FIELD RESEARCH 2010

Report of Progress 1030

Kansas State University Agricultural Experiment Station and Cooperative Extension Service

FIELD RESEARCH 2010

Contents

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East Central Kansas Experiment Field

Introduction

The research program at the East Central Kansas Experiment Field is designed to keep area crop producers abreast of technological advances in agronomic agriculture. Specific objectives are to (1) identify top-performing varieties and hybrids of wheat, corn, soybean, and grain sorghum; (2) establish the amount of soil loosening and crop residue cover needed for optimum crop production; (3) evaluate weed and disease control practices using chemical, no chemical, and combination methods; and (4) test fertilizer rates, timing, and application methods for agronomic efficiency and environmental effects.

Soil Description

Soils on the field's 160 acres are Woodson. The terrain is upland and level to gently rolling. The surface soil is a dark, gray-brown, somewhat poorly drained silt loam to silty clay loam over slowly permeable clay subsoil. The soil is derived from old alluvium. Water intake is slow, averaging less than 0.1 in./hour when saturated. This makes the soil susceptible to water runoff and sheet erosion.

2009 Weather Information

Precipitation during 2009 totaled 48.3 in., which was 11.5 in. above the 35-year average (Table 1). Most of the extra moisture occurred from increased precipitation during the growing season months of April, June, July, August, September, and October, which each averaged nearly 2 in. more rainfall than normal each month. Precipitation for May was 3.63 in. below average, which was fortunate for getting crops planted. The harvest season was wet overall, and there was substantial tracking of fields. No wheat was planted because of continuous wet fall field conditions. The coldest temperatures during 2009 occurred in January and December with 12 days in single digits. The overall coldest day was 1.2°F on January 15. There were 24 days during summer 2009 on which temperatures exceeded 90.0°F. The hottest 5-day period was June 23 to 27, when temperatures averaged 97.4°F. The overall hottest day was June 23, when the temperature reached 101.1°F. The last freezing temperature in the spring was April 7 (average, April 18), and the first killing frost in the fall was October 18 (average, October 21). There were 193 frost-free days, which is more than the long-term average of 185.

Table 1. Precipitation at the East Central Kansas Experiment Field, Ottawa

Month	2009	35-year avg.	Month	2009	35-year avg.
	----------in.----------			--------------in.----------	
January	0.11	1.03	July	4.59	3.37
February	1.04	1.32	August	6.51	3.59
March	3.25	2.49	September	5.85	3.83
April	7.13	3.50	October	5.78	3.43
May	1.60	5.23	Novem ber	2.16	2.32
June	7.86	5.21	December	2.38	1.45
Annual total				48.26	36.78

Evaluation of Nitrogen Rates and Starter Fertilizer for Strip-Till Corn

K. A. Janssen

Summary

Effects of nitrogen (N) rates and starter fertilizer were evaluated for nonirrigated, strip-tilled fertilized corn on a Woodson silt loam soil at the East Central Kansas Experiment Field at Ottawa, KS, in 2006, 2007, 2008, and 2009. Because of below-average seasonal rainfall in 2006 and 2007 and above-average rainfall in 2008 and 2009, 80 to 140 lb/a N were required to maximize yields. Starter fertilizer placed beside and below the seed row at planting increased early season corn growth 3 out of 4 years. However, application of starter at planting did not increase grain yield in any year. Highest grain yields were produced when the starter fertilizer (nitrogen-phosphorus-potassium) was applied along with the rest of the fertilizer in the strip-till zone. These findings suggest that starter fertilizer applied under the row may be as or more effective at increasing yield as placement beside and below the seed row at planting. In regard to N application, not knowing the amount of rainfall that will occur prior to fertilization makes precise application difficult. One strategy might be to apply an intermediate rate of N (between 80 and 140 lb/a). Other strategies might be to apply some of the N with a safener to help minimize potential N losses or side-dress some of the N to better match the N rate with crop need. More years of testing are needed to confirm these findings.

Introduction

Corn growers in eastern Kansas might benefit from more accurate N rate applications when growing strip-till corn. The high cost of N fertilizer and potential for increased N losses with overapplication demand prudent use. Research is also needed to determine whether there is any need to apply starter fertilizer at planting for strip-tilled fertilized corn with under-the-row banded fertilizer. Such research could help strip-till corn growers make better decisions about the amount of N fertilizer to apply, whether it is worthwhile to purchase costly planter fertilizer-banding equipment, and whether to apply starter fertilizer at all at planting.

Procedures

This was the fourth year of this study. Six N rates and three starter fertilizer options were studied. Nitrogen rate treatments were 0, 60, 80, 100, 120, 140 and 160 lb/a. Starter fertilizer treatments were placement of all starter fertilizer 5 to 6 in. below the strip-till row, placement of the starter fertilizer 2.5 in. to the side and 2.5 in. below the seed row at planting, and half of the starter fertilizer applied in the strip-till zone and half applied beside and below the seed row at planting. In all cases, 30 lb/a N was included with the phosphorus (P) and potassium (K) starter fertilizers. Research by Barney Gordon at the North Central Kansas Experiment Field at Scandia, KS, showed that at least a 1:1 ratio of N-P fertilizer mix should be used for best starter P benefits.

The experiment design was a randomized complete block with four replications. No-till soybean was grown prior to the strip-till corn studies each year. For preplant weed control, 1 qt/a atrazine 4L plus 0.66 pint/a 2,4-D LVE, plus 1 qt/a crop oil concentrate was applied. Pioneer 35P17 corn was planted Apr. 6, 2006; May 19, 2007; May 13, 2008; and May 20, 2009. Plantings in 2007, 2008, and 2009 were delayed because of wet weather. Corn was planted at a rate of 24,500 seeds/a in 2006 and at 26,500 seeds/a in 2007, 2008, and 2009. Preemergence herbicides containing 0.5 qt/a atrazine 4L plus 1.33 pint/a Dual II Magnum were applied the day after planting each year for in-season weed control. Effects of the N rates and starter fertilizer treatments were evaluated by measuring early season growth at the 6- to 7-leaf growth stage and grain yield at physiological maturity.

Results

Seasonal moisture for corn was below average in 2006 and 2007 and above average in 2008 and 2009. Under these conditions and with corn following soybean, 80 to 120 lb/a N maximized grain yields in 2006 and 2007, and 100 to 140 lb/a N maximized grain yields in 2008 and 2009 (Table 1). Increased demand for N in 2008 and 2009 was due to higher yield and greater N losses resulting from increased rainfall. Application of starter fertilizer placed 2.5 in. to the side and 2.5 in. below the seed row at planting increased early season growth of corn in 2006, 2008, and 2009 but not in 2007 (Table 1). The combination starter application of applying half the starter fertilizer at planting and half in the strip-till zone produced intermediate early season plant growth effects (Figure 1).

Neither of the planter-placed starter fertilizer options increased grain yield (Figure 2). Grain yields were highest when all starter fertilizer nutrients (i.e., N, P, and K) were included in the strip-till zone along with the rest of the strip-till fertilizer. These data suggest that placing starter fertilizer under the row in the strip-till zone may be as good as or better than placing starter fertilizer beside and below the seed row at planting. Also, there may not be a critical need to even apply starter fertilizer at planting when growing strip-till fertilized corn. These data also suggest that with regard to N application for nonirrigated, upland, strip-tilled fertilized corn, a compromise N rate between 80 and 140 lb/a could be used, some of the N application could be applied using a safener to help control N losses, or N application could be split with some applied preplant and some side-dressed to better match N rate with need. More years of testing under different growing environments and with different hybrids are needed to verify these findings because these factors may affect N management and starter fertilizer responses. This study will be repeated in 2010.

Table 1. Effects of nitrogen rates and starter fertilizer on V6-V7 plant dry weights and grain yields of strip-till corn, East Central Kansas Experiment Field, Ottawa, 2006-2009

Fertilizer treatments		V6-V7 dry weights				Grain yields			
Strip-till	Starter 2.5 × 2.5in.	2006	2007	2008	2009	2006	2007	2008	2009
--N-P_2O_5-K_2O, lb/a ---		-------- g/plant -------				--------- bu/a ---------			
Check 0-0-0		2.1	5.3	7.1	5.1	47	37	63	61
60-40-20		5.5	9.5	10.9	7.3	101	89	121	108
80-40-20		4.2	9.8	11.4	8.3	109	95	134	118
100-40-20		4.4	8.3	11.4	7.6	103	93	138	132
120-40-20		4.3	9.4	9.7	7.0	108	99	138	136
140-40-20		3.9	9.0	10.5	6.7	109	98	147	136
160-40-20		4.0	8.9	10.1	6.7	108	101	145	142
Evaluation of starter at three N levels									
80-40-20		4.2	9.8	11.4	8.3	109	95	134	118
50-20-10 +	30-20-10	6.4	9.5	12.8	9.8	101	88	124	96
50 +	30-40-20	6.6	9.7	12.9	10.0	103	90	121	92
120-40-20		4.3	9.4	9.7	7.0	108	99	138	136
90-20-10 +	30-20-10	6.2	9.5	11.8	9.3	105	102	140	133
90 +	30-40-20	7.6	9.2	12.2	10.9	102	95	136	124
160-40-20		4.0	8.9	10.1	6.7	108	101	145	142
130-20-10 +	30-20-10	5.3	9.2	12.4	8.8	106	99	150	140
130 +	30-40-20	6.8	8.7	14.5	9.6	100	98	143	131
LSD (0.05)		1.0	1.4	0.9	1.3	6	9	7	11

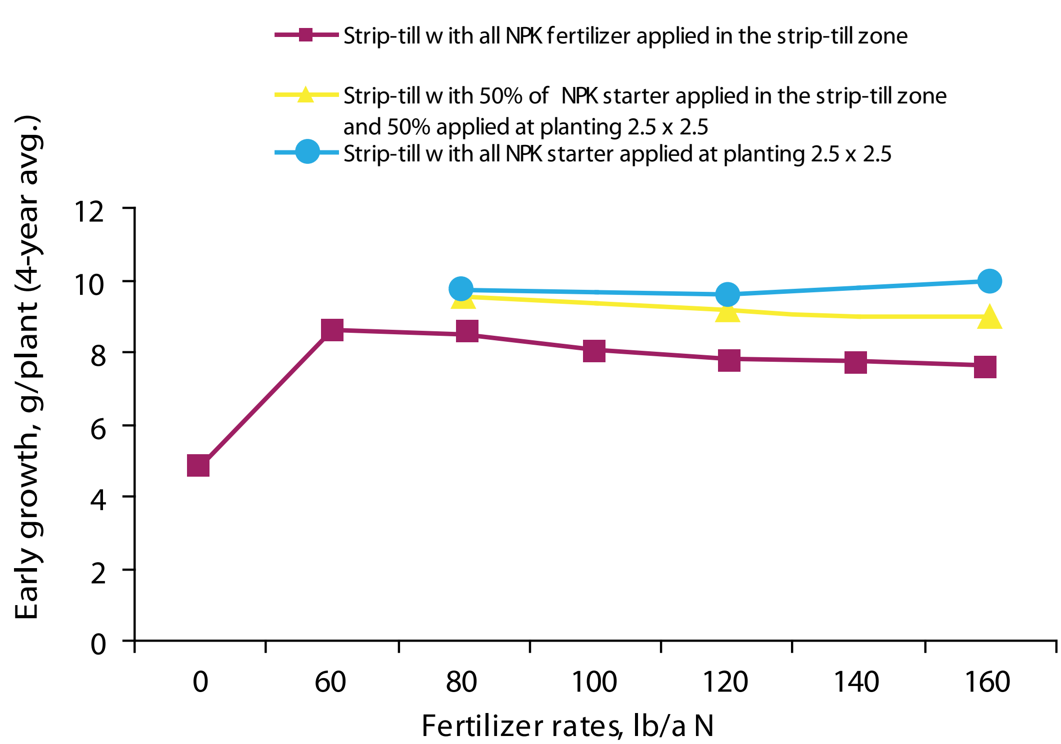


Figure 1. Nitrogen rate and starter fertilizer placement effects on 6- to 7-leaf stage growth of strip-till corn.

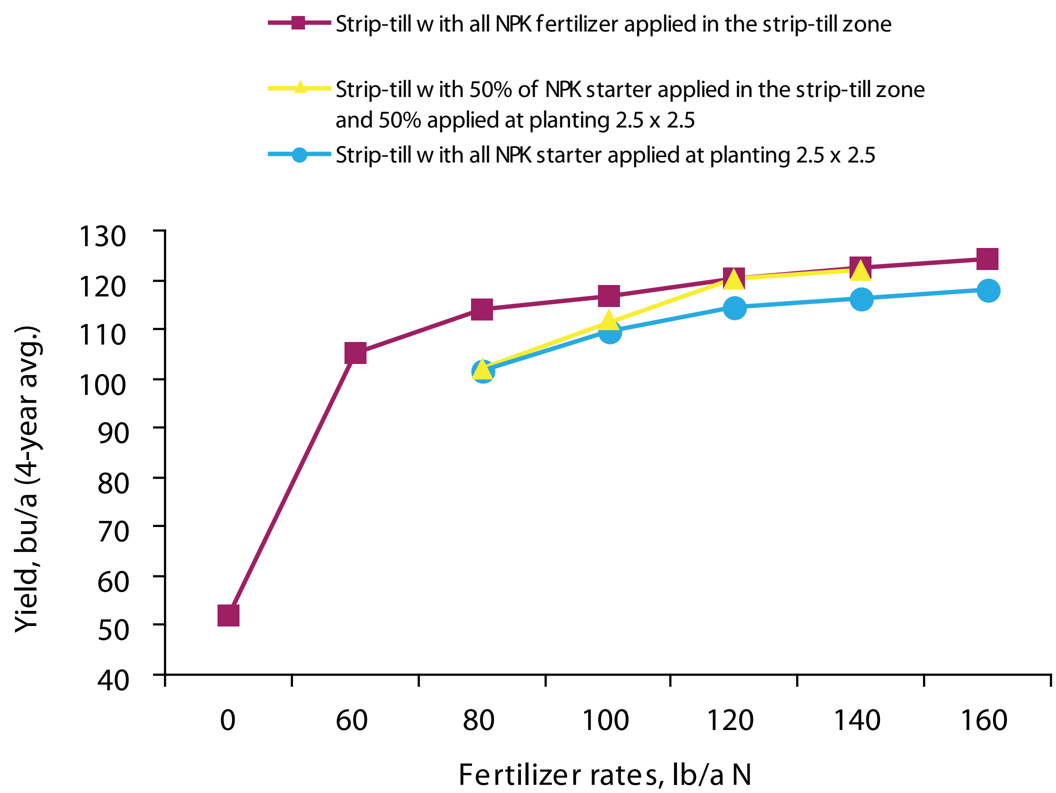


Figure 2. Nitrogen rate and starter fertilizer placement effects on yield of strip-till corn.

Evaluation of Strip-Till and No-Till Systems for April- and June-Planted Grain Sorghum in Eastern Kansas[1]

K. A. Janssen

Summary
Field studies were conducted at the East Central Kansas Experiment Field at Ottawa, KS, in 2006, 2007, 2008, and 2009 to determine how strip tillage performed compared with no-till for growing grain sorghum planted early and at the more customary June planting time. Nitrogen (N) rates and effects of starter fertilizer were also studied. Overall, few differences were observed between the strip-till and no-till systems except for the June 5 planting date in 2007, the June 19 planting date in 2008, and the June 5 planting date in 2009. In 2007, strip tillage increased grain sorghum yield 3 to 6 bu/a, on average, compared with no-till. In 2008, yield of sorghum planted June 19 was 12 bu/a less for strip tillage than for no-till. The lower yield was due to greater N loss with strip till compared with no-till because of earlier N application for strip till. In 2009, plant population was increased by more than 1,000 plants/a with strip till compared with no-till, but yields were not statistically different. Application of starter fertilizer at planting produced little yield benefit for strip-tilled fertilized grain sorghum, except when it offset N that had been previously lost. On average, 60 to 90 lb/a N optimized grain sorghum yields for both tillage systems following soybean when moisture was limiting. Up to 150 lb/a N was required to maximize yields when rainfall and yields were higher. Sorghum planted in June generally produced higher yield than sorghum targeted for April planting. Both tillage fertilization systems were suitable for planting grain sorghum either early or in June.

Introduction
In Kansas, midsummer heat and drought are significant factors limiting grain sorghum production. Scheduling grain sorghum planting to avoid pollination and grain fill during this midsummer period is important. One strategy is to plant grain sorghum early, grow the crop with moisture received from winter and early springs rains, and then rely on stored soil moisture and possibly an occasional summer rain for grain production. Another strategy is to wait, accumulate as much moisture in the soil profile as possible, plant grain sorghum in early to mid-June, and then rely on stored soil moisture and fall rains to produce the crop.

When planting grain sorghum early and using conservation tillage practices, strip tillage may be beneficial. Soil loosening in the row helps warm the soil and allows the plants to get off to a rapid start. Conversely, no-till may be an advantage for sorghum planted later because soils are normally warm by planting time and with less soil and residue disturbance, there should be less soil water loss and more moisture available for crop use.

[1] Financial support for this research was provided by the Kansas Grain Sorghum Commission.

Objectives of this study were to (1) compare performance of strip-till and no-till tillage fertilization systems for grain sorghum in eastern Kansas planted early and at the more traditional June planting time, (2) determine N needs when using these systems, and (3) determine whether there is any yield benefit from applying starter fertilizer at planting for strip-tilled fertilized grain sorghum.

Procedures

Field experiments were conducted on an upland Woodson silt loam soil in 2006, 2007, 2008, and 2009 at the East Central Kansas Experiment Field to compare strip-till and no-till systems. Nitrogen rates ranging from 0 to150 lb/a were also tested. In addition, effects of starter fertilizer placed 2.5 in. to the side and 2.5 in. below the seed row at planting were evaluated for strip-tilled fertilized sorghum. The sorghum experiments followed no-till soybean each year. Pioneer 84G62 grain sorghum was planted Apr. 14, 2006 (early) and May 24, 2006 (traditional). In 2007, early planting was not possible because of a prolonged wet spring. Instead, two hybrids were planted in June (Pioneer 84G62, June 7 and Pioneer 86G08, June 11). In 2008, early planting was delayed again by wet weather. Pioneer 87G57 grain sorghum was planted May 15 (targeted early), and Pioneer 84G62 was planted June 19 (traditional). In 2009, it again was not possible to plan grain sorghum early because of persistent spring rains and wet soil. Pioneer 86G32 sorghum was planted May 29, and Pioneer 84G62 sorghum was planted June 5. The seeding rate for all sorghum planting dates was 69,000 seeds/a. For preplant weed control, 1 qt/a atrazine 4L plus 0.66 pint/a 2,4-D LVE, plus 1 qt/a crop oil concentrate was applied. Preemergence herbicides containing 0.5 qt/a atrazine 4L plus 1.33 pint/a Dual II Magnum were applied each year at planting for additional weed control.

The effectiveness of these tillage systems, fertilizer applications, and dates of planting were evaluated by collecting data on plant population, early season grain sorghum growth, and grain yield.

Results

Moisture for pollination and grain fill was below average for all planting dates during 2006 and 2007 and the May planting date of 2008. Seasonal moisture was above average for the June planting date in 2008 and both planting dates in 2009. Overall, few differences in plant population, early season grain sorghum growth, and grain yield occurred between the strip-tillage and no-till systems except for the June 7 planting date in 2007, the June 19 planting date in 2008, and the June 5 planting date in 2009 (Tables 1 and 2, Figure 1).

In 2007, when planting was delayed and two hybrids were planted in June, strip tillage increased early growth of Pioneer 84G62 grain sorghum slightly and increased grain yields 3 to 6 bu/a, on average, compared with no-till. In 2008, grain yield for strip-till sorghum planted June 19 was 12 bu/a less than that of no-till sorghum. For this planting date, strip-till fertilizer was applied during the strip-till operation on April 30, and fertilizer for the no-till sorghum was applied at planting on June 19. Twelve inches of rain fell between these two fertilizer application dates. Thus, we believe that some of the N in the strip-till fertilizer was lost and that this precipitated the difference in tillage response.

Overall, effects of the starter fertilizer applied at planting for the strip-tilled fertilized sorghum were negligible except for sorghum planted June 19, 2008. Starter fertilizer (30-20-10) applied at planting to sorghum planted June 19 increased strip-till yield by 10 bu/a compared with all starter fertilizer applied in the strip-till zone. This one-time starter effect is thought to be a result of the loss of N from the strip-till fertilizer as well. The N in the starter applied at planting simply compensated for some of the N loss from the earlier strip-till N application.

In 2009, plant stand (data not shown) was increased by approximately 1,000 plants/a with strip till compared with no-till. However, grain yields were not statistically different. With both tillage systems following soybean, 60 to 90 lb/a N optimized grain sorghum yields when moisture was limited. Up to 150 lb/a N was required to maximize yields when rainfall was greater, yield potential was higher, and N losses were greater. June-planted sorghum yields tended to be higher than those for April-planted sorghum, which were mostly May planting dates. Both of these tillage fertilization systems appear to be acceptable for planting grain sorghum either early or in June.

