Spring greenup on May 4, 2010, was better (P<0.05) for 'Midland 99' than for 'Sungrazer I,' 'CIS-CD 4,' and 'Sungrazer Plus' (Table 1). On May 28, the stand of 'Wrangler' was better than that of all others except 'Cherokee.' Those two had better stands than six of the other cultivars, whereas 'KF 111' had a poorer stand than eight other cultivars. Stands of 'Wrangler,' 'Cherokee,' 'Riata,' and 'Sungrazer' were better than those of 'KF 111,' 'Sungrazer Plus,' and 'KF 888.'

All stands had improved by August 8 (Table 1), but 'Cherokee' still had a better stand than those of six other cultivars. 'Cherokee,' 'Wrangler,' and 'SG 19' had better stands than 'KF 194' and 'Sungrazer Plus.'

Average annual yields for 2006, 2008, and 2009 were greater for 'SG 19' and 'Sungrazer' than for 10 of the other 12 cultivars (Table 1). 'Riata,' 'CIS-CD 4,' 'Cherokee,' and 'Wrangler' produced less than 9 of the other 10 cultivars. Although the two highest-yielding cultivars had lower stands on May 4 than 'Cherokee' and 'Wrangler,' their stands were similar to that of 'Midland 99.' By August 8, 'SG 19' and 'Sungrazer' had stands that were not significantly ($P<0.05$) less than 'Wrangler' and 'Cherokee.'

Table 1. Three-year average yield and 2010 greenup and stand ratings for bermudagrass seeded in 2005, Southeast Agricultural Research Center, Mound Valley Unit

Source	Entry	Spring greenup 5/4	Stand 5/28	Stand 8/8	3-year average yield
		- - - - - 0 to 5 rating - - - - -			ton/a[1]
K-F Seeds	KF 888	2.3	1.8	3.0	5.76
K-F Seeds	KF 194	2.5	2.5	2.8	5.63
K-F Seeds	KF 111	2.5	1.5	3.0	6.14
K-F Seeds	KF 222	2.8	2.3	3.3	5.83
K-F Seeds	SG 19	3.0	2.5	4.0	6.53
Genetic Seed & Chemical	Sungrazer	2.5	2.8	3.5	6.53
Genetic Seed & Chemical	Sungrazer I	1.8	2.0	3.3	5.94
Genetic Seed & Chemical	Sungrazer Plus	2.0	1.8	2.8	5.42
Nixa Hardware & Seed	Cherokee	3.0	3.3	4.3	4.65
Genetic Seed & Chemical	Jackpot	2.3	2.5	3.5	5.08
Oklahoma State University	Wrangler	3.3	3.8	4.0	4.77
Oklahoma State University	Midland 99[1]	3.8	2.5	3.3	5.68
Johnston Seed	Riata	3.0	2.8	3.0	4.54
DLF International Seeds	CIS-CD 4	1.8	2.3	3.0	4.61
Average		2.6	2.4	3.3	5.51
LSD 0.05		1.6	0.9	1.0	0.59

[1] Moisture: 12%.

Alfalfa Variety Performance in Southeastern Kansas[1]

J.L. Moyer

Summary
A 16-line alfalfa test was seeded in 2010 and cut three times. Yields from 'AA112E', '6530', and 'FSG505' were greater ($P<0.05$) than from six other cultivars . Three-year production from 'FSG505' was greater than from seven other entries.

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

Experimental Procedures
A 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 and treated with 2 qt/a of Eptam 7E preplant-incorporated. Harvests were taken on July 1, August 3, and December 1. No treatment for insects or disease was necessary.

Results and Discussion
Dry growing conditions in August delayed regrowth of the third cutting. Wet soil after the killing frost delayed the final harvest (see Annual Summary of Weather Data, page 39), so some leaf loss occurred. First-cut yields (at 10% bloom) were significantly greater ($P<0.05$) for 'Perry' than for 12 other entries (Table 1). In addition, yields for 'Kanza,' 'FSG408DP Bt,' and 'AmeriStand 407TQ' were greater than for six other entries.

Second-cut yields were greater for 'FSG639ST Bt' than for 11 other entries, and yield for FSG408DP Bt was greater than for seven others. Third-cut yields were greater for Kanza than for seven other entries.

Total 2010 yield for 'FSG639ST Bt' was greater than for seven other entries. Nine entries had higher 2010 yield than 'DKA50-18' and 'WL 343 HQ.'

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[1]Statewide alfalfa performance tests results can be found at http://www.agronomy.ksu.edu/extension/p.aspx?tabid=91.

Table 1. 2010 Forage Yields (tons/a at 12% moisture) for three cuttings of the alfalfa variety test, Mound Valley Unit

		Cutting date			
Source	Entry	7/1	8/3	12/1	Total
America's Alfalfa	AmeriStand 403T+	1.67	1.36	0.83	3.86
America's Alfalfa	AmeriStand 407TQ	1.71	1.27	1.06	4.04
America's Alfalfa	Archer III	1.49	1.24	0.99	3.72
Allied	FSG505 Bt	1.56	1.29	1.00	3.84
Allied	FSG408DP Bt	1.74	1.40	1.05	4.18
Allied	FSG639ST Bt	1.64	1.44	1.17	4.25
CPS	DG 4210	1.48	1.28	0.79	3.50
Farm Science Genetics	FSG 528SF	1.54	1.22	0.90	3.65
Garst Seed	6552	1.53	1.25	0.84	3.63
Monsanto Seed	DKA50-18	1.48	1.19	0.68	3.35
Syngenta	6422Q	1.58	1.30	0.88	3.76
W-L Research	WL 343 HQ	1.44	1.24	0.68	3.36
W-L Research	WL 363 HQ	1.62	1.31	1.03	3.97
Kansas AES and USDA	Kanza	1.74	1.22	1.22	4.18
Nebraska AES and USDA	Perry	1.89	1.08	1.12	4.08
Wisconsin AES and USDA	Vernal	1.62	1.08	1.17	3.87
Average		1.61	1.26	0.97	3.83
LSD (0.05)		0.19	0.15	0.26	0.41

AES, Agricultural Experiment Station.

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

D.W. Sweeney and K.W. Kelley

Summary
Conventional tillage resulted in higher yields than with strip-till or no-till at one site, but the differences were not significant at a second site. These differences appear largely related to differences in plant stand. In general, although seeding rate increased plant stand, it had little corresponding effect on yield. Subsurface band (knife) fertilizer application resulted in greater yield than with surface band (dribble) at both sites in 2010.

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 where early spring soil temperatures might be greater than those in no-till soils. But 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 2010, the experiment was conducted at the Mound Valley Unit (Site 1) and the Parsons Unit (Site 2) 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 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 fertilizer placement methods: surface band (dribble) on 30-in. centers near the row and subsurface band (knife) at 4 in. deep. At the Mound Valley site, N and P nutrients were supplied as 28% urea ammonium nitrate and ammonium polyphosphate (10-34-0) applied at 125 lb/a N and 40 lb/a P_2O_5. Based on initial soil tests, at the Parsons site only N was applied by the two placement methods.

Results and Discussion
Yield or yield components were not affected by any interaction among the tillage, seeding rate, and fertilizer placement treatments at either site. Overall, yields and yield components were less at the Mound Valley site than at Parsons. At Mound Valley, yield was 14 to 20 bu/a greater with conventional tillage than with strip-till or no-till (Table 1). This difference was due to a reduced stand with strip-till and no-till; less than 60% of the seed planted in no-till emerged and lived. Seeding rate had no effect on yield at Mound Valley. Stand increased with seeding rate as expected. However, when expressed

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

as a percentage of planted seed, stand tended to decline with increased seeding rate. Increased seeding rate decreased kernel weight and kernels per ear, but had no effect on the number of ears per plant. Knife fertilizer placement increased yields by 40% compared with dribble surface applications by increasing kernel weight, ears per plant, and kernels per ear.