Table 1. Effects of tillage, nitrogen rates, and starter fertilizer placement on V6-V7 plant dry weights of April- and June-planted grain sorghum, East Central Kansas Experiment Field, Ottawa, 2006-2009

		V6-V7 plant dry weights							
		April planting (targeted)			June planting (targeted)				
Tillage	Fertilizer rate and placement	2006	2008	2009	2006	2007a	2007b	2008	2009
	------ N-P_2O_5-K_2O, lb/a -----	---------- g/plant ----------							
Strip-till	0-0-0	4.3	6.8	3.8	7.3	2.5	18.3	7.1	9.8
Strip-till	60-30-10, 5-6 in. below the row	6.0	13.8	7.0	9.4	4.4	24.0	10.6	13.4
Strip-till	90-30-10, 5-6 in. below the row	7.0	14.8	6.7	8.7	3.7	23.0	11.6	13.4
Strip-till	120-30-10, 5-6 in. below the row	6.4	14.6	6.3	8.9	3.5	19.8	11.2	14.1
Strip-till	150-30-10, 5-6 in. below the row	6.7	15.1	5.8	8.2	3.0	21.8	12.2	12.0
Mean		6.1	13.0	5.9	8.5	3.4	21.4	10.5	12.5
No-till	0-0-0	5.4	5.2	4.5	6.4	2.2	15.7	7.5	10.4
No-till	60-30-10, 2.5 × 2.5 in. at planting	6.8	13.3	6.6	8.8	3.7	21.1	11.0	11.8
No-till	90-30-10, 2.5 × 2.5 in. at planting	6.7	13.6	6.0	8.6	3.2	20.0	10.3	12.7
No-till	120-30-10, 2.5 × 2.5 in. at planting	5.5	14.7	6.8	8.4	2.7	20.7	10.2	11.1
No-till	150-30-10, 2.5 × 2.5 in. at planting	5.5	13.0	6.1	8.0	2.6	17.9	9.9	13.5
Mean		5.9	12.0	6.0	8.0	2.9	19.1	9.8	11.9
Evaluation of starter									
Strip-till	90-30-10, 5-6 in. below the row	7.0	14.8	6.7	8.7	3.7	23.0	11.6	13.4
Strip-till	60-15-5 strip-till and 30-15-5 at planting	6.6	15.6	6.4	9.2	4.2	22.2	11.9	14.3
Strip-till	120-30-10, 5-6 in. below the row	6.4	14.6	6.3	8.9	3.5	19.8	11.2	14.1
Strip-till	90-15-5 strip-till and 30-15-5 at planting	6.8	13.6	7.1	9.0	3.4	23.9	11.8	11.9
LSD (0.05)		1.1	2.4	1.3	1.4	0.6	2.7	1.5	3.4

Table 2. Effects of tillage, nitrogen rates, and starter fertilizer placement on yield of April- and June-planted grain sorghum, East Central Kansas Experiment Field, Ottawa, 2006-2009

		Yield							
		April planting (targeted)			June planting (targeted)				
Tillage	Fertilizer rate and placement	2006	2008	2009	2006	2007a	2007b	2008	2009
	------ N-P_2O_5-K_2O, lb/a -----	---			bu/a ---				
Strip-till	0-0-0	73	24	57	85	59	50	50	75
Strip-till	60-30-10, 5-6 in. below the row	93	71	100	107	94	71	85	120
Strip-till	90-30-10, 5-6 in. below the row	101	88	108	115	98	75	91	135
Strip-till	120-30-10, 5-6 in. below the row	95	83	98	101	92	73	107	138
Strip-till	150-30-10, 5 in. below the row	84	88	93	108	95	76	115	144
Mean		89	71	92	103	88	69	90	122
No-till	0-0-0	74	27	65	48	50	45	48	65
No-till	60-30-10, 2.5 × 2.5 in. at planting	106	76	94	95	83	71	105	103
No-till	90-30-10, 2.5 × 2.5 in. at planting	92	81	105	101	91	70	113	122
No-till	120-30-10, 2.5 × 2.5 in. at planting	94	85	106	84	92	74	119	129
No-till	150-30-10, 2.5 × 2.5 in. at planting	96	73	108	93	94	71	127	139
Mean		92	68	96	84	82	66	102	112
Evaluation of starter									
Strip-till	90-30-10, 5-6 in. below the row	101	88	108	115	98	75	105	135
Strip-till	60-15-5 strip-till and 30-15-5 at planting	83	87	83	107	96	75	111	132
Strip-till	120-30-10, 5-6 in. below the row	95	83	98	101	92	73	107	138
Strip-till	90-15-5 strip-till and 30-15-5 at planting	94	88	94	100	93	75	122	144
LSD (0.05)		15	13	23	22	5	7	10	12

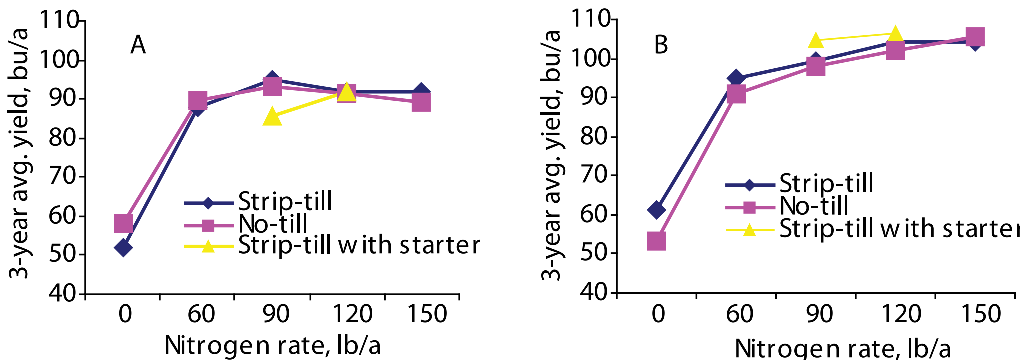


Figure 1. Average effects of tillage, nitrogen rate, and starter fertilizer on grain sorghum with targeted planting dates of (A) April (primarily May planting dates) and (B) June.

Impact of Planting at Different Distances from the Center of Strip-Tilled Fertilized Rows on Early Growth and Yield of Corn

K. A. Janssen

Summary
Corn growers who have automatic guidance systems technology (e.g., GPS and auto-steer) can plant corn directly on top of previously established strip-tilled fertilized rows, but this might not be the best location for planting. The objective of this study was to determine the effects of planting corn at different distances from strip-tilled fertilized rows. The locations evaluated were planting directly on top of the strip-tilled fertilized rows and 3.75, 7.5, and 15 in. off the center of the rows. Planting corn directly on top of freshly tilled strip-tilled fertilized rows negatively impacted yield. Planting at distances greater than 3.75 in. from strip-tilled fertilized rows reduced early season corn growth, uptake of nutrients, and yield. The best location for planting was within 3.75 in. of the strip-till fertilized rows and where the seedbed was firm and moist.

Introduction
Corn growers who have automatic guidance systems technology, such as GPS and auto steer, have the capability to plant corn in precise locations relative to previously established strip-tilled fertilized rows. However, depending on the amount of time that has elapsed between the strip-till fertilizer operations and planting and the rate and forms of fertilizers applied, the best location for planting may not be directly on top of the strip-tilled fertilized rows. For example, strip-tilled fertilized rows could have air pockets under the row, might be dry or cloddy, or could have excessive levels of fertilizer salts or free ammonia. On the other hand, planting too far away from the strip-tilled fertilized rows might reduce benefits from residue management including warmer loosened soil and rapid root-to-fertilizer contact. The objective of this study was to determine the effects of planting corn at various distances from the center of previously established strip-tilled fertilized rows on fine-textured soils in eastern Kansas.

Procedures
Field experiments were conducted on an Osage silty clay loam soil at a field site near Lane, KS, in 2006 and 2008 and on a Woodson silt loam soil at the East Central Kansas Experiment Field at Ottawa, KS, in 2009. The planting distances evaluated were directly on top of strip-tilled fertilized rows and 3.75, 7.5, and 15 in. off the center of the rows. The experiment was designed as a randomized complete block with three to four replications. Plot size ranged from 0.14 to 0.55 acres depending on the site year. The strip-till fertilization application was performed 1 day before planting in 2006, 2 weeks before planting in 2008, and 2.5 months before planting in 2009. Fertilizer was applied at a standard rate (120-30-10 lb/a). The fertilizer source was a mixture of dry urea, diammonium phosphate, and muriate of potash. Depth of the strip-till fertilizer application was 5 to 6 in. below the row. The planting treatments were evaluated for effects on plant population, early season corn growth, nutrient uptake, and grain yield.

Results

In 2006 and 2008, plant populations were higher for corn planted 3.75 in. off the center of the strip-tilled fertilized rows than for corn planted directly on top of the rows (Figure 1). This was expected in 2006 because the strip-till fertilization operation was performed only 1 day before planting and the soil was loose and had air pockets under the row. In 2008, when there were 2 weeks between the strip-till operation and planting, plant population was still increased by planting just slightly off the strip-tilled fertilized rows. No differences in plant populations occurred in 2009, when the strip-till operation was performed 2.5 months before planting.

Early season corn growth at the 2- to 3- and 6- to 7-leaf growth stages tended to be better for corn planted directly on top of the strip-tilled fertilized rows or just slightly off (3.75 in. off) than for corn planted 7.5 and 15 in. off the center of the rows (Figures 2A and 2B). Planting corn 7.5 in. from the center of the strip-tilled fertilized rows reduced early season corn growth 12% on average, and planting 15 in. away reduced early season growth 38%. Uptake of plant nutrients (i.e., nitrogen, phosphorus, and potassium) followed a pattern similar to that for plant growth (data not shown).

In 2006, yield of corn planted directly on top of the strip-tilled fertilized rows was 8% less that that of corn planted 3.75 in. off the center of the rows (Figure 3). This was a result of the reduced plant population. In 2008, corn planted 3.75 in. off the center of the strip-tilled fertilized rows had the highest plant population and the highest numerical grain yield. In 2009, when the strip-till operation was performed 2.5 months before planting and there was plenty of time for the strip-tilled seedbed to settle and become firm, there were no differences in plant population and no differences in yield between planting directly on the strip-tilled rows and planting 3.75 in. off the rows.

These results indicate that the best location for planting will vary depending on the condition of the strip-tilled fertilized seedbed and the amount of time between planting and when the strip-till fertilizer operation was performed. Corn should be planted in a moist, firm seedbed to obtain good stands and within 3.75 in. of strip-tilled fertilized rows to ensure quick contact between corn roots and fertilizer.

Additional years testing are needed to determine if these guidelines might also apply to strip-tilled fertilized corn planted on course-textured soils and when higher rates of fertilizer and other sources of nitrogen are applied.

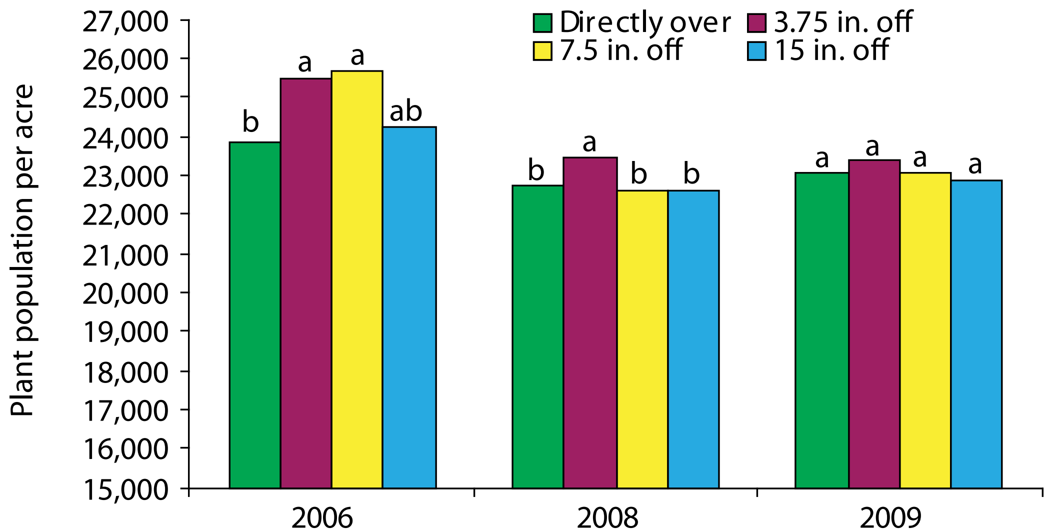


Figure 1. Impact of planting at different distances from the center of strip-tilled fertilized rows on corn plant population.
Means with the same letter within years are not significantly different at P<0.05.

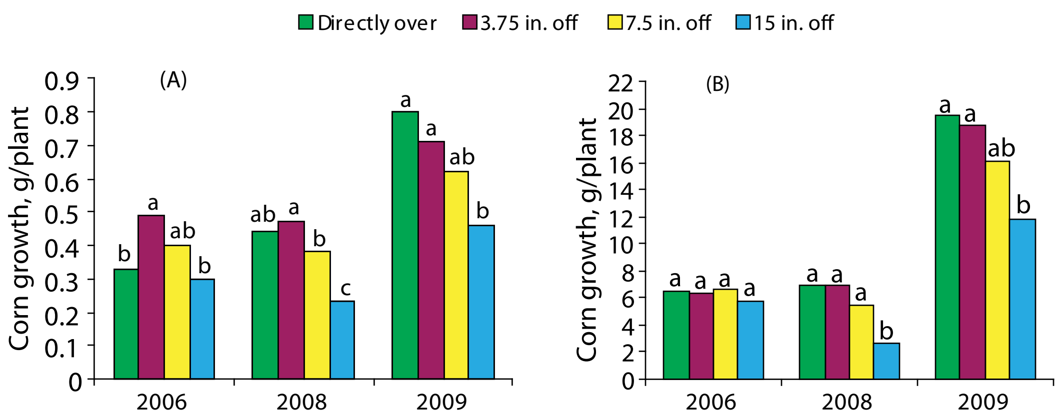


Figure 2. Impact of planting at different distances from the center of strip-tilled fertilized rows on corn growth at the (A) 2- to 3-leaf growth stage and (B) 6- to 7-leaf growth stage.
Means with the same letter within years are not significantly different at P<0.05.

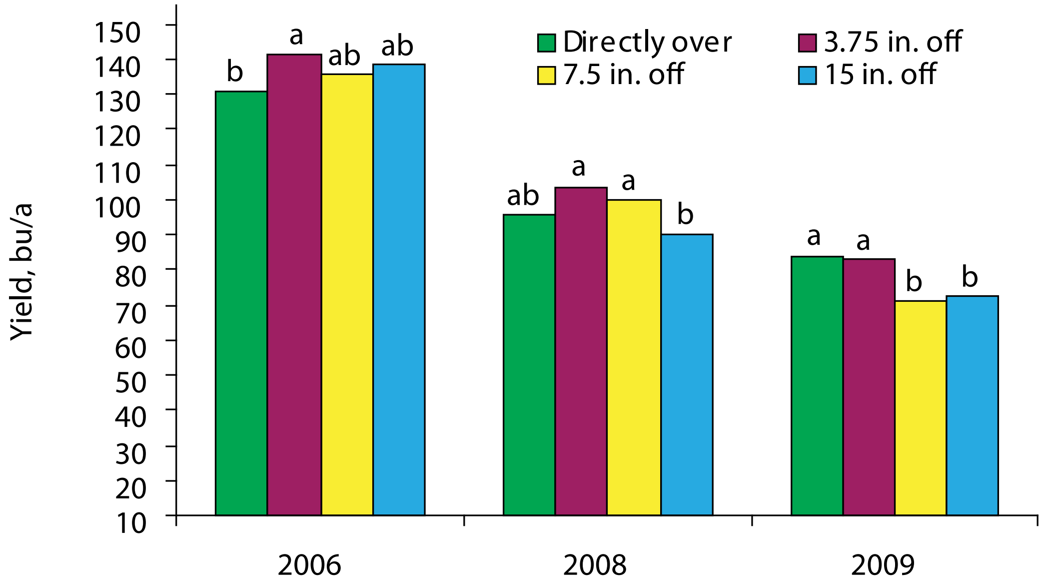


Figure 3. Impact of planting at different distances from the center of strip-tilled fertilized rows on corn grain yield.
Means with the same letter within years are not significantly different at P<0.05.

Effect of Various Fertilizer Materials on Dryland Grain Sorghum

L. D. Maddux

Summary

A lower-than-optimal nitrogen (N) rate (60 lb/a) applied to dryland grain sorghum in 2009 resulted in yields equal to those obtained with the same N rate plus calcium thiosulfate (CaTs), Trisert NB, and magnesium thiosulfate (MagThio). All treatments yielded more than the no-N check, with the 90 lb/a N treatments yielding about 20 bu/a more than the 60 lb/a N treatments. No significant differences were observed in flag leaf phosphorus (P) or grain N content. All treatments had higher leaf N content and lower grain P content than the no-N check. The 90 lb/a N treatments had higher leaf N content and lower grain P content than the 60 lb/a N treatments.

Introduction

This study was funded by a grant provided by Tessenderlo Kerley, Inc., a producer of specialty products used in the agriculture, mining, and process chemical industries. The Tessenderlo Kerley products tested were CaTs (0-0-0-10S-6Ca), Trisert NB (26-0-0 with 33% slow-release N), and MagThio (0-0-0-10S-4Mg). A lower-than-optimal N rate (60 lb/a) was used to evaluate the effectiveness of Trisert NB at supplying foliar N to sorghum plants to increase grain yield. Applications of CaTs and MagThio with urea-ammonium nitrate (UAN) solution were also evaluated for their effect on grain yield at the lower N rate.

Procedures

This study was conducted in 2009 on no-till dryland grain sorghum following soybean on a Woodson silt loam soil at the East Central Kansas Experiment Field near Ottawa, KS. Treatments were: a no-N check; 90 and 60 lb/a N; 60 lb/a N + 5 or 10 gal/a CaTs; 60 lb/a N + 5 gal/a CaTs + 4 gal/a foliar N; 60 lb/a N + 4 gal/a foliar N; and 60 lb/a N + 1.0, 1.5, or 2.0 gal/a MagThio. Urea-ammonium nitrate solution was used as the N source and knifed 6 to 8 in. deep on 30-in. centers. Grain sorghum hybrid Pioneer 84G62 was planted no-till into soybean stubble at 65,000 seeds/a on May 18. The UAN, CaTs, and MagThio treatments were applied on 30-in. centers between the planted rows on May 19. The Trisert NB treatments were applied in 20 gal/a solution to 10-leaf sorghum on July 13. Herbicides were applied as needed for weed control. Flag leaf samples were taken at boot stage of growth for N and P analyses. Plots were harvested with a John Deere 3300 plot combine, and grain samples were saved for N and P analyses.

Results

Nitrogen content of sorghum leaf tissue at boot stage responded to N rate (Table 1). The check plot had the lowest N content, the 90 lb/a N rate had the highest, and the treatments with the 60 lb/a N rate were intermediate. Phosphorus content of the grain was the reverse of the leaf N content; the check plot had the highest P content, the 90 lb/a N rate had the lowest, and the treatments with the 60 lb/a N rate were again intermediate. However, there were no significant differences in leaf tissue P content or grain N content. All treatments increased yield of dryland sorghum over that of the no-N check. The 90 lb/a N rate yielded 20 bu/a more than most of the other 60 lb/a N treatments, but there were no significant differences among the treatments receiving 60 lb/a N as UAN.

Table 1. Effect of calcium thiosulfate, magnesium thiosulfate, and Trisert NB rate on nitrogen and phosphorus content in the flag leaf and grain, test weight, and grain yield of sorghum, East Central Kansas Experiment Field, 2009

Treatment[1]	Leaf N	Leaf P	Grain N	Grain P	Test weight	Yield
	------------------	%	------------------		lb/bu	bu/a
Check	1.65	0.257	1.02	0.722	56.7	49.2
UAN 90	2.41	0.264	1.05	0.435	55.6	96.8
UAN 60	2.03	0.254	0.98	0.649	54.9	76.0
UAN 60; CaTs, 5 gal	1.82	0.263	0.97	0.636	55.8	69.0
UAN 60; CaTs, 10 gal	1.97	0.252	0.94	0.635	55.6	74.9
UAN 60; CaTs, 5 gal; Trisert NB	2.09	0.251	1.01	0.667	55.4	78.4
UAN 60; Trisert NB, 4 gal foliar	2.19	0.254	1.03	0.616	55.6	79.6
UAN 60; MagThio, 1.0 gal	1.94	0.254	0.99	0.665	56.0	78.3
UAN 60; MagThio,1.5 gal	2.10	0.253	1.01	0.617	55.8	74.4
UAN 60; MagThio, 2.0 gal	1.97	0.255	0.99	0.647	55.0	75.2
LSD (0.05)	0.17	NS	NS	0.142	0.8	10.9

[1] UAN, urea-ammonium nitrate solution; CaTs, calcium thiosulfate; MagThio, magnesium thiosulfate.

Kansas River Valley Experiment Field

Introduction

The Kansas River Valley Experiment Field was established to study management and effective use of irrigation resources for crop production in the Kansas River Valley. The Paramore Unit consists of 80 acres located 3.5 miles east of Silver Lake on U.S. Highway 24, then 1 mile south of Kiro, and 1.5 miles east on 17th street. The Rossville Unit consists of 80 acres located 1 mile east of Rossville or 4 miles west of Silver Lake on U.S. Highway 24.

Soil Description

Soils on the two fields are predominately in the Eudora series. Small areas of soils in the Sarpy, Kimo, and Wabash series also occur. Except for small areas of Kimo and Wabash soils in low areas, the soils are well drained. Soil texture varies from silt loam to sandy loam, and the soils are subject to wind erosion. Most soils are deep, but texture and surface drainage vary widely.

2009 Weather Information

The frost-free season was 186 and 176 days at the Paramore and Rossville units, respectively (average = 173 days). The last spring freeze was April 7 and 14 (average = April 21), and the first fall freeze was October 10 and 7 (average = October 11) at the Paramore and Rossville units, respectively. There were only 25 and 24 days above 90°F at the Paramore and Rossville units, respectively, and no days were above 100°F. Precipitation was above normal at both fields for the growing season (Table 1). The rain gauge at the Paramore Unit does not record the proper total for heavy rainfall events, so the total appears to be lower than the average. Precipitation was below average from November through March. Corn yield was excellent and soybean yield was good at both fields.

Table 1. Precipitation at the Kansas River Valley Experiment Field

	Rossville Unit		Paramore Unit	
Month	2008-2009	30-year avg.	2008-2009	30-year avg.
	------------in.------------		------------in.------------	
October	3.66	0.95	3.43	0.95
November	0.97	0.89	0.62	1.04
December	1.52	2.42	1.06	2.46
January	0.00	3.18	0.03	3.08
February	0.28	4.88	0.15	4.45
March	2.74	5.46	2.61	5.54
April	6.73	3.67	3.90	3.59
May	1.77	3.44	1.25	3.89
June	7.04	4.64	5.85	3.81
July	7.31	2.97	5.93	3.06
August	5.09	1.90	4.00	1.93
September	3.33	1.24	1.41	1.43
Total	40.44	35.64	30.24	35.23

Corn Herbicide Performance Test

L. D. Maddux

Summary
Two tests were conducted at the Rossville Unit. Herbicide applications consisting of preemergence (PRE), two-pass (PRE plus mid-postemergence [MP]), and early postemergence (EP) were compared. Ratings made on July 6 showed that the PRE + MP treatments resulted in the best weed control and highest yields in both tests. Only a couple of the EP only treatments had weed control and yields equivalent to those of the two-pass treatments. All treatments in both tests resulted in much greater yield than the untreated check.

Introduction
Controlling weeds in row crops with chemical weed control and cultivation can reduce weed competition and, in turn, weed yields. Timeliness of application is a major factor in effective weed control. These two tests compared the effectiveness of 21 herbicide treatments including PRE, EP, and PRE + MP for controlling large crabgrass, Palmer amaranth, common sunflower, and ivyleaf morningglory.

Procedures
Two tests were conducted on a Eudora silt loam soil previously cropped to soybean at the Rossville Unit. Test 1 consisted of eight treatments plus an untreated check, and Test 2 consisted of 13 treatments plus an untreated check. The tests were conducted next to each other on soil with 1.1% organic matter and pH 6.9. Corn hybrid Hoegemeyer 8778, Herculex, LL RR2 was planted May 9 at 29,600 seeds/a in 30-in. rows. Anhydrous ammonia at 150 lb/a nitrogen was applied preplant, and 100 lb/a of 11-52-0 fertilizer was broadcast and incorporated before planting. Herbicides were broadcast in 15 gal/a with 8003XR flat fan nozzles at 17 psi.

The experimental design was a randomized complete block with three replications. Preemergence treatments were applied May 9. Early postemergence treatments were applied June 1 to 6-leaf corn, 1- to 4-in. large crabgrass, 8- to 12-in. Palmer amaranth and common sunflower, and 2- to 4-in. ivyleaf morningglory. Mid-postemergence treatments were applied June 12 to 7-leaf corn, 1- to 3-in. large crabgrass, 4- to 8-in. Palmer amaranth, and 1- to 4-in. ivyleaf morningglory. Populations of all four weed species were moderate to heavy. However, weed populations were generally light to moderate at the time of the MP treatment in plots that received a PRE treatment. Plots were not cultivated. The reported weed control ratings were made July 6. Rainfall of 1.10 in. was received 6 days after PRE applications. Irrigation was not required. The test was harvested September 30 with a modified John Deere 3300 plot combine.

Results
Some crop injury from the Integrity treatments was observed (data not reported). In Test 1, most treatments gave excellent control (greater than 90%) of Palmer amaranth and common sunflower (Table 1). Integrity (PRE) and SureStart + Durango DMA

(PRE + MP) gave poor control of large crabgrass. Ivyleaf morningglory control was usually better with a two-pass herbicide treatment. Even though the MP application of SureStart + Durango DMA resulted in fairly good weed control, grain yield was lower than that in the other treatments, likely because of early season weed competition. No differences in yield were observed among the other treatments.

Table 2 shows the results of Test 2. All of the two-pass (PRE + MP) treatments resulted in excellent weed control and grain yields. However, most of the EP treatments resulted in less weed control, especially of large crabgrass. The lower weed control also translated into lower yields. Only the Capreno + AAtrex 4L + MSO + UAN and Laudis + AAtrex 4L + MSO + UAN had weed control and yields similar to those of the two-pass treatments.

Table 1. Effects of preemergence and postemergence herbicides on weed control and grain yield of corn, Kansas River Valley Experiment Field, Rossville, 2009

Treatment	Rate	Application time[1]	Weed control, July 6[2]				Grain yield
			LC	PA	CS	IM	
			------------%------------				bu/a
Untreated check	—	—	0	0	0	0	98
Lexar	3.0 qt/a	PRE	88	100	100	73	247
Integrity	20 oz/a	PRE	60	92	100	78	255
Integrity *fb* Roundup PowerMax + AMS	13 oz/a 22 oz/a + 17 lb/100 gal	PRE MP	87	93	100	87	256
Sharpen + Prowl H2O *fb* Roundup PowerMax + AMS	2.5 oz/a + 3.0 pt/a 22 oz/a + 17 lb/100 gal	PRE MP	97	98	100	88	254
Sharpen + Harness Xtra 5.6 *fb* Roundup PowerMax + AMS	2.5 oz/a + 1.5 qt/a 22 oz/a + 17 lb/100 gal	PRE MP	90	93	100	87	232
Integrity *fb* Roundup PowerMax + AMS + Status + NIS	13 oz/a 22 oz/a + 17 lb/100 gal + 2.5 oz/a + 0.25% v/v	PRE MP	92	100	100	95	231
SureStart *fb* Durango DMA + AMS	1.75 pt/a 24 fl oz/a + 2.5 lb/a	PRE MP	88	97	100	70	229
SureStart + Durango DMA + AMS	1.75 pt/a + 24 fl oz/a + 2.5 lb/a	MP	73	87	100	83	201
LSD (0.05)			11	10	1	15	29

[1] PRE, preemergence (May 9); MP, mid-postemergence (June 12).
[2] LC, large crabgrass; PA, Palmer amaranth; CS, common sunflower; IM, ivyleaf morningglory.

Table 2. Effects of preemergence and postemergence herbicides on weed control and grain yield of corn, Kansas River Valley Experiment Field, Rossville, 2009

Treatment	Rate	Application time[1]	Weed control, July 6[2]				Grain yield
			LC	PA	CS	IM	
			----------%----------				bu/a
Untreated check	—	—	0	0	0	0	57
Corvus + AAtrex 4L *fb*	3.0 oz/a + 1.0 qt/a	PRE	98	100	100	95	226
Capreno + AAtrex 4L	3.0 oz/a + 1.0 pt/a	MP					
+ COC + UAN	+ 1.0% v/v + 1.5 qt/a						
Corvus + AAtrex 4L *fb*	3.0 oz/a + 1.0 qt/a	PRE	98	100	100	95	226
Laudis + AAtrex 4L	3.0 oz/a + 1.0 pt/a	MP					
+ MSO + UAN	+ 0.5% v/v + 1.5 qt/a						
Lumax *fb*	1.5 qt/a	PRE	98	100	100	97	198
Capreno + AAtrex 4L	3.0 oz/a + 1.0 pt/a	MP					
+ COC + UAN	+ 1.0% v/v + 1.5 qt/a						
Balance Flexx + Aatrex 4L *fb*	3.0 oz/a + 1.0 qt/a	PRE	97	100	100	95	231
Capreno + AAtrex 4L	3.0 oz/a + 1.0 pt/a	MP					
+ COC + UAN	+ 1.0% v/v + 1.5 qt/a						
Balance Flexx + Aatrex 4L *fb*	3.0 oz/a + 1.0 qt/a	PRE	100	100	100	98	225
Laudis + AAtrex 4L	3.0 oz/a + 1.0 pt/a	MP					
+ MSO + UAN	+ 0.5% v/v + 1.5 qt/a						
Capreno	3.0 oz/a	EP	60	95	100	80	178
+ Roundup PM + Superb HC	+ 11 oz/a + 0.75 pt/a						
Capreno + AAtrex 4L	3.0 oz/a + 1.0 qt/a	EP	77	100	100	90	210
+ Roundup PM + Superb HC	+ 11 oz/a + 0.75 pt/a						

continued

Table 2. Effects of preemergence and postemergence herbicides on weed control and grain yield of corn, Kansas River Valley Experiment Field, Rossville, 2009

Treatment	Rate	Application time[1]	Weed control, July 6[2]				Grain yield
			LC	PA	CS	IM	
			--%--				bu/a
Capreno + Ignite 280	3.0 oz/a + 22 oz/a	EP	47	85	100	77	146
Halex GT + NIS	3.5 pt/a + 0.25% v/v	EP	60	100	100	80	227
Capreno + AAtrex 4L + COC + UAN	3.0 oz/a + 1.0 qt/a + 1.0% v/v + 1.5 qt/a	EP	65	100	100	90	186
Impact + AAtrex 4L + COC + UAN	0.75 oz/a + 1.0 qt/a + 1.0% v/v + 1.5 qt/a	EP	77	97	100	83	184
Capreno + AAtrex 4L + MSO + UAN	3.0 oz/a + 1.0 qt/a + 0.5% v/v + 1.5 qt/a	EP	82	100	100	82	238
Laudis + AAtrex 4L + MSO + UAN	3.0 oz/a + 1.0 qt/a + 1.0% v/v + 1.5 qt/a	EP	92	100	100	92	248
LSD (0.05)			20	8	1	10	45

[1] PRE, preemergence (May 9); EP, early postemergence (June 1); MP, mid-postemergence (June 12).

[2] LC, large crabgrass; PA, Palmer amaranth; CS, common sunflower; IM, ivyleaf morningglory.

Soybean Herbicide Performance Test

L. D. Maddux

Summary
This study was conducted at the Rossville Unit to compare herbicide treatments for soybean. Twelve herbicide treatments were evaluated for control of large crabgrass, Palmer amaranth, common sunflower, and ivyleaf morningglory and their effect on grain yield. All treatments resulted in excellent control of large crabgrass, Palmer amaranth, and common sunflower. Some treatments provided only 60% to 70% control of ivyleaf morningglory. Some injury was observed with Optil, Valor XL, Flexstar GT, Cobra, and Resource. There was no significant difference in grain yield among herbicide treatments.

Introduction
Controlling weeds in row crops with chemical weed control and cultivation can reduce weed competition and, in turn, weed yields. Treatments in this study included an untreated check, preemergence (PRE) applications followed by glyphosate alone or with a tank mix partner, a two-pass postemergence treatment, and a treatment of only one application of glyphosate. Four weeds were evaluated in this test: large crabgrass, Palmer amaranth, common sunflower, and ivyleaf morningglory.

Procedures
This test was conducted on a Eudora silt loam soil previously cropped to corn. Soil at the test site had 1.1% organic matter and pH 6.9. Corn stubble had been disked and chiseled in the fall and field cultivated in the spring. Before field cultivation, 100 lb/a of 11-52-0 fertilizer was broadcast. Soybean variety Taylor 398 was planted May 23 at 139,000 seeds/a in 30-in. rows. Herbicides were broadcast at 15 gal/a with 8003XR flat fan nozzles at 17 psi.

The experimental design was a randomized complete block with three replications per treatment. Herbicide treatments were applied as follows: PRE on May 23; early postemergence (EP) on June 27 to V4 soybeans, 2- to 4-in. large crabgrass and ivyleaf morningglory, and 4- to 8-in Palmer amaranth and common sunflower; mid-postemergence (MP) on July 6 to V6 soybean, 3- to 8-in. large crabgrass, 4- to 18-in. Palmer amaranth, 4- to 10-in. common sunflower, and 2- to 6-in. ivyleaf morningglory; and late postemergence (LP) on July 23 to R2 soybean, 2- to 4-in. large crabgrass and Palmer amaranth, and 2- to 6-in. ivyleaf morningglory. Herbicides and rates applied are listed in Table 1. Populations of all four weeds were moderate to heavy. Plots were not cultivated. Rainfall of 0.32 in. was received 9 days after PRE applications. Irrigation was not necessary this year. The test was harvested October 7 with a modified John Deere 3300 plot combine.

Results
Sufficient rainfall to activate the PRE herbicides was received 9 days after application. Significant crop injury was observed from the PRE application of Optil and Valor XLT and the postemergence applications of Flexstar, Cobra, and Resource (data not shown).

Table 1 shows weed control ratings made August 4 and grain yield. Control of common sunflower was excellent for all treatments (100%). Common sunflower pressure was lighter than normal this year, likely because of the late tillage for the late planting date. Control of large crabgrass and Palmer amaranth also was excellent; all treatments had 97% or greater control ratings. Control of ivyleaf morningglory ranged from 62% to 98%. Sonic *fb* Durango DMA and the two-pass treatment of Flexstar GT resulted in the best control of ivyleaf morningglory. All treatments had higher grain yields than the untreated check. The lack of significant differences among treatments suggests that the crop injury observed had no effect on yields.

Table 1. Effects of herbicide application on weed control and grain yield of soybean, Kansas River Valley Experiment Field, Rossville, 2009

Treatment	Rate	Application time[1]	Weed control, August 4[2]				Grain yield
			LC	PA	CS	IM	
			--------------------------%--------------------------				bu/a
Untreated check	—	—	0	0	0	0	34.0
Boundary *fb* Flexstar GT + AMS	1.5 pt/a 3.0 pt/a + 17 lb/100 gal	PRE MP	100	100	100	77	50.4
Flexstar GT + AMS *fb* Flexstar GT + AMS	3.0 pt/a + 17 lb/100 gal 3.0 pt/a + 17 lb/100 gal	EP LP	100	100	100	97	51.3
Flexstar GT + AMS *fb*	3.0 pt/a + 17 lb/100 gal	MP	100	100	100	63	48.2
Roundup PowerMax + Cobra + AMS	28 oz/a + 10.0 oz/a + 17 lb/100 gal	MP	100	100	100	78	52.1
Roundup PowerMax + Resource + AMS	28 oz/a + 3.0 oz/a + 17 lb/100 gal	MP	100	97	100	67	49.3
Roundup PowerMax + AMS	28 oz/a + 17 lb/100 gal	MP	100	98	100	75	49.3
Optill *fb* Roundup PowerMax + AMS	2.0 oz/a 22 oz/a + 17 lb/100 gal	PRE MP	98	100	100	93	48.9
Optill + Prowl H2O *fb* Roundup PowerMax + AMS	2.0 oz/a + 2.1 pt/a 22 oz/a + 17 lb/100 gal	PRE MP	100	98	100	87	53.1
Valor *fb* Roundup PowerMax + AMS	2.0 oz/a 22 oz/a + 17 lb/100 gal	PRE MP	100	98	100	67	57.3

continued

Table 1. Effects of herbicide application on weed control and grain yield of soybean, Kansas River Valley Experiment Field, Rossville, 2009

Treatment	Rate	Application time[1]	Weed control, August 4[2]				Grain yield
			LC	PA	CS	IM	
			--------------------------%--------------------------				bu/a
Sonic *fb*	3.0 oz/a	PRE	100	100	100	98	56.2
Durango DMA + AMS	24.0 oz/a + 2% w/w	MP					
Sonic *fb*	4.5 oz/a	PRE	98	100	100	97	53.6
Durango + AMS	24.0 oz/a + 2% w/w	MP					
Valor XLT + Intrro *fb*	3.0 oz/a + 1.5 pt/a	PRE	100	100	100	90	57.8
Roundup WeatherMax	22.0 oz/a	MP					
+ SelectMax + AMS	+ 6.0 oz/a + 2% w/w						
LSD (0.05)			2	4	1	11	12.2

[1] PRE, preemergence (May 23); EP = early postemergence (June 27); MP = mid-postemergence (July 6); LP = late postemergence (July 23).

[2] LC, large crabgrass; PA, Palmer amaranth; CS, common sunflower; IM, ivyleaf morningglory.

Effect of Various Foliar Fertilizer Materials on Irrigated Soybean

L. D. Maddux

Summary
Various fertilizer materials were foliar applied to soybean at V5 to R3 growth stages depending on the fertilizer material being applied. Manganese thiosulfate was also applied with the 2 × 2 starter. None of the fertilizer materials significantly affected grain yield.

Introduction
This study was conducted with a grant provided by Tessenderlo Kerley, Inc., a producer of specialty products used in the agriculture, mining, and process chemical industries. Treatments varied in 2008 and 2009. The Tessenderlo Kerley products tested included calcium thiosulfate (CaTs; 0-0-0-10S-6Ca), Trisert K+ (5-0-20-13S), Trisert CB (26-0-0-0.5B), magnesium thiosulfate (MagThio; 0-0-0-10S-4Mg) and manganese thiosulfate (MnThio; analyses unknown). This study was conducted to evaluate the effect of foliar applications of these materials on soybean yield.

Procedures
This study was conducted in 2008 on a Eudora silt loam soil at the Rossville Unit and in 2009 at the Paramore Unit. Treatments included a check; Trisert K+ at 2.5 and 5 gal/a applied at V5; MagThio at 1.0, 1.5, and 2.0 gal/a applied at V5; Trisert CB at 1.0 and 1.5 gal/a applied at R2; CaTs at 3.0 and 5.0 gal/a applied at R1; and MnThio at 2.5 and 5.0 gal/a applied with starter in a 2 × 2 band and 8 days after glyphosate was applied (about R3 growth stage). A starter of 10 gal/a of 10-34-0 was applied to all plots at planting in a 2 × 2 band. Soybean varieties NK S37-F7 and Pioneer 94Y01 were planted at 139,000 seeds/a on May 16, 2008, and June 5, 2009, respectively. The foliar treatments were applied as follows: V5 – June 30, 2008; R1 – July 2, 2008 and July 10, 2009; R2 – July 14, 2008 and July 17, 2009; and R3 – July 27, 2009. In 2008, glyphosate (0.75 lb ae/a) + Intrro (2.0 qt/a) was applied on June 17 and glyphosate was applied on June 30. In 2009, glyphosate + Select + Resource was applied on June 29, and glyphosate was applied on July 19. Plots were harvested with a John Deere 3300 plot combine.

Results
Soybean yields are shown in Table 1. Yields for the untreated check were 59.9 and 69.6 bu/a in 2008 and 2009, respectively. Although yield increases of up to 4.0 bu/a in 2008 and 6.0 bu/a in 2009 were observed with some treatments, these yield increases were not statistically significant.

Table 1. Effect of various fertilizer applications on soybean yield, Kansas River Valley Experiment Field, Rossville, 2008 and 2009

Fertilizer	Rate	Growth stage	Soybean yield	
		2008/2009	2008	2009
	gal/a		-----bu/a-----	
Check			59.9	69.6
Trisert K+	2.5	V5/NA	60.6	
Trisert K+	5.0	V5/NA	59.3	
MagThio	1.0	V5/NA	60.7	
MagThio	1.5	V5/R1	61.0	70.0
MagThio	2.0	V5/R1	63.9	71.3
Trisert CB	1.0	R2/NA	60.9	
Trisert CB	1.5	R2/NA	57.5	
CaTs	3.0	R1/R2	61.1	70.6
CaTs	5.0	R1/R2	63.2	73.0
MnThio, 2 × 2 with starter	2.5	NA/at planting		72.9
MnThio, 2 × 2 with starter	5.0	NA/at planting		71.3
MnThio, glyphosate application 8 days after treatment	2.5	NA/R3		68.9
MnThio, glyphosate application 8 days after treatment	5.0	NAR3		75.6
LSD (0.05)			NS	NS

Macronutrient Fertility on Irrigated Corn and Soybean in a Corn/Soybean Rotation

L. D. Maddux

Summary

Effects of nitrogen (N), phosphorus (P), and potassium (K) fertilization on a corn/soybean cropping sequence were evaluated from 1983 to 2009 (corn planted in odd years). Corn yield increased with increasing N rates up to 160 lb/a N. Fertilization at 240 lb/a N did not increase yield over that obtained with 160 lb/a N. Phosphorus fertilization resulted in corn yield increases 3 of the 14 years of this test. Potassium fertilization increased corn yield an average of 6 bu/a from 1983 to 1995, but no significant differences have been observed since then.

Introduction

This study was initiated in 1972 at the Paramore Unit of the Kansas River Valley Experiment Field to evaluate effects of N, P, and K on furrow-irrigated soybean. In 1983, the study was changed to a corn/soybean rotation with corn planted and fertilizer treatments applied in odd years. In 2002, sprinkler irrigation with a linear move irrigation system replaced the furrow irrigation. Study objectives are to evaluate effects of N, P, and K applications to a corn crop on grain yields of corn and the following soybean crop and on soil test values.

Procedures

The initial soil test in March 1972 on this silt loam soil was 47 lb/a available P and 312 lb/a exchangeable K in the top 6 in. of the soil profile. Rates of P were 50 and 100 lb/a P_2O_5 (1972–1975) and 30 and 60 lb/a P_2O_5 (1976–2009), except in 1997 and 1998, when a starter of 120 lb/a of 10-34-0 (12 lb/a N + 41 lb/a P_2O_5) was applied to all plots of corn and soybean. Rates of K were 100 lb/a K_2O (1972–1975), 60 lb/a K_2O (1976–1995), and 150 lb/a K_2O (1997–2009). Nitrogen rates included a factorial arrangement of 0, 40, and 160 lb/a preplant N (with single treatments of 80 and 240 lb/a N). The 40 lb/a N rate was changed to 120 lb/a N in 1997. Treatments of N, P, and K were applied every year to continuous soybean (1972–1982) and every other year (odd years) to corn (1983–1995, 1999–2009).

Corn hybrids planted were: BoJac 603 (1983), Pioneer 3377 (1985, 1987, 1989), Jacques 7820 (1991, 1993), Mycogen 7250 (1995), DeKalb DKC626 (1997, 1999), Golden Harvest H2547 (2001), Pioneer 33R77 (2003), DeKalb DKC63-81 (2005), Asgrow RX785 (2007), and DeKalb DKC63-42 (2009). Corn was planted in mid-April, herbicides were applied preplant and incorporated each year, and postemergence herbicides were applied as needed. Plots were cultivated, furrowed, and furrow irrigated through 2001 and sprinkler irrigated with a linear move irrigation system from 2002 to 2009. A plot combine was used to harvest grain yields.

Results

Average corn yields for the 7-year period from 1983 to 1995 and yields for 1997 to 2009 are shown in Table 1. Yields were maximized with 160 lb/a N in most years. Fertilization at 240 lb/a N did not significantly increase corn yield. From 1997 to 2009, corn yield with 120 lb/a N was not significantly different from that with 160 lb/a N and ranged from 0 to 8 bu/a less (LSD 0.05 was 11 to 19 bu/a). A yield response to P fertilization was obtained in 1985 and 1993 (yearly data not shown), but the 7-year average showed no significant difference in yield. No P response was observed in 1997, when starter fertilizer was applied to all plots. A significant yield response to P was obtained in 2003. The 7-year average from 1997 to 2009 showed a nonsignificant 7 bu/a yield increase for the 60 lb/a P_2O_5 treatment over that when no P was applied. Fertilization with K resulted in a significant yield increase in 1985, 1989, and 1993 (yearly data not shown), and the 7-year average showed a 6 bu/a yield increase. No significant corn yield response to K fertilization was observed from 1997 to 2009. No significant interactions between N, P, and/or K were observed. However, in 2005 and 2009, the years with the highest corn yields, the 160-60-150 treatment had the highest grain yield. This suggests a balanced fertility program is necessary for best yields in good production years.

Table 1. Effects of nitrogen, phosphorus, and potassium applications on corn yields in a corn/soybean cropping sequence, Kansas River Valley Experiment Field, Paramore Unit

Fertilizer[1]			Corn yield							
N	P_2O_5[2]	K2O	1983–1995	1997	1999	2001	2003	2005	2007	2009
----------lb/a----------			---bu/a---							
0	0	0	87	93	88	119	88	92	126	141
0	0	60/150	86	95	106	123	84	83	101	132
0	30	0	93	101	115	124	107	114	120	154
0	30	60/150	86	87	90	115	102	80	108	136
0	60	0	84	86	76	110	101	102	100	157
0	60	60/150	92	89	79	115	106	105	104	139
40/120	0	0	129	200	202	183	174	171	191	208
40/120	0	60/150	126	181	195	173	167	189	201	216
40/120	30	0	123	189	188	168	188	179	187	192
40/120	30	60/150	138	208	181	192	198	200	189	223
40/120	60	0	117	195	159	183	202	194	194	201
40/120	60	60/150	132	190	213	182	195	201	194	232
160	0	0	171	203	171	171	188	196	197	217
160	0	60/150	177	177	206	168	175	194	206	211
160	30	0	168	184	189	174	184	174	168	193
160	30	60/150	181	205	209	190	211	200	184	216
160	60	0	167	191	199	205	205	203	196	218
160	60	60/150	178	204	203	198	193	213	201	242
80	30	60/150	151	187	177	167	167	167	202	219
240	30	60/150	182	206	219	192	192	192	197	220
LSD (0.05)			15	27	46	26	34	28	26	41
Nitrogen means										
0			88	92	92	118	98	96	110	143
40/120			127	194	190	180	187	189	193	212
160			174	194	196	184	193	197	192	216
LSD (0.05)			8	19	19	13	17	13	13	11
Phosphorus means										
	0		129	158	161	156	146	154	170	187
	30		131	162	162	160	165	158	159	186
	60		128	159	155	166	167	170	165	198
LSD (0.05)			NS	NS	NS	NS	17	NS	NS	NS
Potassium means										
		0	127	160	154	160	160	158	164	187
		60/150	133	159	165	162	159	163	165	194
LSD (0.05)			6	NS	NS	NS	NS	NS	NS	NS

[1] Fertilizer applied to corn in odd years from 1983 to 2009 and to soybean for 11 years prior to 1983 (the first number of two is the rate applied to corn from 1983 to 1995).

[2] Potassium treatments were not applied in 1997. Starter fertilizer of 10 gal/a of 10-34-0 was applied to all treatments in 1997 and 1998 (corn and soybean). Nitrogen and potassium treatments were applied to corn in 1997.

Fixed- and Flex-Ear Corn Hybrid Response to Different Plant Populations

S. R. Duncan and L. D. Maddux

Summary
Very favorable precipitation throughout the 2009 growing season may have confounded results. These studies were in close proximity, so the biggest differences were population and nitrogen fertilization. Grain yields were excellent and tended to increase as populations increased in both studies. Yield increases were not as pronounced at the irrigated site as at the dryland site, presumably because of higher populations. The fixed-ear hybrid produced primary ears larger than those of the flex-ear hybrid and also set an increasing number of secondary ears as population decreased. The flex-ear hybrid did not set secondary ears. This study will be repeated to make the same comparisons under more typical environmental conditions. Seed size and shape contributed to greater seed drop and higher-than-expected pre-thinning populations in the irrigated fixed-ear plots. Optimum rainfall may have led to delayed emergence after the initial thinning. A secondary thinning will be incorporated in future studies.

Introduction
Recommended plant populations for corn production have steadily increased during the past three decades. Insect resistance traits were included in hybrids in the mid to late 1990s. Since then, different insect and herbicide resistance traits have been incorporated into a greater percentage of newly released hybrids. At the same time, the price per unit of corn seed has also increased, leading to interest among corn growers in targeting optimum populations for their particular acreage.

Dryland corn growers tend to plant hybrids that will produce profitable yields at reasonable populations and have the ability to increase ("flex") ear size and, consequently, yields when environmental conditions are optimum. Hybrids differ in their relative ability to flex when yield-limiting factors are minimal. The objective of this study was to compare a fixed-ear hybrid that would maintain a relatively stable ear size with a flex-ear hybrid over a range of populations in dryland and irrigated environments.

Procedures
Dryland and irrigated experiments were established at the Kansas River Valley Experiment Field (KRV) at Rossville on a Eudora silt loam soil. Irrigated and dryland plots received 150 and 125 lb/a nitrogen, respectively, preplant as anhydrous ammonia. Just before planting, 100 lb/a of 11-52-0 was broadcast and incorporated on all plots. Weed control was achieved with a preplant incorporated application of Harness Xtra at the rate of 2.4 qt/a. The irrigated plots were never irrigated because of adequate and timely rainfall throughout the growing season, resulting in two dryland plots at different plant population levels. However, in this paper, the plots are still referred to as dryland and irrigated.