At Parsons, conventional tillage tended to result in higher yield than strip-till and no-till, but the differences were not statistically significant (Table 2). The stand was similar for strip-till and conventional tillage, with no-till resulting in lower stand. Corn seeded at 18,000 seeds/a yield less than corn seeded at 22,000 to 34,000 seed/a. Increasing seeding rate increased the stand, but, in contrast to results from Mound Valley, the percentage of seed that produced live plants was not affected by seeding rate. Increasing seeding rate reduced the number of kernels per ear and somewhat the number of ears per plant. Knife fertilizer placement improved corn yield by more than 10%, primarily by increasing the number of kernels per ear.

Table 1. Effect of tillage, seeding rate, and fertilizer placement on yield and yield components in 2010 at site 1, Mound Valley Unit of the Southeast Agricultural Research Center

	Yield	Stand		Kernel weight	Ears	Kernels
	bu/a	plants/a	% of planted	mg	/plant	/ear
Tillage						
Conventional	73.7	22,000	85.5	244	0.97	370
Strip	59.3	17,500	68.4	245	0.98	368
No-till	53.7	14,200	56.2	252	1.05	380
LSD (0.05)	12.5	2,800	9.3	NS	NS	NS
Seeding rate, seeds/a						
18,000	60.1	14,000	77.7	254	1.03	422
22,000	64.6	16,300	74.1	255	1.02	391
26,000	62.3	17,900	69.0	247	0.99	373
30,000	66.1	19,100	63.7	245	0.96	379
34,000	58.1	22,300	65.7	235	1.01	298
LSD (0.05)	NS	2,100	7.4	11	NS	48
Fertilizer placement						
Dribble	51.9	17,800	69.6	240	0.97	335
Knife	72.6	18,100	70.4	254	1.04	410
LSD (0.05)	5.7	NS	NS	7	0.07	30

NS, non-significant.

Table 2. Effect of tillage, seeding rate, and fertilizer placement on yield and yield components in 2010 at site 2, Parsons Unit of the Southeast Agricultural Research Center

	Yield	Stand		Kernel weight	Ears	Kernels
	bu/a	plants/a	% of planted	mg	/plant	/ear
Tillage						
Conventional	108	22,900	88.4	256	1.03	471
Strip	100	22,200	86.0	248	1.07	451
No-till	102	20,500	79.2	254	1.04	494
LSD (0.05)	NS	1,400	5.6	NS	NS	NS
Seeding rate, seeds/a						
18,000	93	15,600	86.6	251	1.11	554
22,000	105	19,200	87.2	254	1.06	524
26,000	104	22,100	84.8	249	1.01	478
30,000	106	25,000	83.3	259	1.02	408
34,000	110	27,400	80.6	251	1.03	396
LSD (0.05)	10	1,300	NS	NS	0.06	46
Fertilizer placement						
Dribble	97	21,500	82.9	252	1.04	456
Knife	110	22,200	86.1	253	1.06	488
LSD (0.05)	6	NS	NS	NS	NS	29

NS, non-significant.

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

D.W. Sweeney and K.W. Kelley

Summary
Because of a poor stand, wheat was replaced by oats in 2010. Oat yield was increased by nitrogen (N) fertilization, but was unaffected by tillage, N application method, or their interaction. Double-crop soybean yields were unaffected by tillage or N fertilization.