The corn hybrids used in the experiment were Garst 83X61 (fixed ear) and Garst 84U96 (flex ear). Irrigated plots were seeded at 35,500 seeds/a, and dryland seeding rates were 25,500 seeds/a. Five target populations (Table 1) were established by hand thinning to the desired populations when the plants were at V4 (four leaf collars showing). Standard target populations at the KRV area of influence are approximately 27,000 plants/a on irrigated land and 20,500 plants/a on dryland acres.

Some plots had plants that produced a secondary ear. Secondary ears were hand harvested before plots were machine harvested. Grain yields from all ears were adjusted to 15.5% moisture. Measurements taken include harvest populations; grain yield from the whole plot, main ears, and secondary ears; grain moisture and test weight; average kernel weight; and percentage of plants producing secondary ears and their contribution to total yield.

Results

Irrigated Plots

Across all five population groups (PG), the fixed-ear hybrid averaged 5% more plants than the flex-ear hybrid, resulting in 15% greater grain yields (Table 2). Thinning resulted in the desired differences between population groups except between the two lowest groups. The harvest stand of PG 2 was 6.5% greater than that of PG 1, but that difference was not significant. Population group 5, at 31,102 plants/a, produced 13% and 15% more grain than PG 2 and PG 1, respectively. Population group 2 yields (233 bu/a) were also significantly greater than PG 1 yields. Flex-ear hybrid kernel weight and test weight were slightly greater (13% and 2%, respectively) and moisture was slightly lower (1%) than those of the fixed-ear hybrid, but there were no differences between PG for those parameters (results not shown). The primary, or main, ears of the fixed-ear hybrid (8.3 oz) were 11% heavier than those of the flex-ear hybrid (7.4 oz), and main ear size decreased as population increased. Only the fixed-ear hybrid produced secondary ears, which averaged from 0.9 to 3.4 oz as population decreased. Yield contributions from secondary ears in PG 5, PG 4, and PG 3 were less than 2 bu/a (<1%). Secondary ears from PG 2 and PG 1 were more than 3 oz and contributed approximately 3% of the total grain yield, 7.8 and 6.7 bu/a, respectively.

Dryland Plots

Grain yield of the fixed-ear hybrid at the highest population was greater than yield of all flex-ear hybrid populations except PG 5 and greater than yield of the lowest population of the fixed-ear hybrid (Table 3). When the flex-ear hybrid was planted at standard and lower populations, grain yields were below those of any fixed-ear hybrid treatment and those of the flex-ear hybrid with above-standard populations. Overall harvest populations of the fixed- and flex-ear hybrids were similar, and each PG was distinct (Table 4). The flex-ear hybrid at the highest population produced grain yields similar to those of all fixed-ear hybrid populations (Table 3). No differences in kernel weight, moisture, or test weight were recorded between hybrids or PG (data not shown). Main ears of the fixed-ear hybrid weighed 9.2 oz/ear (Table 4) and were 11% heavier than those of the flex ear hybrid (8.3 oz). Across hybrids, main ear size decreased steadily as population increased, but the reduction was significant only in PG 5. Only the fixed-ear hybrid produced secondary ears. Half of the plants in PG 1 produced secondary ears (4.5 oz/ear), resulting in nearly 18% of the total plot yield (36 bu/a). As plant population increased, secondary ears' contribution to yield declined to less than 2% of plot yield (4 bu/a) in PG 5, in which only 7% of the plants produced secondary ears (2.1 oz/ear).

Table 1. Target populations for a flex- and fixed-ear hybrid comparison study

Population group	Target population
1	Standard – 5,000 plants/a
2	Standard – 2,500 plants/a
3	Standard
4	Standard + 2,500 plants/a
5	Standard + 5,000 plants/a

Table 2. Flex- and fixed-ear hybrid response to different populations, irrigated study

	Harvest population	Yield	Main ear	Fixed-ear hybrid secondary ear contribution		
	plants/a	bu/a	oz/ear			
Hybrid ear type						
Fixed	27,338	241	8.3			
Flex	26,031	209	7.4			
LSD (0.05)	952	12	0.4			
Population group				bu/a	oz/ear	% of yield
1	22,586	209	8.6	6.7	3.2	2.9
2	24,045	214	8.1	7.8	3.4	3.3
3	26,223	227	7.9	1.7	2.5	0.7
4	29,468	233	7.5	1.6	1.4	0.7
5	31,102	241	7.1	1.0	0.9	0.4
LSD (0.05)	1,505	19	0.6	2.6	1.7	1.0

Table 3. Flex- and fixed-ear hybrid yield response at different plant populations, dryland study

Hybrid ear type	Population group	Yield
		bu/a
Fixed	1	205
	2	214
	3	214
	4	218
	5	235
Flex	1	129
	2	167
	3	173
	4	199
	5	214
LSD (0.05)		23

Table 4. Flex- and fixed-ear hybrid response to different populations, dryland study

	Harvest population	Main ear	Secondary ears	Fixed-ear hybrid secondary ear contribution		
	plants/a	oz/ear				
Hybrid ear type						
Fixed	20,290	9.2				
Flex	19,898	8.3				
LSD (0.05)	NS	0.5				
Population group			%	bu/a	oz/ear	% of yield
1	15,290	9.0	50	36.1	4.5	17.6
2	17,849	9.1	29	18.1	3.6	8.5
3	19,667	9.1	25	15.1	3.0	7.1
4	22,967	8.4	10	5.8	2.4	2.6
5	24,699	8.2	7	4.2	2.1	1.7
LSD (0.05)	887	0.8	8	7.4	0.6	3.5

South Central Kansas Experiment Field

Introduction

The South Central Kansas Experiment Field–Hutchinson was established in 1951 on the U.S. Coast Guard Radio Receiving Station located southwest of Hutchinson, KS. The first research data were collected with the harvest of 1952. Prior to this, data for the south central area of Kansas were collected at three locations: Kingman, Wichita/Goddard, and Hutchinson. The current South Central Kansas Experiment Field location is approximately ¾ miles south and east of the old Hutchinson location on the Walter Peirce farm.

Research at the South Central Kansas Experiment Field is designed to help the area's agriculture develop to its full agronomic potential by using sound environmental practices. The principal objective is achieved through investigations of fertilizer use, weed and insect control, tillage methods, seeding techniques, cover crops and crop rotations, variety improvement, and selection of hybrids and varieties adapted to the area as well as alternative crops that may be beneficial to the area's agriculture production. Experiments focus on problems related to production of wheat, grain and forage sorghum, oat, alfalfa, corn, soybean, cotton, rapeseed/canola, and sunflower and soil tilth, water, and fertility. Breeder and foundation seed of wheat, oat, and canola varieties and hybrids are produced to improve seed stocks available to farmers. A large portion of the research program at the field is currently dedicated to wheat and canola breeding and germplasm development.

In March 2004, the Kansas State University Foundation took possession of approximately 300 acres of land southwest of Partridge, KS. This land was donated to the foundation by George V. Redd and Mabel E. Bargdill for use in developing and improving plants and crops. The acreage is in two parcels; one is approximately 134 acres and lies south of Highway 61 and west of county road Centennial. In December 2007, two wells were drilled on this quarter to provide for future irrigation research. In 2009, the first irrigation water was pumped to irrigate approximately 55 acres of soybean. The second parcel, a full quarter, is currently used for various cropping rotation research involving wheat, canola, grain sorghum, and soybean. Both quarters are being worked into the research activities of the South Central Kansas Experiment Field.

Soil Description

A new soil survey was completed for Reno County and has renamed some of the soils on the experiment field. The new survey overlooks some of the soil types present in the older survey, and we believe the following descriptions of soils on the experiment field are more precise. The South Central Kansas Experiment Field has approximately 120 acres classified as nearly level to gently sloping Clark/Ost loams with calcareous subsoils. This soil requires adequate inputs of phosphate and nitrogen fertilizers for maximum crop production. The Clark soils are well drained and have good water-holding capacity. They are more calcareous at the surface and less clayey in the subsurface than the Ost. The Ost soils are shallower than the Clark, having an average surface layer of only 9 in. Both soils are excellent for wheat and grain sorghum production. Large areas of these soils are found in southwest and southeast Reno County and in western Kingman County. The Clark soils are associated with the Ladysmith and Kaski soils common in Harvey County but are less clayey and contain more calcium carbonate. Approximately 30 acres of Ost Natrustolls Complex with associated alkali slick spots occur on the north edge of the experiment field. This soil requires special management and timely tillage because it puddles when wet and forms a hard crust when dry. A 10-acre depression on the south edge of the field is a Tabler-Natrustolls Complex (Tabler slick spot complex). This area is unsuitable for cultivated crop production and was seeded to switchgrass in 1983. Small pockets of the Tabler-Natrustolls are found throughout the experiment field.

The soils on the Redd-Bargdill Foundation land are different from those on the experiment field. The south quarter (CRP) has mostly Shellabarger fine sandy loams with 1% to 3% slopes. There are also some Farnums on this quarter. The new classification has these soils classified as Nalim loam. The north quarter was previously all classified as Tabler clay loam. However, the new survey classifies the soils as Funmar-Taver loams, Funmar loams, and Tever loams.

Weather Information

The U.S. Department of Commerce National Oceanic and Atmospheric Administration National Weather Service rain gage (Hutchinson 10 S.W. 143930) collected 33.58 in. of precipitation in 2009, which is 3.71 in. above the 30-year (most recent) average of 29.87 in. From 1997 to 2000, precipitation was above average. In 2001, 2003, and 2006, precipitation recorded at the experiment field was below normal. Precipitation for 2002, 2004, 2005, 2008, and 2009 was above normal. These figures are different from those available through the Kansas State University automated weather station (http://www.ksre.k-state.edu/wdl/) because of the distance between the two rain gages. As with all years, distribution within the year and rainfall intensity determine the usefulness of the precipitation. The late spring and early summer months of April, May, and June are still the months when the field receives most of the yearly precipitation (Table 1). In 2009, precipitation received in August, September, and October was unusually high. The record amount of precipitation occurred in 1978 with a little more than 47 in. recorded. A frost-free growing season of 210 days (Mar. 14 to Oct. 10, 2009) was recorded. This is 27 days more than the average frost-free season of 183 days (April 19 to October 17).

Table 1. Precipitation at the South Central Kansas Experiment Field, Hutchinson, NOAA 10 S.W. 143930

Month	Rainfall	30-year avg.[1]	Month	Rainfall	30-year avg.
	---------------in.---------------			---------------in.---------------	
2008			2009		
September	5.73	2.34	May	3.91	4.15
October	5.10	2.48	June	4.58	4.56
November	1.06	1.23	July	2.05	3.27
December	0.37	1.09	August	4.13	3.09
2009			September	6.79	2.41
January	0.02	0.75	October	3.18	2.65
February	0.23	1.09	November	0.58	2.65
March	1.78	2.75	December	0.39	1.09
April	5.94	2.53	2009 total	33.58	29.87

[1] Most recent 30 years.

Crop Performance Tests at the South Central Kansas Experiment Field

W. F. Heer and J. E. Lingenfelser

Summary

Performance tests for winter wheat, grain sorghum, alfalfa, canola, and sunflower were conducted at the South Central Kansas Experiment Field. Off-site tests for irrigated corn, soybean, and grain sorghum were also conducted. Results of these tests can be found in the following publications, which are available through your local K-State Research and Extension office or online at www.ksre.ksu.edu/library/.

For additional information, see the Kansas Crop Performance Test Web site: www.agronomy.ksu.edu/kscpt

2009 Kansas Performance Tests with Winter Wheat Varieties
Kansas Ag. Exp. Stn. Report of Progress 1018

2009 Kansas Performance Tests with Corn Hybrids
Kansas Ag. Exp. Stn. Report of Progress 1019

2009 Kansas Performance Tests with Soybean Varieties
Kansas Ag. Exp. Stn. Report of Progress 1022

2009 Kansas Performance Tests with Grain Sorghum Hybrids
Kansas Ag. Exp. Stn. Report of Progress 1023

2009 Kansas Performance Tests with Sunflower Hybrids
Kansas Ag. Exp. Stn. Report of Progress 1024

2009 National Winter Canola Variety Trial
Kansas Ag. Exp. Stn. Report of Progress 1026

Effects of Nitrogen Rate and Previous Crop on Grain Yield in Continuous Wheat and Alternative Cropping Systems in South Central Kansas

W. F. Heer

Summary

Predominant cropping systems in south central Kansas have been continuous wheat and wheat/grain sorghum/fallow. With continuous wheat, tillage is preformed to control diseases and weeds. In the wheat/sorghum/fallow system, only two crops are produced every 3 years. Other crops (corn, soybean, sunflower, winter cover crops, and canola) can be placed in these cropping systems. To determine how yields of winter wheat and alternative crops are affected by alternative cropping systems, winter wheat was planted in rotations following the alternative crops. Yields were compared with yield of continuous winter wheat under conventional tillage (CT) and no-till (NT) practices. Initially, CT continuous wheat yields were greater than those from the other systems. However, over time, wheat yields following soybean have increased, reflecting the effects of reduced weed and disease pressure and increased soil nitrogen (N). However, CT continuous winter wheat seems to out yield NT winter wheat regardless of the previous crop.

Introduction

In south central Kansas, continuous hard red winter wheat and winter wheat/grain sorghum/fallow are the predominant dryland cropping systems. A summer fallow period following sorghum is required because the sorghum crop is harvested in late fall, after the optimum planting date for wheat in this region. Average annual rainfall is only 30 in./year, with 60% to 70% occurring between March and July. Therefore, soil moisture is often not sufficient for optimum wheat growth in the fall. No-till systems often increase soil moisture by increasing infiltration and decreasing evaporation. However, higher grain yields associated with increased soil water in NT have not always been observed. Cropping systems with winter wheat following several alternative crops would provide improved weed control through additional herbicide options, reduce disease incidence by interrupting disease cycles, and allow producers several options under the 1995 Farm Bill. However, the fertilizer N requirement for many crops is often greater under NT than CT. Increased immobilization and denitrification of inorganic soil N and decreased mineralization of organic soil N have been related to the increased N requirements under NT. Therefore, effect of N rates on hard red winter wheat in continuous wheat and in cropping systems involving alternative crops for the area have been evaluated at the South Central Kansas Experiment Field. The continuous winter wheat study was established in 1979 and restructured to include a tillage factor in 1987. The first of the alternative cropping systems in which wheat follows short-season corn was established in 1986 and modified in 1996 to a wheat/cover crop/grain sorghum rotation and in 2007 to a wheat/grain sorghum/canola cropping system. The second alternative cropping system, established in 1990, has winter wheat following soybean. Both cropping systems are seeded NT into the previous crop's residue. All three systems have the same N rate treatments.

Procedures

The research is conducted at the South Central Kansas Experiment Field–Hutchinson. Soil is an Ost loam. The sites were in wheat prior to the start of the cropping systems. The research is replicated four or five times in a randomized block design with a split-plot arrangement. The main plot is crop, and the subplot is six N levels (0, 25, 50, 75, 100, and 125 lb/a). Nitrogen treatments were broadcast applied prior to planting as NH_4NO_3 and as urea after ammonium nitrate became unavailable. Phosphate is applied in the row at planting. All crops were produced each year of the study and planted at the normal time for the area. Plots are harvested at maturity to determine grain yield, moisture, and test weight.

Continuous Wheat

These plots were established in 1979 and modified (split into subplots) in 1987 to include both CT and NT. The CT treatments are plowed immediately after harvest and then worked with a disk as necessary to control weed growth. Fertilizer rates are applied with a Barber metered screw spreader prior to the last tillage (field cultivation) on the CT plots and seeding of the NT plots. Plots are cross seeded in mid-October to winter wheat. Because of a cheat infestation in the 1993 crop, plots were planted to oat in spring 1994. Fertility rates were maintained, and the oat crop was harvested in July. Winter wheat has been planted in mid-October each year in the plots since fall 1994. New herbicides have helped control cheat in the NT treatments. These plots were seeded to canola in fall 2005 and then back to wheat in October 2006. We hoped this would provide field data on the effects of canola on wheat yields in a continuous wheat cropping system. However, an extended freeze the first week of April had a major effect on wheat yields as discussed in the results section. Hail adversely affected wheat yields in 2008, but wheat yields were average in 2009.

Wheat After Corn/Grain Sorghum/Fallow

Winter wheat is planted after short-season corn is harvested in late August to early September. This early harvest of short-season corn allows the soil profile water to be recharged (by normal late summer and early fall rains) before winter wheat is planted in mid-October. Fertilizer rates are applied with the Barber metered screw spreader in the same manner as for continuous wheat. In 1996, the corn crop in this rotation was dropped and three legumes (winter pea, hairy vetch, and yellow sweet clover) were added as winter cover crops. Thus, the rotation became a wheat/cover crop/grain sorghum/fallow rotation. The cover crops replaced the 25, 75, and 125 lb/a N treatments in the grain sorghum portion of the rotation. Yield data can be found in Field Research 2000, Kansas Agricultural Experiment Station Report of Progress 854.

Wheat After Soybean

Winter wheat is planted after soybean is harvested in early to mid-September. As with the continuous wheat plots, these plots are planted to winter wheat in mid-October. Fertilizer rates are applied with the Barber metered screw spreader in the same manner as for continuous wheat. Since 1999, a group III soybean has been used. This delayed harvest from late August to early October. In some years, this effectively eliminates the soil profile water recharge time prior to wheat planting.

Wheat After Grain Sorghum in a Cover Crop/Fallow/Grain Sorghum/Wheat Rotation

Winter wheat is planted into stubble from grain sorghum harvested the previous fall. Thus, soil profile water has had 11 months to recharge before winter wheat is planted in mid-October. Nitrogen fertilizer is applied at a uniform rate of 75 lb/a with the Barber metered screw spreader in the same manner as for the continuous wheat. This rotation was terminated after the harvest of each crop in 2006. In fall 2006, canola was introduced into this rotation in place of the cover crops. The winter canola did not establish uniformly, so spring canola was seeded into these plots to establish canola stubble for the succeeding crop.

Winter wheat is also planted after canola and sunflower to evaluate the effects of these two crops on winter wheat yield. Uniform N fertility is used; therefore, this data is not presented. Yield of wheat after these two crops is similar to yield of wheat after soybean.

Results

Unlike 2008 wheat yields, which were affected by hail, 2009 wheat yields reflected the favorable moisture conditions in the spring. Wheat yields in 2009 were closer to average yields for the time period of these studies.

Continuous Wheat–Canola 2006

Continuous winter wheat grain yield data from the plots are summarized by tillage and N rate in Table 1. Data for years prior to 1996 can be found in Field Research 2000, Kansas Agricultural Experiment Station Report of Progress 854. Conditions in 1996 and 1997 were excellent for winter wheat production in spite of the dry fall of 1995 and the late spring freezes in both years. Excellent moisture and temperatures during the grain filling period resulted in decreased grain yield differences between the CT and NT treatments within N rates. Conditions in the springs of 1998 and 1999 were excellent for grain filling in wheat. However, differences in yield between CT and NT wheat were still expressed. In 2000, differences were wider up to the 100 lb/a N rate. At that point, differences were similar to those of previous years (data for the years 1996 through 2000 can be found in Agronomy Field Research 2006, Kansas Agricultural Experiment Station Report of Progress 975). The wet winter and late spring of the 2003–2004 harvest year allowed for excellent tillering, grain fill, and yields (Table 1). In 2005, the dry period in April and May seemed to affect yields in the 0 and 25 lb/a N rate plots. These plots were seeded to canola in fall 2005. Canola in the NT plots did not survive. Yield data for the CT plots is presented in Table 1. There was a yield increase for each increase in N rate. However, the increase was not significant above the 50 lb/a rate. All N fertilizer was applied in the fall, and effects of the winterkill were more noticeable at the lower N rates. An N-rate study with canola was established at the Redd Foundation land to more fully evaluate effects of fertility on canola. Wheat planted after canola (2007 harvest) looked promising until the April freeze. Because of the growth stage at the time of the freeze, the lower N rate and NT treatment had higher yields than the CT and higher N rate treatments (Table 1). The higher yielding treatments were slightly behind the other plots when the freeze hit; thus, they were not affected as severely by the freeze. The continuous wheat plots were not harvested for yield data in 2008 because of the severe hail damage from the May 5 storm. Yields in 2009 were excellent because moisture and temperatures during grain filling were ideal for winter wheat.

Wheat After Soybean

Wheat yields after soybean also reflect differences in N rate. However, wheat yields from this cropping system are compared with yields from systems in which wheat followed corn, effects of residual N from soybean production in the previous year are evident, particularly for the 0 to 75 lb/a N rates in 1993 and the 0 to 125 lb/a rates in 1994. Yields for 1995 reflect the added N from the previous soybean crop with yield by N rate increases similar to those of 1994. The 1996 yields with spring wheat reflect the lack of response to N fertilizer in spring wheat. Yields for 1997 and 1998 leveled off after the first four increments of N. As with wheat in the other rotations in 1999, ideal moisture and temperature conditions allowed wheat yields after soybean to express differences in N rate up to the 100 lb/a N rate. In the past, those differences stopped at the 75 lb/a N rate. Compared with continuous wheat yields, rotational wheat is starting to reflect the presence of the third crop (grain sorghum) in the rotation. Wheat yields were lower in 2000 than in 1999. This is due to the lack of timely moisture in April and May and the hot days at the end of May. Data for the years 1991 through 2000 can be found in Agronomy Field Research 2006, Kansas Agricultural Experiment Station Report of Progress 975. This heat caused plants to mature early and also caused low test weights. There was not as much cheat in 2004 as in 2003; thus, yields were much improved (Table 2). Yields in 2004 through 2006 indicate that wheat is showing a 50 to 75 lb/a N credit from the soybean and rotational effects. An early April freeze had a major effect on wheat yields in 2007. The effect of the May 2008 hail is reflected in the yields as well as the CV for the data (Table 2). However, the trend for N credits to soybean seems to have continued. As with the continuous wheat cropping system, yields for the 0 and 25 lb/a N rates were less than those for the 50 to 125 lb/a rates, but the differences are not significant. Wheat yields for 2009 continued to reflect the N added by the soybean crop in the cropping sequence. As the rotation continues to cycle, differences at each N rate will probably stabilize after four to five cycles, potentially reducing fertilizer N applications by 25 to 50 lb/a in treatments in which wheat follows soybean.

Wheat After Grain Sorghum/Cover Crop

These plots were severely damaged by hail on May 5, 2008, and, therefore, were not harvested for yield data in 2008. This is only the second time that the wheat plots were not harvested since the rotations were started in this location in 1986. The first year that wheat was harvested after a cover crop/grain sorghum planting was 1997. Data for the years 1997 through 2000 can be found in Agronomy Field Research 2006, Kansas Agricultural Experiment Station Report of Progress 975. From 1997 to 2000, there did not appear to be a definite effect of the cover crop on yield. This is most likely due to the variance in cover crop growth within a given year. In years such as 1998 and 1999 when sufficient moisture and warm winter temperatures produced good cover crop growth, additional N from the cover crop appears to carry through to wheat yields. Because of the fallow period after sorghum in this rotation, the wheat crop has a moisture advantage over wheat after soybean. Cheat was the limiting factor in this rotation in 2003. More aggressive herbicide control of cheat in the cover crops was started, and 2004 yields reflect the control of cheat. Management of grasses in the cover crop portion of this rotation seems to be the key factor in controlling cheat and increasing yields. This is evident when yields for 2005 and 2006 (Table 3) are compared with continuous wheat yields or yields from wheat in rotation with soybean. Because of the stage of development at the time of the April freeze, wheat yields in these plots were more adversely affected than yields of plants in other rotations. We think that lack of a third crop taken to maturity has positively influenced yields. The canola did not survive the winter; thus, wheat yields in 2009 do not reflect the presence of a canola crop in the cropping sequence.