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

Experimental Procedures
A split-plot design with four replications was initiated in 1983 with tillage system as the whole plot and N treatment as the subplot. In 2005, the rotation was changed to begin a short-season corn/wheat/double-crop soybean sequence. Use of three tillage systems (conventional, reduced, and no-till) continued in the same areas as during the previous 22 years. The conventional system consists of chiseling, disking, and field cultivation. Chiseling occurred in the fall preceding corn or wheat crops. The reduced-tillage system consists of disking and field cultivation prior to planting. Glyphosate (Roundup) was applied to the no-till areas. The four N treatments for the crop were: no N (control), broadcast urea-ammonium nitrate (UAN; 28% N) solution, dribble UAN solution, and knife UAN solution at 4 in. deep. The N rate for the corn crop grown in odd-numbered years was 125 lb/a. The N rate of 120 lb/a for wheat was split as 60 lb/a applied preplant as broadcast, dribble, or knifed UAN. All plots, except for the controls, were top-dressed in the spring with broadcast UAN at 60 lb N/a. In 2010, because wheat stand was erratic and generally poor (visual estimate <50%), wheat was killed with glyphosate and plots were replanted with oats.

Results and Discussion
In 2010, adding fertilizer N, in general, tripled oat yields, compared with yields in the no-N controls (Table 1). However, oat yield was unaffected by tillage, N application method, or their interaction. Double-crop soybean yield was unaffected by tillage or N fertilization.

Table 1. Effect of tillage and N fertilization on oat and double-crop soybean yield in 2010. N fertilization effects for soybean are residual only because no N fertilizer was applied to the soybean crop

	Oat yield	Soybean yield
	------------------------- bu/a	-------------------------
Tillage		
Conventional	32.2	25.9
Reduced	35.3	26.8
No-till	30.3	29.3
LSD (0.05)	NS	NS
N Fertilization		
Control	13.4	28.1
Broadcast	39.1	27.8
Dribble	37.0	26.8
Knife	40.8	26.4
LSD (0.05)	6.4	NS
Interaction	NS	NS

NS, non-significant.

Effect of K, Cl, and N on Short-Season Corn, Wheat, and Double-Crop Sunflower Grown on Claypan Soil

D.W. Sweeney, D.J. Jardine[1], and K.W. Kelley

Summary
Corn yield in 2010 was unaffected by potassium (K) or chloride (Cl) fertilization, but was increased by nitrogen (N). Severity of stalk rot was unaffected by K, Cl, or N fertilization. Early growth was increased by K fertilization, but the effect declined during the growing season. In contrast, N fertilization did not significantly affect early growth, but improved growth during late reproductive growth stages.

Introduction
Corn acreage has been on the rise in southeastern Kansas in recent years because of the introduction of short-season cultivars that enable producers to partially avoid midsummer droughts that are often severe on the upland, claypan soils typical of the area. In addition, producing a crop after wheat and in rotation with corn potentially provides producers an increase in revenue by growing three crops in two years. Recent interest and developments in oil-type sunflower provide an alternative to soybeans for growers to double-crop after wheat. All crops in this corn-wheat-double-crop sunflower rotation require adequate fertilization with N to obtain optimum yields. Also, these crops are potentially affected by diseases that affect the leaf and stalk structures and may reduce yields. K and Cl fertilization of crops has often been found to reduce disease pressure, but how N, K, and Cl interact to affect disease suppression and crop production have not been well defined, especially for corn, wheat, and double-crop sunflower in a two-year rotation on a claypan soil in southeastern Kansas.