Other Observations

Nitrogen application significantly increased grain N content in all crops. Grain phosphate levels did not seem to be affected by increased N rate.

Loss of the wheat crop after corn can occur in years when fall and winter moisture are limited. This loss has not occurred in continuous winter wheat regardless of tillage or in wheat after soybean. Corn has potential to produce grain in favorable (cool and moist) years and silage in non-favorable (hot and dry) years. In extremely dry summers, extremely low grain sorghum and soybean yields can occur. The major weed control problem in the wheat-after-corn system is grasses. This was expected, and work is being done to determine the best herbicides and time of application to control grasses.

Soybean and Grain Sorghum in the Rotations

Soybean was added to intensify the cropping system in south central Kansas. Soybean, a legume, can add N to the soil system. Thus, N rates are not applied when soybean is planted in the plots for the rotation. This provides opportunities for following crops to use the added N and to check yields against yields for the crop in other production systems. Yield data for soybean following grain sorghum in the rotation are given in Table 4. Soybean yields are affected more by the weather for the given year than by the previous crop. This is seen in yields for 2001, 2003, 2005, 2006, 2007, and 2008, when summer growing season moisture was limiting. As in 2007, a combination of a wet spring that delayed planting and a hot, dry period from July through early September 2008 affected yields. Planting was again delayed because of above-average rains in April. There has been a significant effect of N on soybean yield in only 3 out of the 13 years that the research has been conducted. In the 2 of the 3 years that N application rate affected yield, it did so only at the lower N rates.

Yield data for grain sorghum after wheat in the soybean/wheat/grain sorghum rotation are shown in Table 5. As with soybean, weather is the main factor affecting yield. Addition of a third cash crop (soybean), which intensifies the rotation (cropping system), will reduce the yield of grain sorghum in the soybean/wheat/grain sorghum vs. the wheat/cover crop/grain sorghum rotation (Tables 5 and 6). More uniform yields were obtained in the soybean/wheat/grain sorghum rotation (Table 5) than in the wheat/cover crop/grain sorghum rotation (Table 6). The lack of precipitation in 2005 and 2006 can be seen in grain sorghum yields for 2006. As with soybean, the combination of a wet spring that delayed planting and the hot, dry period from July through early September affected yields. The cool, wet weather in September and October 2008 delayed maturation, and the grain did not dry down until after the first killing frost.

Grain sorghum yields were reduced in the intensified cropping system (soybean, wheat, and grain sorghum) compared with the less intense rotation (wheat, winter cover crop, grain sorghum).

Other systems studies at the field are a wheat/cover crop (winter pea)/grain sorghum rotation with N rates and a date of planting, date of termination cover crop rotation with small grains (oat)/grain sorghum.

Table 1. Wheat (2001-2005), canola (2006), and wheat (2007-2009) yields by tillage and nitrogen rate in a continuous wheat cropping system, South Central Kansas Experiment Field, Hutchinson

	Yield[1]															
	2001		2002		2003		2004		2005		2006		2007		2009	
N Rate	CT[2]	NT	CT	NT	CT	NT	CT	NT	CT	NT	CT	NT[3]	CT	NT	CT	NT
lb/a	bu/a															
0	50	11	26	8	54	9	66	27	47	26	10	0	15	14	37	13
25	53	26	34	9	56	9	68	41	63	36	19	0	13	16	44	31
50	54	35	32	8	57	22	65	40	68	38	26	0	12	14	45	22
75	58	36	34	7	57	42	63	37	73	43	28	0	12	14	44	26
100	54	34	35	5	56	35	64	43	73	40	31	0	9	13	43	22
125	56	36	32	5	57	38	63	31	69	35	31	0	9	16	44	14
LSD[4] (0.01)	10	10	6	NS	NS	18	NS	9	14	14	6	0	6	NS	NS	15

Plots were not harvested for yield data in 2008 because of severe hail damage.

[1] Data for years prior to 1996 can be found in Field Research 2000, Kansas Ag. Exp. Stn. Report of Progress 854. Data for the years 1996 through 2000 can be found in Agronomy Field Research 2006, Kansas Ag Exp. Stn. Report of Progress 975, p. SC-8.

[2] CT, conventional tillage; NT, no-till.

[3] NT canola did not get established.

[4] Unless two yields in the same column differ by at least the least significant difference (LSD), little confidence can be placed in one being greater than the other.

Table 2. Wheat yields after soybean in a soybean/wheat/grain sorghum rotation with nitrogen rates, South Central Kansas Experiment Field, Hutchinson

	Yield[1]								
N Rate	2001	2002[2]	2003	2004	2005	2006	2007	2008	2009
lb/a	---------------------------------------bu/a---------------------------------------								
0	12	9	31	40	30	29	15	9	26
25	16	10	48	46	43	38	21	15	29
50	17	9	59	48	49	46	23	19	37
75	17	7	65	46	52	46	24	23	41
100	20	8	67	43	50	52	23	23	44
125	21	8	66	40	48	50	20	23	41
LSD[3] (0.01)	7	4	3	5	5	3	3	3	6
CV (%)	23	24	4	6	6	5	9	11	9

[1] Data for the years 1991 through 2000 can be found in Agronomy Field Research 2006, Kansas Ag. Exp. Stn. Report of Progress 975, p. SC-9.
[2] Yields severely reduced by hail.
[3] Unless two yields in the same column differ by at least the least significant difference (LSD), little confidence can be placed in one being greater than the other.

Table 3. Wheat yields after grain sorghum in a wheat/cover crop/grain sorghum rotation with nitrogen rates, South Central Kansas Experiment Field, Hutchinson

	Yield[1]							
N Rate	2001	2002[2]	2003	2004	2005	2006	2007	2009
lb/a	---------------------------------------bu/a---------------------------------------							
0	45	10	9	47	59	38	10	7
HV[3]	45	10	5	36	63	58	13	16
50	41	8	4	35	56	61	15	26
WP[3]	41	9	8	37	60	64	13	30
100	39	5	5	32	55	58	14	29
SC[3]	42	6	6	36	55	55	11	33
LSD[4] (0.01)	5	3	NS	8	6	5	2	5
CV (%)	6	20	70	12	6	7	10	12

Plots were not harvested yield data in 2008 because of severe hail damage.
[1] Data for the years 1997 through 2000 can be found in Agronomy Field Research 2006, Kansas Ag. Exp. Stn. Report of Progress 975, p. SC-10.
[2] Yields severely reduced by hail.
[3] HV, hairy vetch; WP, winter pea; SC, sweet clover.
[4] Unless two yields in the same column differ by at least the least significant difference (LSD), little confidence can be placed in one being greater than the other.

Table 4. Soybean yields after grain sorghum in a soybean/wheat/grain sorghum rotation with nitrogen rates, South Central Kansas Experiment Field, Hutchinson

	Yield													
N Rate[1]	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
lb/a	bu/a													
0	16	26	22	33	25	7	22	5	53	20	18	15	36	33
25	17	29	23	35	21	8	22	6	50	19	18	16	39	33
50	18	30	23	36	23	9	22	6	50	18	18	14	37	35
75	20	29	24	36	24	8	21	7	51	18	18	15	37	34
100	22	31	25	37	21	9	21	7	51	19	18	16	39	34
125	20	25	24	34	22	8	22	7	49	19	19	14	39	34
LSD[2] (0.01)	3	NS	NS	NS	NS	NS	NS	1.4	NS	NS	1	NS	NS	NS
CV (%)	10	12	6	12	15	13	7	17	6	11	5	11	8	9

[1] N rates are not applied to the soybean plots in the rotation.

[2] Unless two yields in the same column differ by at least the least significant difference (LSD), little confidence can be placed in one being greater than the other.

Table 5. Grain sorghum yields after wheat in a soybean/wheat/grain sorghum rotation with nitrogen rates, South Central Kansas Experiment Field, Hutchinson

	Yield													
N Rate	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007[1]	2008	2009
lb/a	--bu/a--													
0	32	13	57	52	55	15	34	10	86	86	19	---	39	92
25	76	29	63	67	56	15	41	10	112	90	18	---	43	92
50	93	40	61	82	54	13	43	9	129	97	16	---	54	96
75	107	41	60	84	49	9	43	8	136	95	14	---	56	87
100	106	65	55	77	50	7	46	8	141	101	12	---	61	82
125	101	54	55	82	49	7	47	9	142	95	12	---	74	87
LSD[2] (0.01)	8	13	NS	13	NS	NS	8	NS	9	12	4	---	16	NS
CV (%)	5	18	10	9	10	58	11	24	4	7	18	---	17	18

[1] Because of the dry, hot conditions in July and August and the excessive amount of bird damage (100% in some plots), these plots were not harvested for yield in 2007.

[2] Unless two yields in the same column differ by at least the least significant difference (LSD), little confidence can be placed in one being greater than the other.

Table 6. Grain sorghum yields after canola in a canola/grain sorghum/wheat rotation with nitrogen rates, South Central Kansas Experiment Field, Hutchinson

	Yield[1]													
N Rate	1996	1997	1998	1999	2000	2001	2002[2]	2003	2004	2005	2006	2007	2008	2009
lb/a	--bu/a--													
0	73	26	69	81	68	17	22	21	92	84	20	37	70	118
25	99	36	70	106	54	17	21	16	138	93	21	50	85	127
50	111	52	73	109	66	13	25	15	135	90	28	48	98	129
75	93	35	72	95	51	19	23	17	138	101	23	52	96	131
100	109	54	67	103	45	12	25	14	136	89	27	52	100	122
125	94	21	72	92	51	19	19	19	94	80	28	53	101	129
LSD[3] (0.01)	13	14	NS	21	16	6	NS	5	19	16	6	16	18	NS
CV (%)	8	22	13	12	16	21	20	22	9	10	19	18	11	8

[1] In years 1996–2007, the 25, 75, and 125 lb/a N rates were replaced with hairy vetch, winter pea, and sweet clover, respectively.

[2] Yields affected by hot, dry conditions in July and bird damage.

[3] Unless two yields in the same column differ by at least the least significant difference (LSD), little confidence can be placed in one being greater than the other.

Impacts of Long-Term Cropping Systems on Soil Physical Properties and Their Relationships with Soil Organic Carbon

H. Blanco-Canqui, L.R. Stone, and P.W. Stahlman

Summary
Cropping systems may differ in their ability to conserve soil and water, sequester soil organic carbon (C), and improve soil productivity. We studied the impacts of 33-year cropping systems on near-surface soil structural, compaction, and hydraulic properties as well as the relationships between soil physical properties and soil organic C concentration on a nearly level Crete silty clay loam (fine, smectitic, mesic Pachic Argiustolls) near Hays, KS. Five cropping systems were studied: sorghum-fallow, continuous sorghum, wheat-sorghum-fallow, wheat-fallow, and continuous wheat in reduced till and no-till. Cropping system significantly affected soil physical properties and their relationships with soil organic C concentration. Wet aggregate stability and aggregate water repellency were two to five times greater in continuous wheat than in other rotations for the 0- to 1-in. soil depth. Differences in soil physical properties and soil organic C concentration among cropping systems were greater in no-till than in reduced till. Under no-till, continuous wheat reduced bulk density and increased cumulative water infiltration over other rotations. No-till soils under continuous wheat had increased water retention and soil organic C concentration compared with sorghum-fallow and continuous sorghum. The sorghum-fallow rotation appeared to affect soil properties more adversely than wheat-fallow. Accumulation of soil organic C concentration increased wet aggregate stability, water repellency, total porosity, cumulative water infiltration, and soil water retention and reduced bulk density. Overall, results indicate that intensive cropping systems combined with no-till farming can improve soil physical properties and increase soil organic C concentration over crop-fallow systems.

Introduction
Evaluation of changes in soil properties and soil organic C under different long-term cropping systems is important to understand how soil management affects soil and water conservation as well as crop production. Information on soil response to different cropping systems, such as intensive or diversified cropping systems, is limited, particularly in the central Great Plains. Compared with crop-fallow systems, intensive cropping systems may improve soil properties and increase soil organic C accumulation because of greater annual return of biomass. Differences in rooting depth and distribution, canopy cover, and row spacing among crops can also influence soil properties.

Because changes in soil physical properties and organic C concentration under cropping systems are often slow, long-term cropping system experiments provide ideal field laboratories for studying how the cropping system affects soil physical properties and organic C concentration. Many researchers have studied effects of tillage systems on soil properties, but few studies have assessed the impacts of cropping systems managed under no-till. A particular need exists to assess cropping system effects on soil properties for no-till management to develop and identify cropping systems that enhance performance of no-till. Intensive and diverse cropping systems in combination with no-till practices may be potential alternatives to tilled systems for improving soil properties and increasing soil organic C concentration. We quantified the impacts of five long-term (33-year) cropping systems under reduced till and no-till on near-surface soil structural, compaction, and hydraulic properties and established relationships between soil physical properties and soil organic C concentration.

Procedures

This study was conducted in spring 2009 on an experiment of five cropping systems (sorghum-fallow, continuous sorghum, wheat-sorghum-fallow, wheat-fallow, and continuous wheat) managed under no-till and reduced till at the Agricultural Research Center in Hays, KS. The experiment was established in 1976 on a Crete silty clay loam with <1% slope as a split-plot design with the five cropping systems as main plots and the two tillage systems as subplots. Each phase of the rotation was present each year. The main plots were 80 ft by 80 ft, and the subplots were 40 ft by 80 ft. Row spacing was 7.5 in. for wheat and 30 in. for sorghum. The reduced-till plots were tilled with an undercutter and fallow master to a depth of about 3 to 4 in. three to four times per year as needed to control weeds. Weeds in no-till plots were controlled with herbicides. Wheat and sorghum phases of each rotation received 21 kg/ha nitrogen.

Soil structural properties including dry aggregate stability, wet aggregate stability, and aggregate wettability were determined for the 0- to 1-in. and 1- to 4-in. soil depths. Hydraulic properties including water infiltration, soil water retention, and saturated hydraulic conductivity were determined on soil cores (3 in. tall by 3 in. in diameter). Pore size distribution, total porosity, and effective porosity were estimated from soil water retention data. Bulk density, cone index, and shear strength were determined to characterize impacts of cropping system on soil compaction. The intact soil cores collected for determination of saturated hydraulic conductivity and soil water retention were used to determine bulk density. Because differences in soil water content can mask the "true" treatment impacts on cone index and shear strength, gravimetric water content was determined at the time of cone index and shear strength measurements to correct the cone index and shear strength readings. Because of significant cropping system × soil depth, tillage system × soil depth, and cropping system × tillage system × soil depth interactions, statistical analysis using the PROC GLM procedure of SAS (SAS Institute Inc., Cary, NC) was conducted by tillage and soil depth. Simple regressions and correlations between soil physical properties and soil organic C concentration were performed. Means among cropping and tillage systems were separated using a least significant difference test at the 0.05 probability level.

Results

Differences in soil structural, compaction, and hydraulic properties among the five cropping systems after 33 years of management were significant. Most changes occurred within the near-surface layers. Cropping system altered wet aggregate stability and wettability but had no impact on dry aggregate stability. The lack of significant differences in dry aggregate stability among the cropping systems suggests that all the five cropping systems can be equally affected by wind erosion. However, intensive cropping systems in no-till, which return crop residues to the soil surface annually, can minimize risks of wind erosion over crop-fallow systems with limited residue input. Continuous wheat had the greatest wet aggregate stability, whereas sorghum-fallow had the lowest under both tillage systems in the 0- to 1-in. soil depth (Table 1). Tillage also affected wet aggregate stability. No-till had about 2-fold greater wet aggregate stability than reduced-till management for continuous sorghum in the 0- to 1-in. depth. Aggregate wettability under continuous wheat was about 5-fold greater than the average across sorghum-fallow, wheat-sorghum-fallow, continuous sorghum, and wheat-fallow for no-till for the 0- to 1-in. soil depth (Table 1). Under reduced till, water drop penetration time under continuous wheat was 6.7-fold greater than the average across sorghum-fallow and wheat-sorghum-fallow and 2.4-fold greater than the average across wheat-fallow and continuous sorghum. These results showed that continuous wheat induced slight water repellent properties to soil aggregates over other cropping systems. Changes in aggregate wettability explained 69% of the variability in wet aggregate stability across both tillage systems (Figure 1). This strong correlation between wet aggregate stability and aggregate water repellency suggests that slow water entry into aggregates probably contributed to reduced aggregate breakdown under continuous wheat. Rapid water entry into aggregates can cause slaking. The greater wet aggregate stability in soils under no-till continuous wheat indicates greater resistance against soil erosion by water compared to no-till crop-fallow systems.

Cropping system impacts on soil compaction parameters were small. Under no-till, sorghum-fallow (1.18 Mg/m^3) had about 16% greater soil bulk density than continuous wheat (1.02 Mg/m^3), but there were no differences in bulk density among cropping systems in reduced till. Cropping system had no impact on cone index and shear strength (data not shown). Cropping system impacts on soil hydraulic properties were mostly significant between continuous wheat and the rest of the cropping systems. Under no-till, continuous wheat and wheat-sorghum-fallow retained 10% to 16% more water than sorghum-fallow between 0 and -3 kPa soil matric potentials (Figure 2). Under reduced till, continuous sorghum, wheat-sorghum-fallow, and sorghum-fallow systems retained about 8% more water than wheat-fallow between -1 and -60 kPa matric potential. No-till retained more water than reduced till by 8% for wheat-sorghum-fallow at -1,500 kPa. Differences in saturated hydraulic conductivity and plant-available water were not significant (data not shown). Cropping system affected total soil porosity, equivalent to volumetric water content at 0 kPa soil matric potential, in both tillage systems (Figure 2). Total soil porosity was about 18% greater in continuous wheat and wheat-sorghum-fallow than in sorghum-fallow under no-till and 7% greater in continuous sorghum and wheat-sorghum-fallow than in wheat-fallow under reduced till. Cropping system also affected effective porosity and pore size distribution. Effective porosity was 0.16 m^3/m^3 under no-till and 0.08 m^3/m^3 in sorghum-fallow. Cumulative infiltration differed only between continuous wheat and the rest of the cropping systems for no-till (Figure 3). Cumulative infiltration in continuous sorghum, wheat-fallow, and sorghum-fallow was about 25% of that in continuous wheat for no-till.

Cropping system affected near-surface soil organic C concentration in both tillage systems (Table 1). For the 0- to 1-in. depth, soil organic C concentration was the greatest in continuous wheat and lowest in sorghum-fallow in both tillage systems. Fallowing in sorghum-fallow reduced soil organic C concentration to one half that of continuous wheat. Differences in soil organic C concentration among cropping systems explained the changes in soil physical properties. Amount of macroaggregates (Figure 4A) and aggregate water repellency (Figure 4B) were strongly correlated with soil organic C concentration, indicating that accumulation of soil organic C favored formation of water-stable macroaggregates and reduced aggregate slaking. Accumulation of soil organic C also increased pore space (Figure 4C) and water retention (Figure 4D). Bulk density also tended to decrease with increased soil organic C concentration. These results show that accumulation of soil organic C improves soil physical quality.

The greater wet aggregate stability, aggregate water repellency, soil water retention, porosity, water infiltration, and soil organic C concentration in continuous wheat compared with crop-fallow systems (particularly sorghum-fallow) clearly shows that cropping rotations without summer fallow practices improve soil physical properties and store more soil organic C. The improved soil conditions under continuous wheat are due to their greater annual return of crop residues compared with crop-fallow systems. Despite the lower biomass production in wheat compared with sorghum, continuous wheat had more beneficial impacts on increasing wet aggregate stability, aggregate water repellency, cumulative water infiltration, and soil organic C accumulation than continuous sorghum. This may be due to differences in residue distribution on the soil surface between wheat and sorghum, particularly in no-till. The more uniform soil cover and narrower row spacing in wheat than in sorghum may better protect the soil surface from water and wind erosion.

The greater water infiltration and soil water retention under continuous wheat compared with sorghum-fallow suggests that intensive cropping systems with high residue return can not only increase the amount of water that can infiltrate into the soil but also improve the soil's ability to retain water. Thus, intensive or diversified cropping systems can be more receptive of precipitation water than crop-fallow systems. In this study, continuous wheat had more pore space for water to infiltrate than sorghum-fallow. The greater residue cover in intensive cropping systems can reduce water loss through evaporation and runoff. Overall, this study indicates that elimination or reduction of fallowing and intensification of cropping systems coupled with no-till technology are potential strategies to improve soil properties and sequester soil organic C in this climate.

Acknowledgments

We thank William M. Phillips and Carlyle A. Thompson, retired scientists, for establishing and maintaining this valuable long-term experiment and Michael R. Eckroat, support technician, for managing and maintaining the research plots.

Table 1. Mean weight diameter of wet aggregates, water drop penetration time, and soil organic carbon concentration under five cropping systems managed with no-till and reduced till

Cropping system	Tillage system	Depth	Mean weight diameter of soil aggregates	Water drop penetration time	Soil organic carbon
		in.	mm	seconds	g/kg
Sorghum-fallow	No-till	0–1	0.70b	0.8b	12.5cA
Continuous sorghum	No-till	0–1	0.77abA	1.4b	16.4bcA
Wheat-sorghum-fallow	No-till	0–1	0.55b	0.9bA	16.0bcA
Wheat-fallow	No-till	0–1	1.04ab	1.3b	17.1b
Continuous wheat	No-till	0–1	1.91a	6.0aA	24.9aA
Sorghum-fallow	Reduced till	0–1	0.38b	0.3c	9.3bB
Continuous sorghum	Reduced till	0–1	0.41bB	0.7b	9.6bB
Wheat-sorghum-fallow	Reduced till	0–1	0.40b	0.3cB	10.3abB
Wheat-fallow	Reduced till	0–1	0.58ab	0.9b	10.5ab
Continuous wheat	Reduced till	0–1	0.93a	2.3aB	12.1aB
Sorghum-fallow	No-till	1-4	0.37b	1.1a	10.8c
Continuous sorghum	No-till	1-4	0.77a	2.2a	14.9ab
Wheat-sorghum-fallow	No-till	1-4	0.85a	1.7a	13.5abc
Wheat-fallow	No-till	1-4	0.64ab	1.8a	12.4bc
Continuous wheat	No-till	1-4	0.85a	1.9a	15.9a
Sorghum-fallow	Reduced till	1-4	0.44b	0.8a	11.8ab
Continuous sorghum	Reduced till	1-4	0.96a	2.3a	13.5ab
Wheat-sorghum-fallow	Reduced till	1-4	0.44b	1.5a	14.1a
Wheat-fallow	Reduced till	1-4	0.41b	3.0a	11.6b
Continuous wheat	Reduced till	1-4	0.38b	1.1a	13.5ab

Means followed by the same lowercase letter within each tillage system did not differ for the same soil depth. Within columns, uppercase letters indicate differences between no-till and reduced till for the same depth.