Experimental Procedures
The experiment was initiated in 2010 at the Southeast Agricultural Research Center at Parsons, KS. The experimental design was a split-plot design with three replications. The whole plots were a 2 × 2 factorial of K and Cl fertilization. The K and Cl rates were 0 and 50 lb K_2O/a and 0 and 40 lb Cl/a. K and Cl fertilizer sources used to achieve these four fertility whole plots were potassium chloride, potassium sulfate, and calcium chloride and were spread using a small, handheld broadcast unit. The N rate subplots for corn were 0, 50, 100, and 150 lb/a surface-band applied as urea ammonium nitrate (UAN) solution. In addition to K, Cl, and N treatments, all plots received uniform applications of phosphorus (P) at 50 lb P_2O_5/a applied with a drop spreader. Fertilizers were incorporated by disking prior to planting. Pioneer 35F40 Roundup-Ready corn was planted at 28,000 seeds/a on April 15, 2010. Grain was harvested for yield on August 27, 2010, by using a small-plot combine equipped with a corn head. Before harvest, corn ears were removed from 10 plants in the harvest rows and were placed in the combine as the rest of the plot was harvested. Stalks from these plants were split and the bottom five nodes above the brace roots were visually evaluated for stalk rot. At the

[1] Kansas State University Department of Plant Pathology, Manhattan.

V6, V12, R1 (silk), R4 (dough), and PM (physiological maturity) growth stages, whole plant samples were collected and dry matter determined.

Results and Discussion

Overall yields in 2010 were poor, averaging less than 100 bu/a. Corn yield was not affected by K, Cl, or any interactions with K or Cl. Yield was affected only by N, increasing from 57 bu/a with no N to 103 bu/a with 150 lb N/a (Fig. 1). This yield increase with N was primarily due to increased kernels per ear and somewhat to increased kernel weight. Severity of stalk rot was unaffected by any fertilizer treatments.

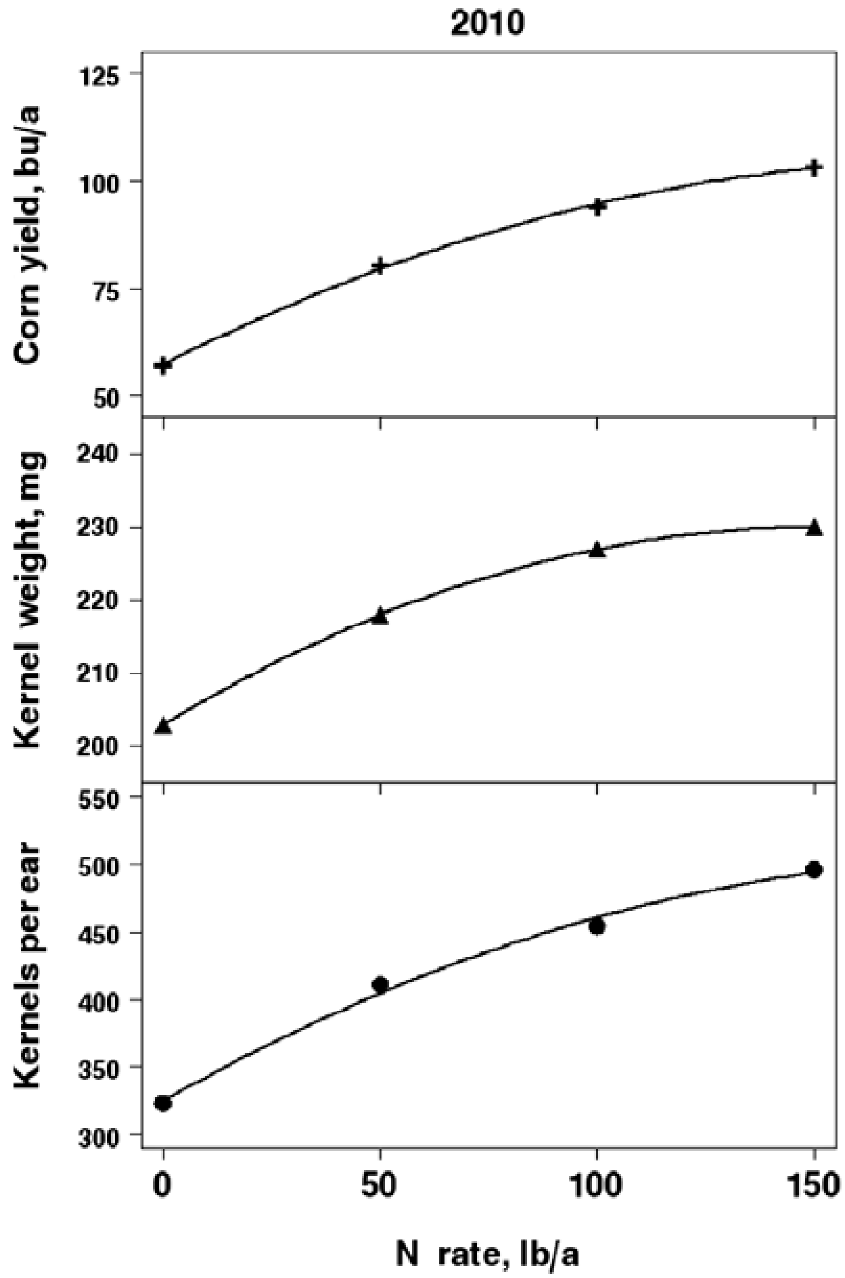
Growth, as measured by dry matter samples taken from V6 to physiological maturity (PM), was improved early in the growing season by K fertilization (Table 1). However, this effect declined to be non-significant by PM. Even though N fertilization did not significantly affect early growth, by late reproductive stages dry matter production was increased by more than 30% with 150 lb N/a as compared to the zero-N control. These growth results help explain the lack of yield response to K and the yield response to N.