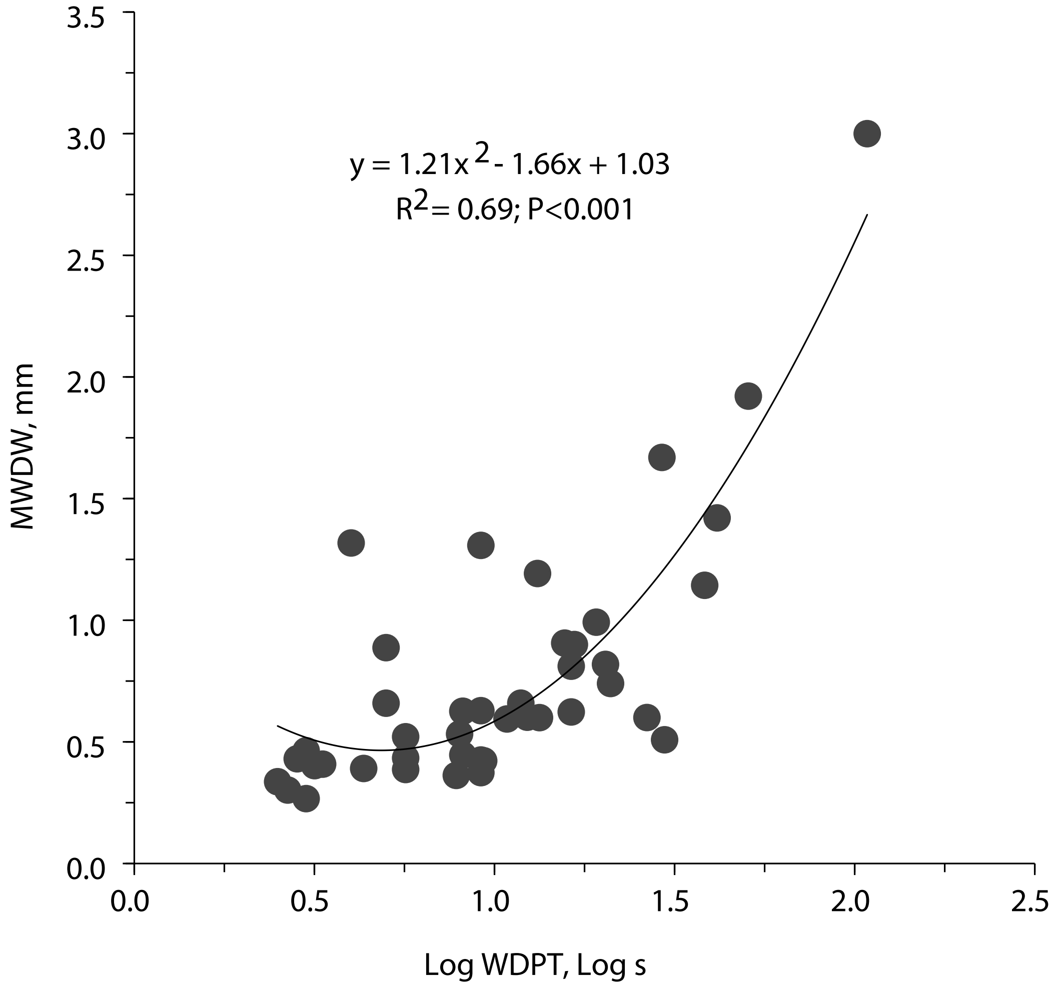


Figure 1. Relationship between mean weight diameter of wet aggregates (MWDW) and log water drop penetration time (Log WDPT) as affected by cropping system across no-till and reduced till for the 0- to 1-in. soil depth.

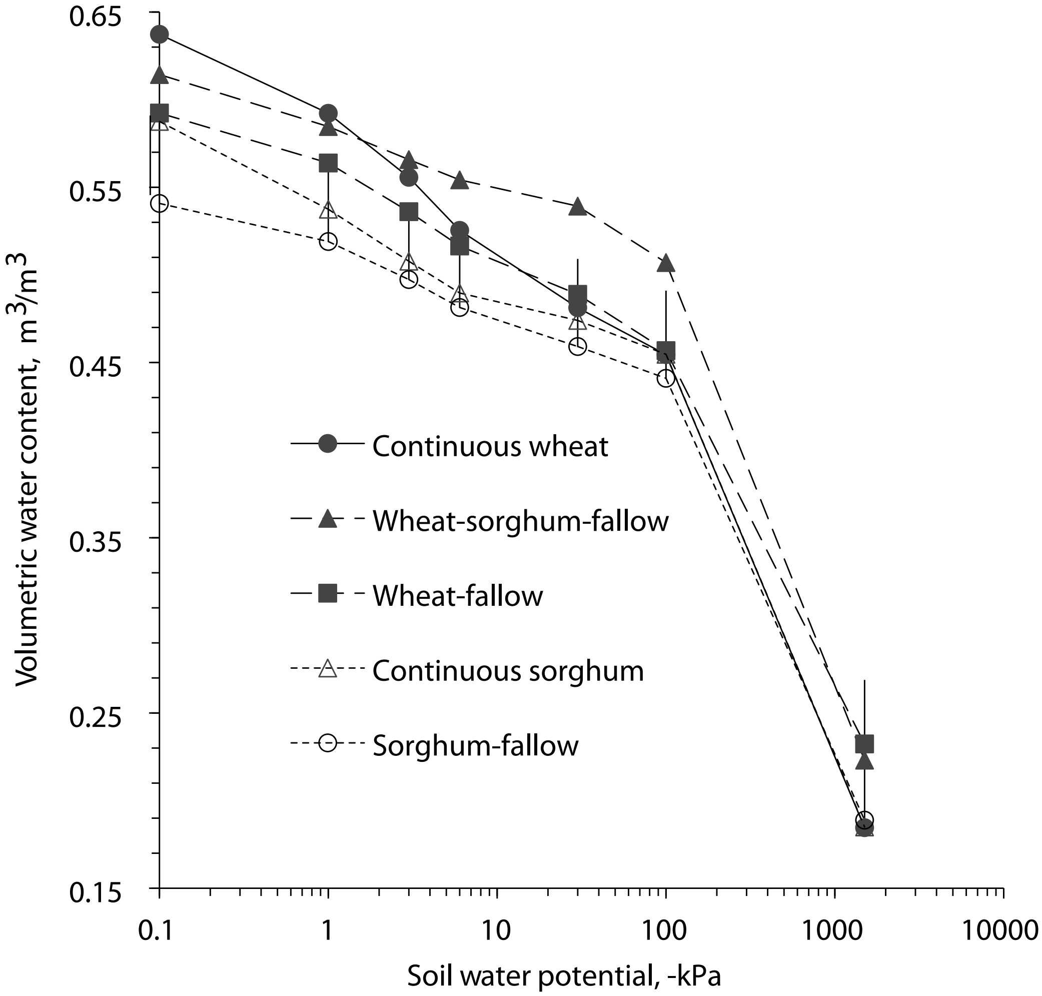


Figure 2. Soil water characteristics curve for five cropping systems under no-till for the 0- to 3-in. soil depth.

Error bars signify LSD values.

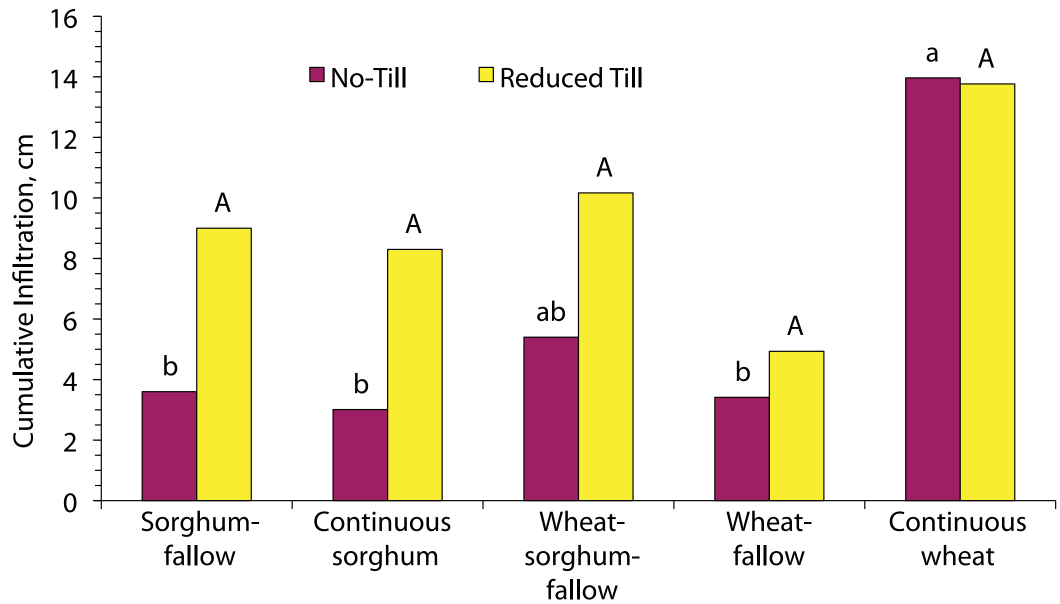


Figure 3. Cumulative water infiltration for five cropping systems under no-till and reduced till.
Letters indicate statistical differences among cropping systems within the same tillage system.

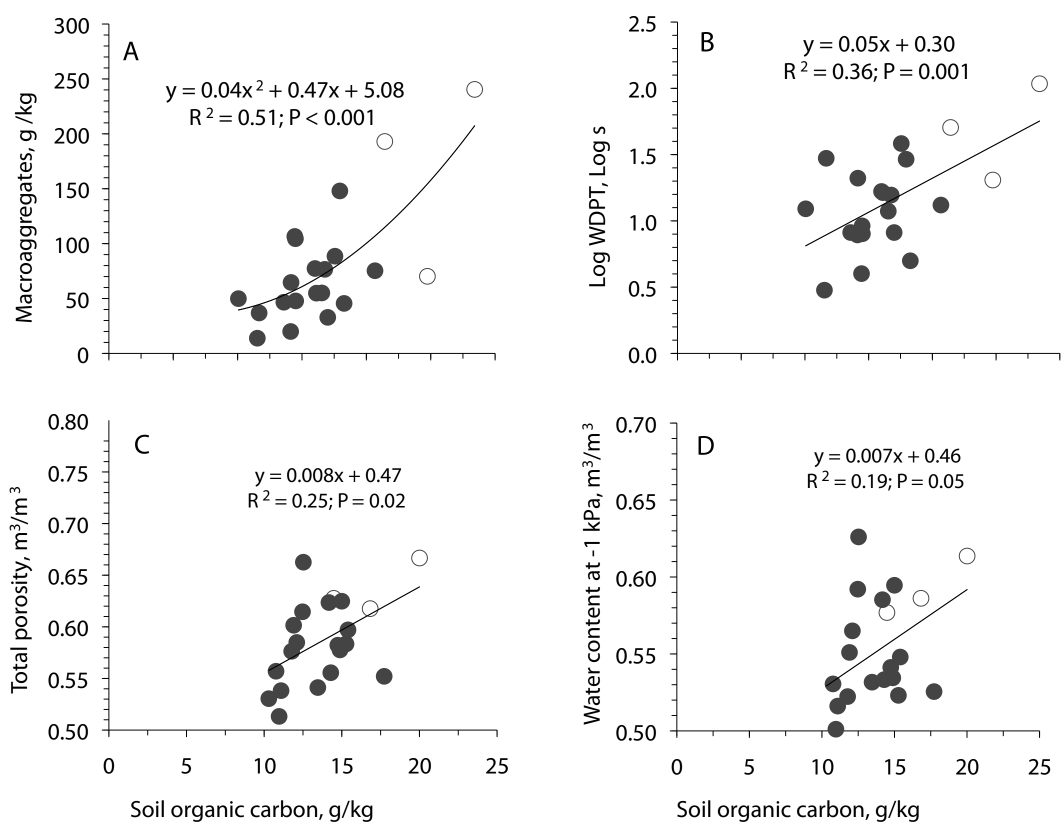


Figure 4. Relationship between soil organic carbon concentration and (A) macroaggregates (>0.25 mm in diameter), (B) log water drop penetration time (Log WDPT) for the 0- to 1-in. soil depth, (C) total porosity, and (D) volumetric water content at -1 kPa of soil matric potential using soil organic carbon data collected for the 0- to 4-in. depth.
White circles in each graph represent data points for the continuous wheat rotation.

Deficit Irrigation and Carbon Concentration in No-Till Soils

H. Blanco-Canqui, N.L. Klocke, A.J. Schlegel, and L.R. Stone

Summary
Increased concerns about reduced water supplies are prompting use of deficit irrigation in arid and semiarid regions. We determined the impacts of deficit irrigation on soil organic and inorganic carbon (C) concentration and selected soil physical properties at two western Kansas locations on Ulysses silt loam (fine-silty, mixed, mesic Aridic Haplustoll) with <1% slope. Six sprinkler irrigation treatments (2.6, 3.4, 4.6, 6.0, 7.2, and 8.5 in. of water applied) were used at Garden City, KS, and three (5, 10, and 15 in. of water applied) were used at Tribune, KS. At both sites, soil organic C concentration and wet aggregate stability increased with water in the 0- to 4-in. soil depth, but bulk density, particle size distribution, and soil inorganic C concentration were unaffected. At Garden City, soil organic C concentration increased by about 45% (5.6 vs. 8.2 Mg/ha) from the lowest (2.6 in.) to the highest (8.5 in.) irrigation level in the 0- to 4-in. depth. At Tribune, soil organic C concentration increased by 30% with an increase in the amount of water applied in the 2- to 4-in. soil depth. At both sites, the amount of macroaggregates increased with an increase in the amount of water applied. Deficit irrigation affected soil organic C concentration and soil structural development near the soil surface, but the magnitude of impacts was site specific.

Introduction
Irrigation is an important management practice used to enhance C sequestration in agricultural soils. Quantifying the amount of C sequestered in irrigated lands is a research priority because it can further our understanding of the role agricultural practices play in global C cycles. Irrigation influences soil C balance through two opposite processes: It can increase soil organic C sequestration by increasing biomass production and reduce soil organic C accumulation by accelerating soil organic matter decomposition through increased soil water content and biological activity. Previous studies showed that irrigation impacts on soil C concentration can vary depending on soil type and management. Irrigation can also affect soil inorganic C concentration because carbonates can react with calcium and form precipitates of calcium (e.g., $CaCO_3$), resulting in increased sequestration of soil inorganic C. Most of the few published studies compared differences in soil C sequestration between two irrigation treatments (irrigated vs. nonirrigated fields), and little or no information exists on the response of soil C concentration to different levels of irrigation water applied. In the central Great Plains, deficit irrigation is receiving increased attention because of concerns about decreased water levels in the Ogallala Aquifer. The objectives of this study were to determine changes in soil organic and inorganic C and soil physical properties under deficit irrigation.

Procedures

This study, conducted in spring 2009, used two linear-move sprinkler irrigation experiments established in western Kansas at Garden City in 2004 and Tribune in 2001. Treatments were replicated four times and consisted of different amounts of irrigation water applied on specific crops. At Garden City, the amount of irrigation water applied averaged across 5 years (2004–2008) for the six irrigation treatments was 2.6, 3.4, 4.6, 6.0, 7.2, and 8.5 in. Irrigation amounts for the three treatments at Tribune were 5, 10, and 15 in./year. At this site, irrigation amounts remained constant each year. At Garden City, irrigation amounts within the same level of treatment varied from year to year depending on rainfall amount and evapotranspiration rates. The cropping system at Garden City was winter wheat-grain sorghum-sunflower-corn-corn; the cropping system at Tribune was sunflower-grain sorghum-soybean-corn, and each rotation phase was present each year. These crop rotations were managed under no-till. This study was conducted during the corn rotation phase.

Bulk density, particle size distribution, wet aggregate stability, and soil organic and inorganic C concentration were measured in soil samples for the 0- to 2-, 2- to 4-, 4- to 8-, and 8- to 12-in. depth. Bulk density was determined by the core method, and soil particle size distribution was determined by the hydrometer method. Water-stable aggregates used to compute mean weight diameter of aggregates were characterized by the wet-sieving procedure. Organic and inorganic C concentrations were determined by the dry combustion method. The C concentration was determined in soil samples pretreated with and without 10% v/v HCl to eliminate carbonates. Total organic C was the amount of C in the acid-treated (i.e., carbonate-free) sample. Total inorganic C was the difference between treated and untreated values. Soil organic and inorganic C concentrations on an area basis (Mg/ha) were the product of bulk density times soil organic and inorganic C concentration on a mass basis (g/kg). A one-way ANOVA model with the GLM procedure in SAS (SAS Institute Inc., Cary, NC) was used to test whether differences in soil organic and inorganic C concentration, particle size distribution, and water-stable aggregates were statistically significant. Statistical significance is reported at the 0.05 probability level.

Results

Soil Carbon Concentration

Deficit irrigation water had moderate effects on soil organic C (Figures 1A through 2B) but no effects on soil inorganic C concentration (Figures 2C and 2D). Effects on soil organic C concentration were significant only within the 0- to 4-in. soil depth. The magnitude of irrigation impacts on soil organic C concentration also varied with site. The differences at Garden City were significant for the 0- to 4-in. soil depth, but differences at Tribune were significant only in the 2- to 4-in. depth. Soil organic C concentration on a mass and area basis increased as amount of water applied increased (Figures 1A through 2B). At Garden City, soil organic C concentration on a mass basis under the highest irrigation level was about 50% greater than in the lowest level in the 0- to 2-in. soil depth and 30% greater in the 0- to 4-in. depth (Figure 1A). At the same site, soil organic C concentration on an area basis under the highest irrigation level was greater than under the lowest level by 45%. These results show that the soil organic C pool after 5 years of irrigation management increased at a rate of about 0.52 Mg/ha per year in the 0- to 4-in. depth when amount of irrigation water applied averaged across the 5-year period increased from 2.6 to 8.5 in. At Tribune, differences in soil organic C concentration among the three irrigation levels were not statistically significant in the 0- to 2-in. depth, although the mean soil organic C concentration on a mass and area basis under 15 in. of irrigation tended to be greater than in 5 in. by about 30% (Figures 1B and 2B). For the 2- to 4-in. depth, however, soil organic C concentration on a mass basis under the 5 in. (7.8 g/kg) level was lower than in the 10 in. (10.2 g/kg) level by 30% (Figure 1B).

The smaller differences in soil organic C concentration at Tribune compared with Garden City may be due to differences in the amount of water applied and crop rotations between the two sites. The increase in soil organic C concentration with increasing amounts of water applied is a result of the greater biomass C input due to increased water availability in the soil. Other dynamic soil factors such as soil temperature and moisture dynamics as well as microbial activity probably also affected soil organic C dynamics. Periodic rewetting of soil can increase decomposition of soil organic matter and offset or reduce gains in residue-derived soil organic C. The larger differences in organic C than in inorganic C concentration observed in this study suggest that changes in irrigation strategies may influence labile fractions of organic matter more than total C. Additional studies with more intensive soil sampling with space and time are warranted to assess spatial and temporal changes in soil C under deficit irrigation strategies.

Soil Physical Properties

Deficit irrigation had no significant effect on bulk density and particle size distribution (data not shown) but had some effects on wet aggregate stability (Table 1). At Garden City, impacts of irrigation level on distribution of wet aggregate stability were not significant in the 0- to 2-in. soil depth but were significant in the 2- to 4-in. depth. At this site, the amount of macroaggregates (4.75 to 8 mm in diameter) in the highest irrigation level (8.5 in.) was 300% more than in the 2.6 and 3.4 in. irrigation levels. Soils irrigated with 7.2 and 8.5 in. of water had 35% fewer microaggregates (<0.25 mm) than soils irrigated with ≤6.0 in. of water. At Tribune, the amount of macroaggregates in soils receiving 10 and 15 in. of irrigation water was about 500% times more than in soils receiving 5 in. of water. At the same site, soils receiving 15 in. of water had 25% fewer microaggregates than soils receiving 5 in. of water. At both sites, there was a reversal in the distribution in the amount of water-stable aggregates with a decrease in the amount of irrigation water applied (Table 1). Plots receiving higher amounts of irrigation water had more macroaggregates but fewer microaggregates than plots receiving less water. Aggregate size and stability increased with irrigation-induced increases in soil organic C concentration at the Garden City site. In general, an increase in the amount of irrigation water applied improved soil structural properties near the soil surface, and the magnitude of impacts varied with site.

Table 1. Distribution of water-stable aggregates (g/100 g) by aggregate size and soil depth under two irrigation experiments at Garden City and Tribune in western Kansas

Site	Irrigation water applied	Aggregate size (mm)					
		>4.75	4.75 to 2	2 to 1	1 to 0.5	0.5 to 0.25	<0.25
	in.	g/100 g					
		0- to 2-in. soil depth					
Garden City	2.6	7.0a	6.8a	4.0a	7.0a	16.9a	58.2a
	3.4	9.0a	9.6a	4.6a	8.1a	19.8a	49.0a
	4.6	9.9a	8.4a	4.0a	7.1a	15.9a	54.8a
	6.0	8.3a	7.7a	5.1a	9.8a	15.3a	53.8a
	7.2	7.8a	7.9a	4.8a	10.1a	17.2a	52.3a
	8.5	10.5a	8.3a	4.0a	6.7a	14.1a	56.4a
Tribune	5	1.0b	4.4a	3.8a	7.3a	15.9a	67.7a
	10	5.4a	4.6a	5.0a	7.1a	13.2a	64.7a
	15	3.8a	5.5a	6.0a	10.1a	17.0a	57.6a
		2- to 4-in. soil depth					
Garden City	2.6	1.5b	7.0a	2.9c	9.8a	22.1a	56.7b
	3.4	1.7b	9.0a	4.1cb	6.4ab	20.9ab	58.0b
	4.6	2.8ab	6.2a	3.8cb	4.3b	13.5b	69.5b
	6.0	2.0ab	6.9a	5.6b	8.7a	22.1ab	54.8b
	7.2	2.0ab	10.2a	11.4a	10.2a	24.6a	41.8a
	8.5	5.0a	11.6a	6.6b	10.3a	19.0ab	47.7a
Tribune	5	1.8b	5.1a	3.7a	5.7a	18.2a	65.6a
	10	2.0b	6.5a	3.9a	7.0a	19.0a	61.7ab
	15	5.8a	7.4a	5.8a	9.1a	18.4a	53.7b

Within columns, means followed by the same letter within the same site and soil depth are not significantly different at the 0.05 probability level.

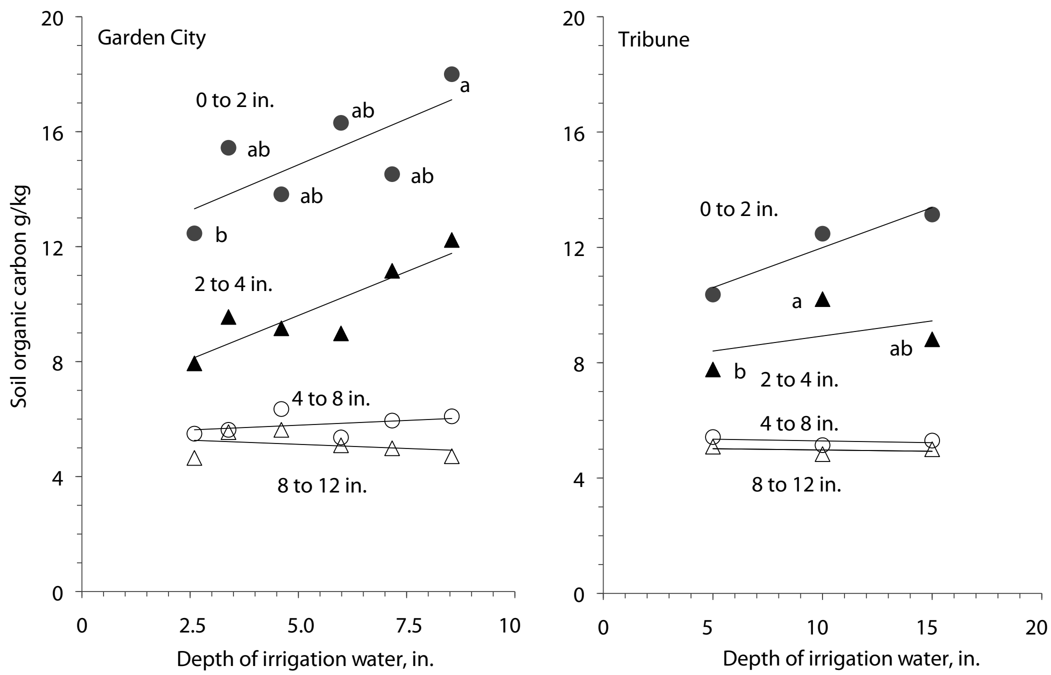


Figure 1. Changes in soil organic carbon concentration on a mass (g/kg) basis with depth in two sites under deficit irrigation in western Kansas.

Means followed by the same lowercase letter within the same depth for each site are not significantly different. Means without lowercase letters within the same depth for each site are not significantly different.

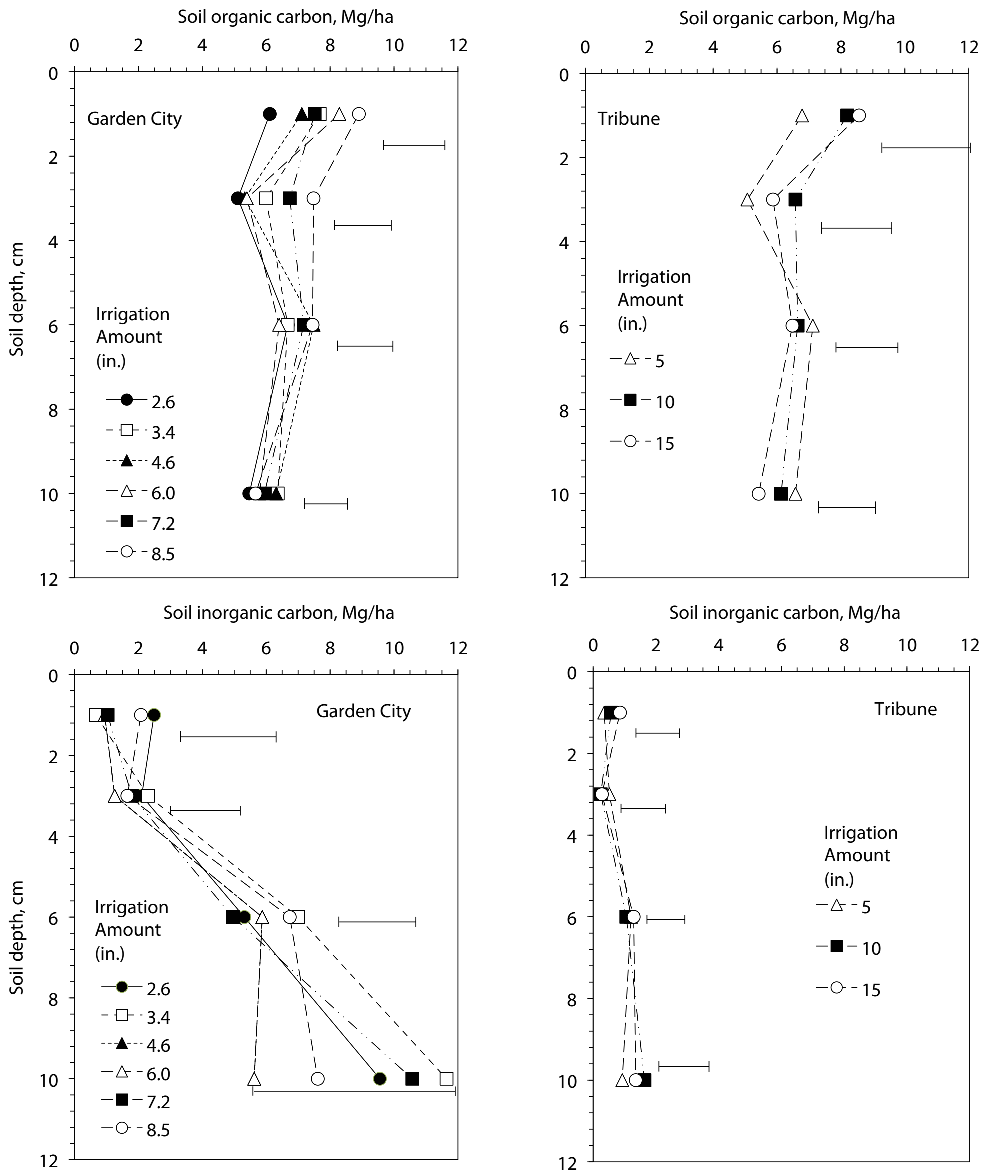


Figure 2. Changes in soil organic and inorganic carbon concentration on a volume (Mg/m^3) basis with depth in two sites under deficit irrigation in western Kansas. Error bars signify the LSD values for each depth interval.

Comparison of Skip-Row Grain Sorghum and Corn in Western Kansas

B. L. Olson, A. J. Schlegel, and J. D. Holman

Summary

Planting corn in a skip-row pattern has become more common over the past few years because it may provide an increase in yield over planting corn in every row when yield potential is low. With the advent of acetolactate synthase (ALS)- and acetyl-CoA carboxylase (ACCase)-resistant grain sorghum by 2012, more viable postemergence weed control options will be available in grain sorghum. Therefore, farmers would like to know if skip-row grain sorghum will also have improved yields. A 3-year study at three sites was initiated in 2007 in western Kansas to compare corn and grain sorghum planted in every row and in a skip-row pattern (i.e., plant two 30-in. rows, and skip two 30-in. rows). Weather conditions were highly variable across sites and years. There was no benefit to growing skip-row grain sorghum over planting grain sorghum in every row in marginal or optimum growing conditions. Therefore, this research indicates there is no benefit to the farmer to plant grain sorghum in a skip-row pattern.

Introduction

Skip-row planting has the potential to provide higher corn yields in adverse environments when yield potential is low for corn planted in every row. In 2009, the Risk Management Association approved coverage for skip-row corn in far western Kansas when the number of plants per acre is at least 75% of that in a field with every row planted. As adoption and use of skip-row corn increases, farmers are starting to question whether grain sorghum would also benefit from being planted in a skip-row pattern.

Weed control in grain sorghum can be problematic because there are few effective postemergence herbicide options. Producers rely on the competitive nature of grain sorghum planted in every row to suppress weeds and provide effective season-long weed control. Planting grain sorghum in a skip-row pattern would diminish competition in the skipped areas, allowing weeds to flourish. However, ALS- and ACCase-resistant grain sorghum has been developed at Kansas State University and should be available in commercial hybrids in 2011 or 2012. These resistant hybrids, which are not genetically modified, would allow use of more effective postemergence herbicide options such as Steadfast (nicosulfuron + rimsulfuron on ALS) and Assure II (quizalofop on ACCase), making weed control in skip-row grain sorghum potentially more viable. Therefore, the objective of this study was to compare corn and grain sorghum planted in every row and in a skip-row pattern (i.e., plant two 30-in. rows, and skip two 30-in. rows).

Procedures

In spring 2007, a 3-year study at three sites was initiated at the Northwest Research-Extension Center at Colby, KS, the Southwest Research-Extension Center at Garden

City, KS, and the Tribune Unit of the Southwest Research-Extension Center. Fertilizer was applied to meet the needs of the crop, and wheat was the previous crop at all sites. Planting date, seeding rate, and hybrids used are listed in Table 1. All treatments (every row and skip row) had the same number of seeds planted per acre. Weeds were controlled by applying a preemergence grass herbicide plus atrazine. Later weed flushes in corn were controlled by glyphosate applications, whereas weeds emerging later in grain sorghum were controlled with directed applications of 2,4-D or hand hoeing. Grain weight, test weight, and moisture content were recorded. Yield was calculated, and data were statistically analyzed; results from Colby 2009 were analyzed separately. The study was set up as a randomized complete block with three to four replications. Crop (corn or grain sorghum) and row pattern (every row or skip row) were fixed effects. Plots were at least eight 30-in. rows wide and between 20 and 30 ft long. No data were collected from Garden City in 2007 because of a planting problem.

Results

Weather conditions were variable across sites and years. Average grain yield at Tribune was 68 bu/a for 2007–2009. At Garden City, average grain yield was 47 bu/a for 2008–2009. At Colby, average grain yield was 94 bu/a for 2007–2008, but in 2009, which had almost optimum growing conditions for corn, average yield across treatments was 138 bu/a. Total precipitation, Tavg (average daily temperature), and Tmax (average daily high temperature) are included in Table 2.

When yield from Tribune 2007–2009, Garden City 2008–2009, and Colby 2007–2008 were combined and analyzed, a site by crop by row pattern interaction was revealed (Table 3). Unlike previous research conducted in western Kansas (Lyon et al., 2009), there was no benefit to planting skip-row corn when yields were below 80 bu/a at any site; this effect could not be explained. In addition, there was no benefit to planting skip-row grain sorghum at any site. Instead, yield loss was significant when growing conditions were good for grain sorghum, as was the case at Colby in 2007–2008. This increase in yield for grain sorghum planted every row over skip-row grain sorghum when conditions were above normal was expected.

For Colby 2009, there was no interaction between factors. As stated previously, 2009 had almost optimum growing conditions for corn, and yields reflected that. Corn yielded 161 bu/a, and grain sorghum yielded 114 bu/a with an LSD (P=0.05) of 12. For row pattern, skip row yielded 45 bu/a less than every row planted. This reduction was expected given the optimum growing conditions.

In conclusion, planting grain sorghum in a skip-row pattern did not provide any additional yield benefit over planting every row in the environments evaluated regardless of growing conditions.

Literature Cited

Lyon, D.J., A.D. Pavilista, G.W. Hergert, R.N. Klein, C.A. Shapiro, S. Knezevic, et al. 2009. Skip-row planting patterns stabilize corn grain yields in the central Great Plains. Crop Management. doi:10.1094/CM-2009-0224-02-RS Available at http://www.plantmanagementnetwork.org/sub/cm/research/2009/skip/

Table 1. Agronomic information

		Tribune			Garden City		Colby		
		2007	2008	2009	2008	2009	2007	2008	2009
Corn	Hybrid	Pioneer 33B54			NK-N67-D6	Pioneer 35P10RR	Pioneer 33B51RR	Pioneer 33B54RR	
	Planting	May 14	April 30	May 8	April 29	April 24	May 1	April 28	May 12
	Rate (seeds/a)	17,000	16,000	16,000	17,000	17,000	18,000	17,700	17,700
Grain sorghum	Hybrid	Pioneer 86G08			NK-5418	Pioneer 85G46	Pioneer 85G46		
	Planting	May 29	June 6	June 7	June 1	May 29	June 11	June 7	June 6
	Rate (seeds/a)	30,000	34,000	35,400	30,000	30,000	34,000	35,000	35,000

Table 2. Weather data averages from April 1 to September 30 of each year

		Precipitation	Tavg	Tmax
		--------in.--------	-----------°F-----------	
Tribune	2007	10.4	74.9	82.4
	2008	10.7	74.0	81.8
	2009	11.7	72.9	80.2
	30-year avg.[1]	13.2	65.8	81.8
Garden City	2008	11.1	75.2	82.6
	2009	16.9	74.2	81.3
	30-year avg.	14.3	67.9	82.2
Colby	2007	14.2	74.3	81.2
	2008	14.6	72.3	79.5
	2009	21.6	67.5	77.4
	30-year avg.	16.3	64.8	79.4

[1] 30-year average from 1971 to 2001.

Table 3. Yield from all sites and years except Colby 2009

Crop	Pattern	Tribune[1]	Garden City[2]	Colby[3]
		-----------------------	bu/a	-----------------------
Corn	Every row	66	28	76
	Skip row	65	25	71
Grain sorghum	Every row	80	69	145
	Skip row	62	64	83
LSD (P=0.05)		13.7	6.1	15.0

[1] Yield from 2007 to 2009.
[2] Yield from 2008 and 2009.
[3] Yield from 2007 and 2008.

Spring Oilseed Planting Method

R. Aiken, R. Wolf, L. Dible, and A. Oien

Summary
Stand establishment was favored by hoe drill in both 2005 and 2006; the earliest 50% bloom dates also occurred in plots planted with a hoe drill. Among spring oilseed crops studied, *Brassica napus* had the best emergence in 2005, and *Camelina sativa* had the poorest emergence and latest 50% bloom dates in both years. The best yield in 2005 was from *B. napus* planted with the direct drill method. In 2006, dry and hot conditions limited yields.

Introduction
Spring oilseed crops such as canola (*B. napus*) offer diversity to grain-based cropping systems, but small seed size and shallow seed placement can hamper stand establishment for spring oilseed crops. In semiarid regions, inadequate moisture can limit germination, and when emerged, seedlings can be vulnerable to dry conditions. Alternative types of grain drills can alter seed placement, soil conditions, and growing conditions; these factors can affect crop establishment and seed yield.

The objective of these field studies was to determine effects of planting method on stand formation, bloom date, and yield of spring oilseed crops under semiarid conditions.

Procedures
Seed from three cool-season oilseed species—*B. juncea* 'Arid', *B. napus* 'Hyola 401', and *C. sativa* 'Boa'—was planted in replicated plots (5 ft × 35 ft) on Mar. 30, 2005, and Apr. 18, 2006, with a seed drop equivalent to 1,200,000 seeds/a (*B. juncea* and *B. napus*) or 1,900,000 seeds/a (*C. sativa*). The direct seeding method used a Great Plains 1005 drill (7.5-in. spacing with press wheels at a ¾ in. depth). The Great Plains drill also was used for broadcast seeding; however, hoses were disconnected from shanks, and drag chains (18 in. length) attached to shanks provided surface incorporation. The hoe drill seeding method used an International Harvester 150 drill (10-in. spacing with standard press wheels at a ¾ in. depth). One day before planting, glyphosate (Roundup UltraMax, 24 oz/a) was applied in a tank mix of 60 lb/a nitrogen (28-0-0) in 2005 or 90 lb/a nitrogen (28-0-0) and 30 lb/a phosphorus (10-34-0) in 2006. Plots were hand weeded on June 9, 2005. The insecticide Capture (1.3 oz/a) was applied both 14 and 21 days after planting to control flea beetles. Field observations included emergence and stand ratings (1 = poor, 5 = complete), 50% bloom date, and maturity date. Seed was harvested and analyzed for water content, test weight, and yield.

Results
In 2005, seeding with the hoe drill provided superior stand ratings for all three oilseed crops and three observation periods (Table 1). Ratings tended to be poorest for the broadcast seeding method and equivalent or intermediate for the direct drill method. The *B. napus* and *C. sativa* lines had the best and poorest emergence ratings and greatest and least yields, respectively; emergence ratings and yields of *B. juncea* were intermediate. *B. napus* yields were greatest with the direct drill method, *C. sativa* yields were

favored by broadcast planting, and *B. juncea* yields were similar for all planting methods (Figure 1).

In 2006, greater stand ratings and the earliest 50% bloom date occurred with the hoe drill method; the broadcast and direct drill methods had the poorest and intermediate stand ratings, respectively (Table 2, Figure 2). Stand ratings were similar for *B. napus* and *B. juncea* but lower for *C. sativa*, and *C. sativa* generally required 5 to 15 more days for flowering than *B. napus* or *B. juncea*. Dry and hot spring conditions limited seed set and yields.

Table 1. Effect of planting method on emergence, time required for flowering, and oilseed yield for spring *Brassica napus, Brassica juncea,* and *Camelina sativa* planted on Mar. 30, 2005, Colby, KS

	Emergence rating[1]				
Effect	19 DAP[2]	27 DAP	34 DAP	50% bloom	Yield
				DAP	lb/a at 8%
Direct drill	2.08	2.67	3.67	53	1,420
Broadcast	1.58	2.17	3.08	56	1,452
Hoe drill	3.00	3.92	4.33	53	1,358
B. napus	2.92	3.75	4.50	53	1,948
B. juncea	2.50	3.17	3.92	53	1,394
C. sativa	1.25	1.83	2.67	55	890

[1] Scale: 1 = poorest, 5 = best.
[2] Days after planting.

Table 2. Effect of planting method on emergence, time required for flowering, and oilseed yield for spring *Brassica napus*, *Brassica juncea*, and *Camelina sativa* planted on Apr. 18, 2006, Colby, KS

Effect	Emergence rating[1]	50% bloom	Yield
		DAP[2]	lb/a
Direct drill	1.6	60	46.1
Broadcast	0.9	62	13.5
Hoe drill	2.8	54	103.9
B. napus	2.0	55	59.1
B. juncea	2.0	56	16.3
C. sativa	1.4	65	88.1

[1] Stand evaluated on May 11, 2006.
[2] Days after planting.

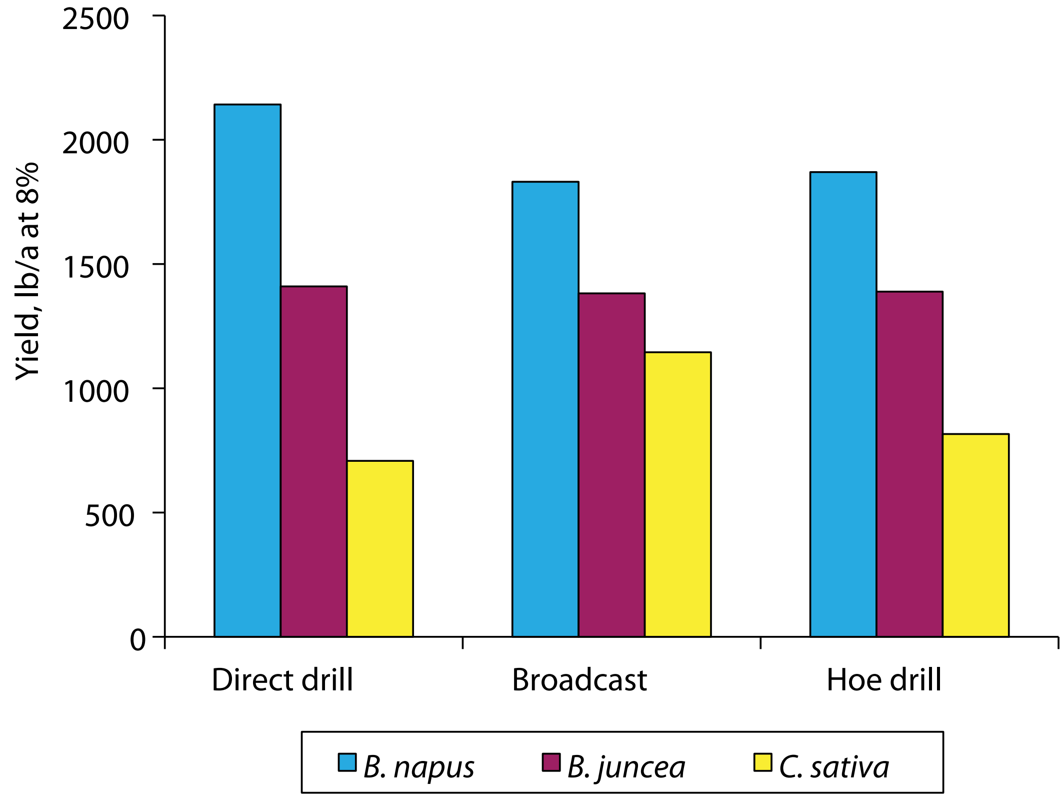


Figure 1. Effect of planting method on yield of spring *Brassica napus, Brassica juncea*, and *Camelina sativa* in 2005.

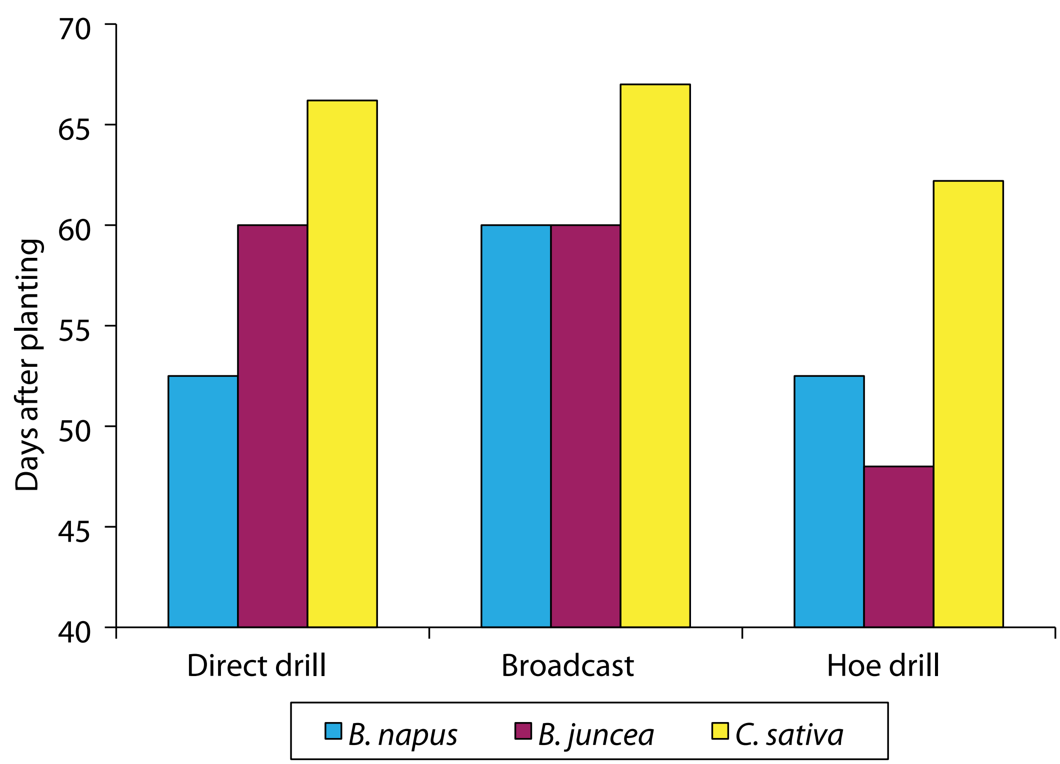


Figure 2. Effect of planting method on days to 50% bloom for spring *Brassica napus*, *Brassica juncea*, and *Camelina sativa* planted on Apr. 18, 2006.

Planting Date Effects on Spring Oilseed Production

R. Aiken, R. Wolf, L. Dible, and A. Oien

Summary

Mid-March plantings generally resulted in best emergence for *Brassica napus* and *B. juncea*. Best emergence for *Camelina sativa* corresponded with mid-February to mid-March planting dates. Days from emergence to 50% bloom generally decreased with later planting and emergence dates; 50% bloom generally occurred in late May to early June. Greatest yields for *B. napus*, *B. juncea*, and *C. sativa* corresponded with the mid-March planting date in 2005, the only growing season with favorable yield formation. Mid-March appears to be a desirable planting period for these spring oilseed crops.

Introduction

Spring oilseed crops such as canola (*B. napus*) offer diversity to grain-based cropping systems. Improved adaptability of dryland mustard and canola oilseed crops on the High Plains of the west central United States can lead to commercially viable cultivation that yields feedstocks for oilseed markets. Spring oilseed crops can be planted from mid-February through April and flower in late May for a mid-July harvest. Available water, stand establishment, and heat avoidance are significant factors affecting spring oilseed yields in the central High Plains. Developing baseline data for oilseed cultivars can help growers in this region evaluate the commercial feasibility of spring oilseed production.

The objective of this study was to determine the effects of planting date on emergence, days to bloom, and oilseed yield.

Procedures

Seed from three cool-season oilseed species—*B. napus* 'Hyola 401', *B. juncea* 'Arid', and *C. sativa* 'Boa'—were direct seeded in replicated plots of 150 sq. ft. Seed was drilled into weed-free wheat stubble in 2004, into terminated wheat stubble in 2005, and on fallowed land in 2006. In 2004, each species was tested with and without a polymer seed coating (Extender; Grow Tec Seed Coatings, Inc., Boston, MA). In 2005 and 2006, *B. juncea* was tested with and without the polymer seed coating. There were five planting dates each year from late winter to early spring, each with seed drop equivalent to 800,000 seeds/a. Supplemental nutrients were applied: 80-30-0 in 2004, 60-30-0 in 2005, and 90-30-0 in 2006. The insecticide Capture (1.3 oz/a) was applied twice, 2 weeks apart, for flea beetle control. In 2004 and 2005, the herbicide Select (5 oz/a) was applied with crop oil to control volunteer wheat and grassy weeds. In 2005, a total of 2.1 in. of irrigation was applied. Field observations included emergence and stand ratings, 50% bloom date, and maturity date. Seed was harvested and analyzed for water content, test weight, and yield.