Table 1. Effect of K and N fertilizer on corn dry matter production during the growing season of 2010 taken at V6, V12, R1 (silk), R4 (dough), and PM (physiological maturity) growth stages

Treatment	Dry matter production				
	V6	V12	R1	R4	PM
	------------ lb/a ------------				
K (lb K_2O/a)					
0	200	1,680	4,300	10,920	12,200
50	270	2,270	5,030	12,200	12,400
F value	*	**	**	NS	NS
N (lb/a)					
0	220	1,960	4,500	9,300	10,700
50	240	2,080	4,800	11,500	12,400
100	220	1,910	4,440	11,400	11,900
150	260	1,940	4,900	14,000	14,000
LSD (0.05)	NS	NS	NS	2,000	1,300

*, ** Significant at the 0.05 and 0.01 levels, respectively.
NS, non-significant.

Figure 1. Corn yield, kernel weight, and kernels per ear as affected by N rate in 2010.



Effect of Timing of Supplemental Irrigation and Nitrogen Placement on Late-Planted Sweet Corn

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

Summary
In 2010, late-planted sweet corn was little affected by irrigation or nitrogen (N) treatments.

Introduction
Sweet corn is a possible value-added, alternative crop for producers in southeastern Kansas. Corn responds to irrigation, and timing of water deficits can affect yield components. Even though large irrigation sources, such as aquifers, are lacking in southeastern Kansas, supplemental irrigation could be supplied from the substantial number of small lakes and ponds in the area. However, information is lacking on the effects of irrigation management, N placement, and planting date on performance of sweet corn, which may hinder producers' adoption of this crop.

Experimental Procedures
The experiment was established on a Parsons silt loam in spring 2008 as a split-plot arrangement of a randomized complete block with three replications. The whole plots were four irrigation schemes: (1) no irrigation, (2) 1.5 in. at VT (tassel), (3) 1.5 in. at R2 (blister), and (4) 1.5 in. at both VT and R2. Subplots were three N treatments consisting of no N and 100 lb N/a applied broadcast or as a subsurface band (knife) at 4 in. Sweet corn target planting date was mid-May. Corn was picked on July 29 and August 3, 2010.

Results and Discussion
In 2010, irrigation had no effect on total ears, total fresh weight, or individual ear weight of sweet corn planted in mid-May (Table 1). Total number of ears, total fresh weight, and individual ear weight were greater with N application than with no N but were unaffected by N placement.

Table 1. Effect of irrigation scheme and nitrogen placement on sweet corn planted in mid-May, Southeast Agricultural Research Center, 2010

Treatment	Total ears	Total fresh weight	Individual ear weight
	ears/a	ton/a	g/ear
Irrigation scheme			
None	15,800	4.47	244
VT (1.5 in.)	16,000	4.40	243
R2 (1.5 in.)	13,000	3.55	237
VT-R2 (1.5 in. at each)	12,900	3.45	211
LSD (0.10)	NS	NS	NS
N Placement			
None	8,000	1.83	197
Broadcast	18,200	5.03	248
Knife	17,500	5.04	257
LSD (0.05)	2,800	0.80	16
Interaction	NS	NS	NS

NS, non-significant.

Annual Summary of Weather Data for Parsons

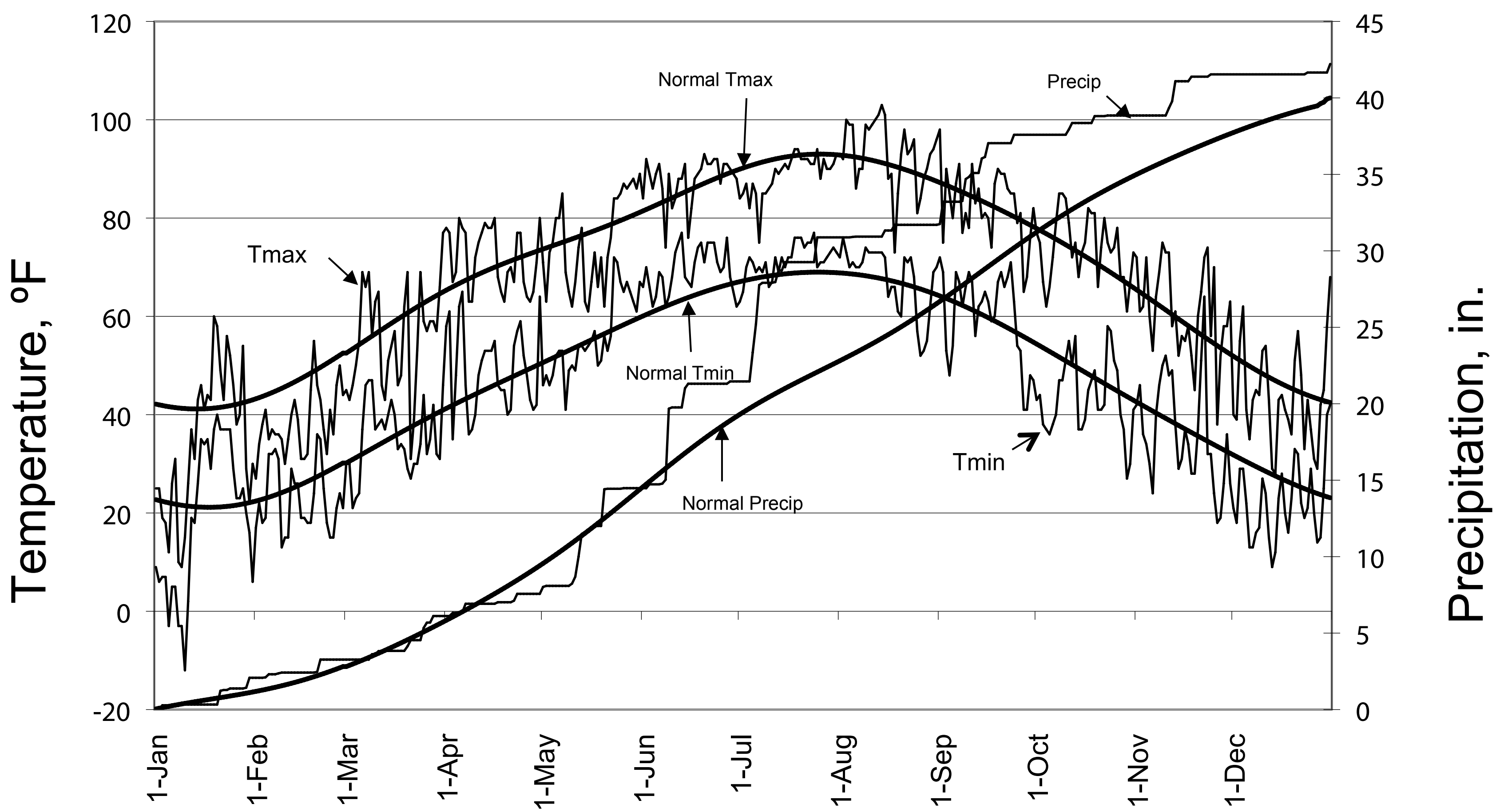
M. Knapp[1]

2010 data													
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Avg. max	34.8	38.4	55.8	71.9	75.2	87.8	88.8	93.1	82.6	74.0	61.2	43.7	67.3
Avg. min	18.8	22.7	35.2	49.3	55.7	69.4	71.4	67.8	60.4	43.5	36.233	22.2	46.0
Avg. mean	26.8	30.6	45.5	60.6	65.4	78.6	80.1	80.4	71.5	58.8	48.7	33.0	56.7
Precip.	2.08	1.19	2.85	1.5	6.91	6.98	9.42	0.82	5.89	1.26	2.69	0.68	42.22
Snow	13.5	1.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	20.5
Heat DD*	1185	965	605	169	98	0	0	0	26	201	491	994	4732
Cool DD*	0	0	0	36	111	408	469	479	222	9	3	0	1734
Rain days	7	6	8	6	12	8	8	4	10	4	5	2	80
Min <10	12	0	0	0	0	0	0	0	0	0	0	1	13
Min <32	22	23	10	0	0	0	0	0	0	2	11	27	95
Max >90	0	0	0	0	0	10	13	20	3	0	0	0	46
Normal values (1971-2000)													
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Avg. max	40.2	47.2	57.2	67.1	76.0	85.0	91.1	90.0	81.0	70.5	55.5	44.4	67.1
Avg. min	20.2	25.6	34.8	44.1	54.4	63.4	68.3	66.0	58.0	46.3	34.9	24.8	45.1
Avg. mean	30.2	36.4	46.0	55.6	65.2	74.2	79.7	78.0	69.5	58.4	45.2	34.6	56.1
Precip.	1.37	1.78	3.37	3.82	5.39	4.82	3.83	3.42	4.93	4.04	3.29	2.03	42.09
Snow	2.0	3.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2	0.0	8.5
Heat DD	1079	800	590	295	95	6	0	3	51	229	594	942	4684
Cool DD	0	0	0	13	101	283	456	406	187	24	0	0	1470
Departure from normal													
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Avg. max	-5.4	-8.8	-1.4	4.8	-0.8	2.8	-2.3	3.1	1.6	3.5	5.7	-0.7	0.2
Avg. min	-1.4	-2.9	0.4	5.2	1.3	6.0	3.1	1.8	2.4	-2.8	1.3333	-2.6	1.0
Avg. mean	-3.4	-5.8	-0.5	5.0	0.2	4.4	0.4	2.4	2.0	0.4	3.5	-1.6	0.6
Precip.	0.71	-0.59	-0.52	-2.37	1.52	2.16	5.59	-2.6	0.96	-2.78	-0.6	-1.35	0.13
Snow	11.5	-2.0	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-2	0.0	12.0
Heat DD	106	165	15	-127	3	-6	0	-3	-25	-28	-103	52	48
Cool DD	0	0	0	23	10	125	13	73	35	-16	3	0	264

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

[1] Kansas State Climatologist, Kansas State University Department of Agronomy, Manhattan.

2010 Weather summary for Parsons, KS



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