Results

The best emergence ratings for *B. napus* and *B. juncea* corresponded with mid-March planting dates, but mid-February through mid-March planting dates resulted in best emergence for *C. sativa* (Figures 1, 2, and 3). Days to stand establishment and days to 50% bloom tended to decrease with later planting dates (Tables 1, 2, and 3), which likely reflects seasonal warming effects on emergence and development as well as photoperiod effects on floral development. Generally, emergence ratings were greatest for *B. napus* (4.5), poorest for *C. sativa* (3.5), and intermediate for *B. juncea*. Polymer coating did not significantly alter emergence rating, days to 50% bloom, or oilseed yield for the *B. juncea* line.

Bloom dates are related to maximum emergence dates to minimize effects of delayed emergence on floral development. Generally, 50% bloom occurred 25 to 50 days after maximum emergence (Figure 3); fewer days to bloom were required with later emergence dates. This relationship between emergence date and days to 50% bloom resulted in late-May to early June flowering for these spring oilseed crops.

Growing conditions resulted in favorable yields in 2005 (Figure 4) but not in 2004 (Figure 5) or 2006. In 2005, *B. napus* yields were greatest for mid- to late-March plantings, which corresponded to emergence in mid-April and 50% bloom in late May; however, there was no significant difference in yield among February 18, March 14, and March 28 plantings. Greatest yields for *B. juncea* and *C. sativa* also corresponded with mid-March plantings. *C. sativa* planted in mid-April achieved 80% of maximum yield that resulted from the mid-March planting. Hand-harvested samples from *C. sativa* plots had 60% greater yields than machine-harvested samples, indicating increased yield potential, which could result from improved stand establishment.

Table 1. Effect of planting date on emergence, time required for flowering and maturity, and oilseed yield for spring *Brassica napus*, *Brassica juncea*, and *Camelina sativa*, Colby, KS, 2004

Effect	Emergence rating		50% bloom	Yield
	Rating[1]	DAP[2]	DAE[3]	lb/a at 8%
Dec. 3, 2003	2.5	96	45	140.6
Jan. 13, 2004	2.6	100	42	119.0
Feb. 16, 2004	3.7	101	38	87.0
Mar. 18, 2004	3.4	107	39	90.1
Apr. 13, 2004	3.3	120	---	83.3
B. napus	3.6	105	37	51.6
B. juncea	2.8	104	39	22.1
C. sativa	2.9	106	---	238.3

[1] Maximum emergence rating, 1 = poorest, 5 = best.
[2] Days after planting.
[3] Days after maximum emergence rating.

Table 2. Effect of planting date on emergence, time required for flowering and maturity, and oilseed yield for spring *Brassica napus*, *Brassica juncea*, and *Camelina sativa*, Colby, KS, 2005

Effect	Emergence rating		50% bloom	Yield
	Rating[1]	DAP[2]	DAE[3]	lb/a at 8%
Feb. 18, 2005	2.6	44	49	755
Mar. 14, 2005	3.9	34	33	1,251
Mar. 28, 2005	2.1	20	45	775
Apr. 4, 2005	3.4	11	41	811
Apr. 25, 2005	2.4	14	33	444
B. napus	3.6	25	37	1,235
B. juncea	2.7	24	42	696
C. sativa	2.4	25	41	622

[1] Maximum emergence rating, 1 = poorest, 5 = best.
[2] Days after planting.
[3] Days after maximum emergence rating.

Table 3. Effect of planting date on emergence, time required for flowering and maturity, and oilseed yield for spring *Brassica napus*, *Brassica juncea*, and *Camelina sativa*, Colby, KS, 2006

Effect	Emergence rating		50% bloom	Yield
	Rating[1]	DAP[2]	DAE[3]	lb/a at 8%
Feb. 28, 2006	1.9	57	40	13
Mar. 30, 2006	3.2	38	29	11
Apr. 3, 2006	2.4	30	32	18
Apr. 17, 2006	2.4	26	34	11
May 1, 2006	3.5	36	14	2
May 16, 2006	2.1	24	---	1
B. napus	3.9	37	26	15
B. juncea	3.1	35	29	8
B. juncea treated	1.6	37	34	2
C. sativa	1.8	32	34	12

[1] Maximum emergence rating, 1 = poorest, 5 = best.
[2] Days after planting.
[3] Days after maximum emergence rating.

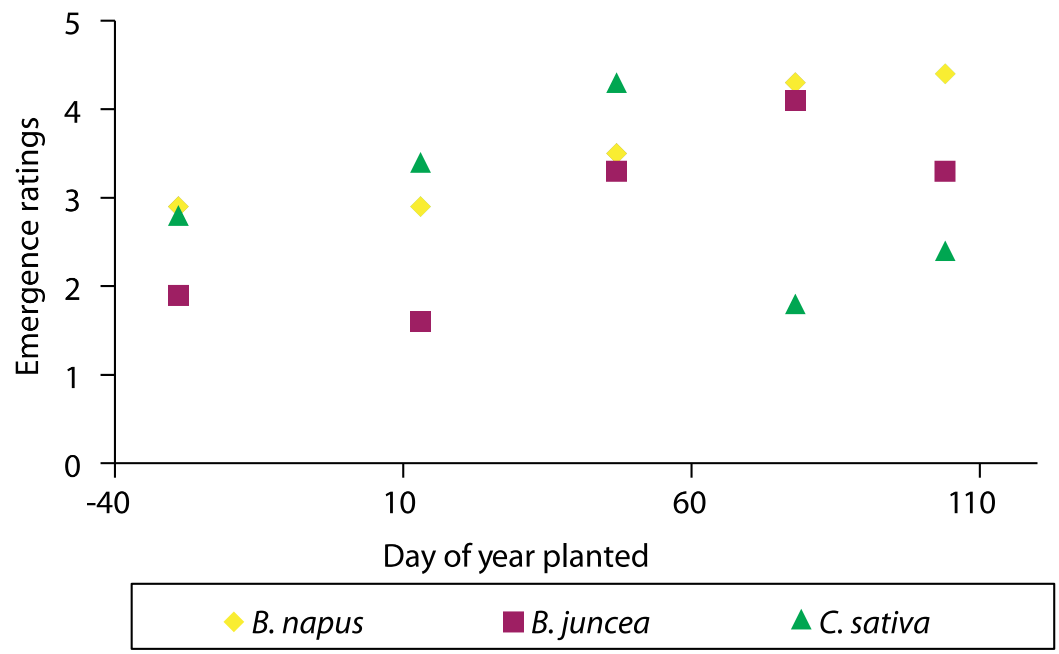


Figure 1. Emergence ratings (Apr. 25, 2004) for *Brassica napus* 'Hyola 401', *Brassica juncea* 'Arid', and *Camelina sativa* 'Boa' shown in relation to planting dates (Dec. 15, 2003 through Apr. 13, 2004) in Colby, KS.
Dec. 3, 2003, planting date is indicated as a negative day of year.

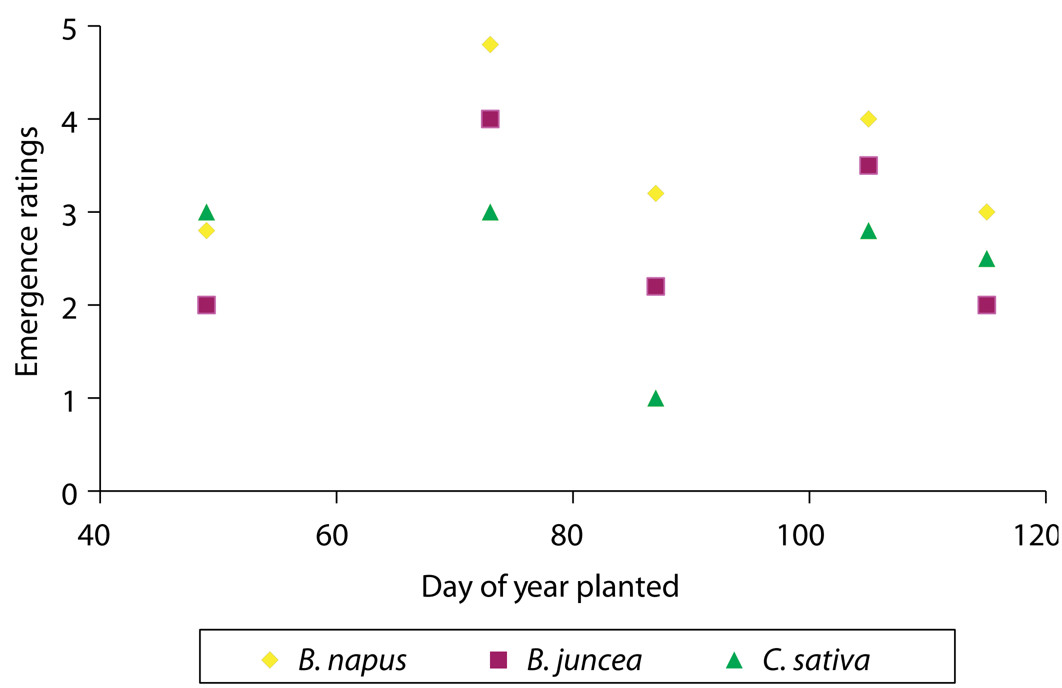


Figure 2. Maximum emergence ratings for *Brassica napus* 'Hyola 401', *Brassica juncea* 'Arid', and *Camelina sativa* 'Boa' shown in relation to planting dates (Feb. 18, 2005 through Apr. 25, 2005) in Colby, KS.

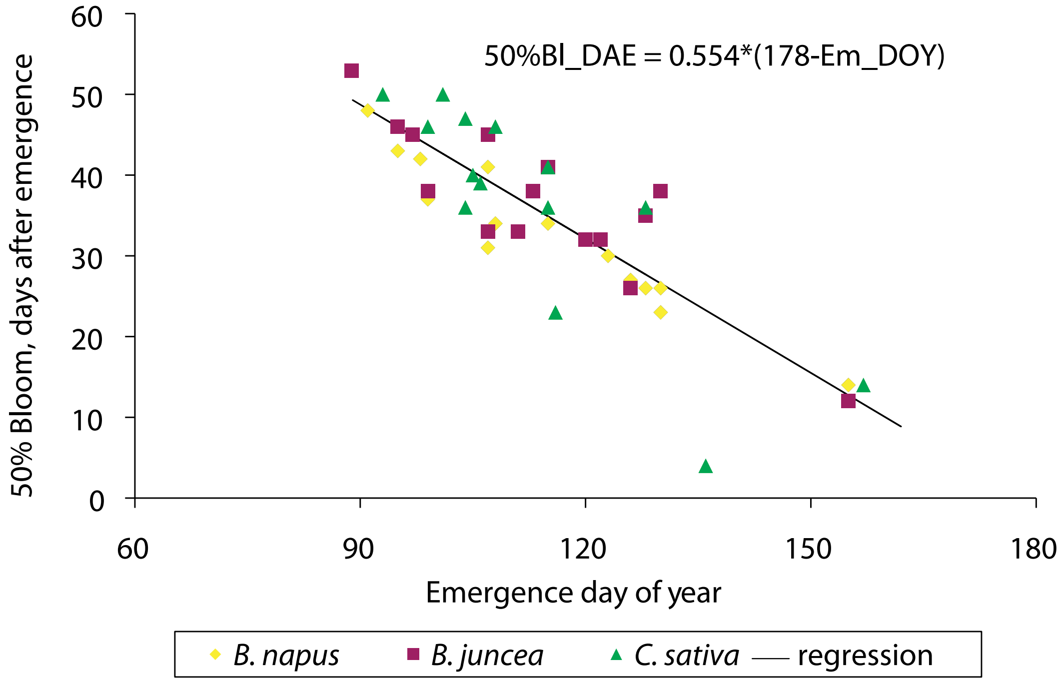


Figure 3. Days from time of maximum emergence required to reach 50% bloom for *Brassica napus* 'Hyola 401', *Brassica juncea* 'Arid', and *Camelina Sativa* 'Boa' grown in 2004, 2005, and 2006 in Colby, KS.

The regression equation ($R^2 = 0.72$) shows that bloom date (50% Bl_DAE, days after maximum emergence) can be calculated from date of maximum emergence (Em_DOY, day of year).

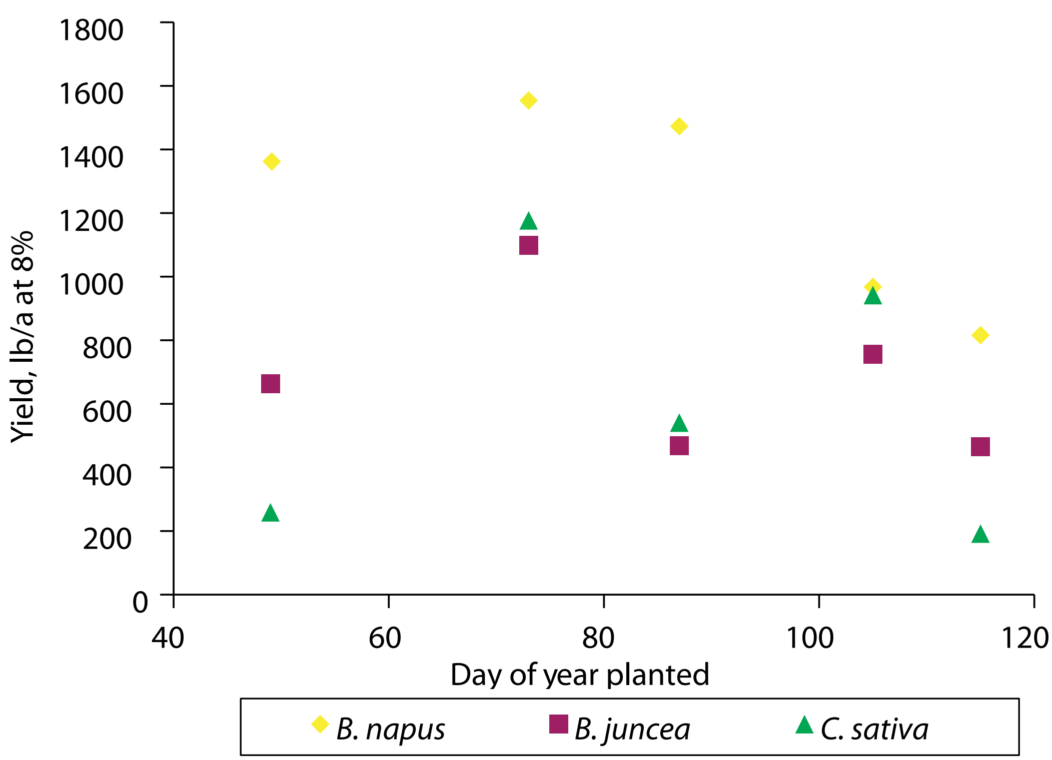


Figure 4. Seed yields (adjusted to 8% moisture content) for *Brassica napus* 'Hyola 401', *Brassica juncea* 'Arid', and *Camelina sativa* 'Boa' shown in relation to planting dates (Feb. 18, 2005 through Apr. 25, 2005) in Colby, KS.

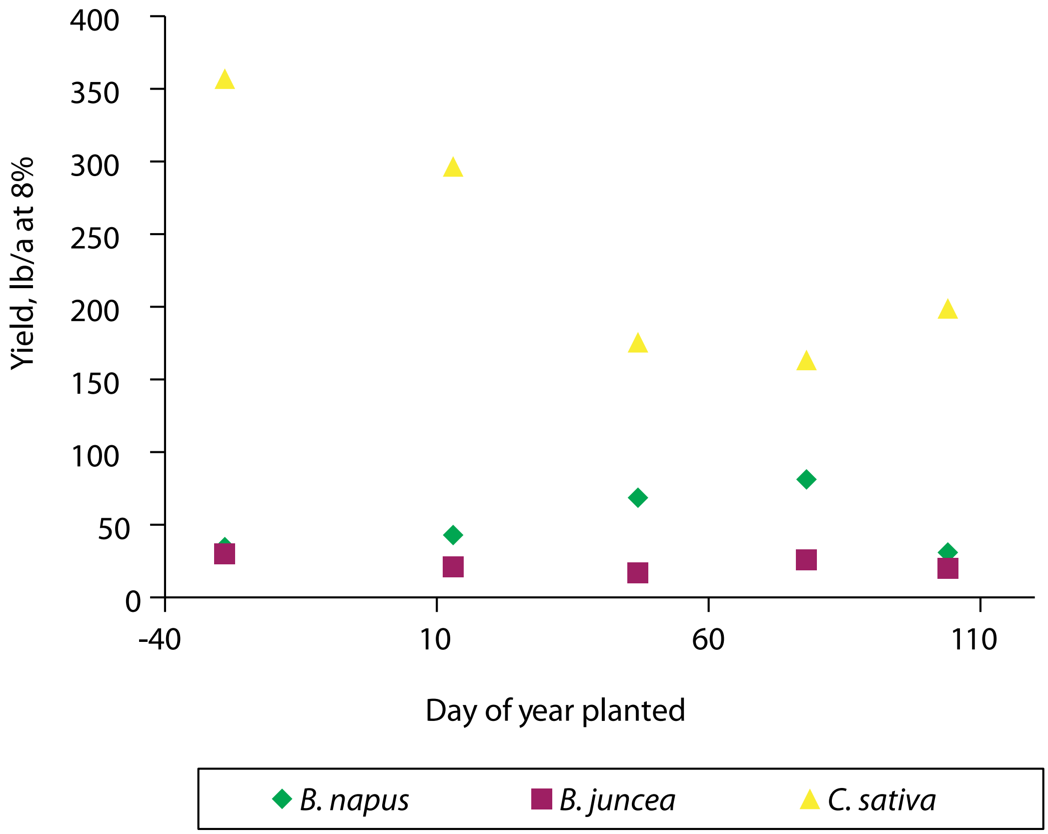


Figure 5. Seed yields (adjusted to 8% moisture content) for *Brassica napus* 'Hyola 401', *Brassica juncea* 'Arid', and *Camelina sativa* 'Boa' shown in relation to planting dates (Dec. 15, 2003 through Apr. 13, 2004) in Colby, KS.

Spring Oilseed Variety Trials

R. Aiken, R. Wolf, L. Dible, and A. Oien

Summary
The yield check cultivar (*Brassica napus* 'Hyola 401') yielded 978 lb/a in 2003, 868 lb/a in 2004, 1,204 lb/a in 2005, and 91 lb/a in 2006. Seven *Brassica* lines were equivalent or superior in 2003, four *Brassica* lines were equivalent or superior in 2004, and five *Brassica* lines were equivalent or superior in 2006. *Camelina sativa* yields were substantially less than *Brassica* yields in 2004 and 2005 but similar in 2003 and 2006.

Introduction
Spring oilseed crops such as canola (*B. napus*) offer diversity to grain-based cropping systems. Other spring oilseed crops include Indian brown mustard (*B. juncea*) and *C. sativa*. Spring oilseed crops can be planted from late March through April and flower in late May for a mid-July harvest. Available water, stand establishment, and heat avoidance are significant factors affecting spring oilseed yields in the central High Plains.

The objective of this study was to evaluate establishment, development, and productivity of *B. napus*, *B. juncea*, and *C. sativa* cultivars.

Procedures
Seed from cool-season oilseed cultivars of *B. juncea*, *B. napus*, and *C. sativa* lines were planted in replicated (three times in 2004, four times in 2005 and 2006) plots in clean-tilled land in 2004 and in terminated wheat stubble in 2005. Each year the study was planted into plots with center-pivot irrigation capability. After planting in 2005, 2.24 in. of precipitation caused crusting, which limited seedling emergence. Soil fertility amendments included 30 lb/a phosphorus (as 7-30-0) with 60 lb/a nitrogen in 2003, 2004, and 2005 and 90 lb/a nitrogen in 2006 (applied preplant). The insecticide Capture was applied (1.3 oz/a) twice each year about 20 days apart to control flea beetles. Glyphosate (Roundup UltraMax, 24 oz/a) was applied with ammonium sulfate just after planting in 2004. In 2005, glyphosate (Roundup UltraMax, 24 oz/a) was applied 1 month before planting. Plots were generally machine harvested with a plot combine at maturity. The 2003 *C. sativa* trial was hand harvested (30 in. × 30 in. samples) because of poor stand.

Results
Results from 2003 through 2006 are shown in Tables 1 through 8. Variety trials indicated differential responses to hot and dry spring conditions among *Camelina* and *Brassica* cultivars. Each year Hyola 401 produced among the greatest yields but never showed a "perfect" stand to begin with. Other lines of *B. napus* and *B. juncea* that did well were Hylite 292CL, Patriot RR, DK 223, Hyola 357, and BSX-41010. Each of these lines showed yields of near or more than 900 lb/a in 2004. Hyola 357 and BSX-41010 yielded more than 1,000 lb/a in 2005. Unusually hot spring conditions in 2006 limited yields.

Table 1. Spring *Brassica napus* and *Brassica juncea* performance trial planted Mar. 26, 2003, in Colby, KS

Entry	Species	Bloom	Stand	Shatter	Height	Yield	Test weight
		DAP[1]		%	ft	lb/a	lb/bu
Ames 19180	carinata	69	2.3	0	3.8	684	45
PI 331377	*carinata*	70	2.2	5	4.3	1,048	50
PI 360882	*carinata*	71	3.0	2	4.1	668	46
PI 390134	*carinata*	69	3.0	5	3.7	958	45
CI3		68	2.7	12	3.8	724	48
CII3		65	2.3	8	3.7	603	48
Ames 725	*juncea*	60	3.7	3	4.3	1,171	50
PI 458934	*juncea*	68	3.3	2	4.5	1,104	51
PI 531217	*juncea*	82	3.7	5	5.7	317	52
ZEM I	*juncea*	63	3.3	3	4.5	1,153	50
Brigade	napus	70	2.7	13	4.0	431	48
Cyclone	*napus*	68	2.3	12	3.9	704	48
Hyola 308	*napus*	59	2.3	5	3.0	1,212	48
Hyola 330	*napus*	59	4.0	3	3.3	1,294	50
Hyola 401	*napus*	59	3.3	2	3.2	978	50
Legend	*napus*	63	2.3	12	3.7	496	45

[1] Days after planting.

Table 2. Spring *Camelina sativa* performance trial planted Mar. 26, 2003, in Colby, KS

Entry	Species	Stand	Shatter	Height	Yield
			%	ft	lb/a
Hyola 401	*B. napus*	2.0	2	2.4	2,498
Ames 22984	*C. sativa*	1.5	27	1.8	59
Ames 22985	*C. sativa*	1.0	10	1.8	1,041
Ames 22986	*C. sativa*	1.0	12	1.9	1,082
Ames 26667	*C. sativa*	0.5	10	1.6	447
Ames 26668	*C. sativa*	1.5	12	1.9	1,370
Ames 26670	*C. sativa*	1.0	15	1.9	955
Ames 26677	*C. sativa*	1.0	8	1.8	202
Ames 26679	*C. sativa*	1.0	18	1.8	829
Ames 26682	*C. sativa*	1.0	8	2.0	512
Ames 26683	*C. sativa*	1.5	5	1.8	140
Ames 26684	*C. sativa*	1.0	8	1.6	339
Ames 26685	*C. sativa*	1.0	5	2.0	1,167
Ames 26687	*C. sativa*	1.0	22	1.6	252
Ames 26688	*C. sativa*	1.5	5	2.0	212
Ames 26689	*C. sativa*	1.0	12	1.6	344
PI 597833	*C. sativa*	1.0	10	1.8	190

Table 3. Spring *Brassica napus* and *Brassica juncea* performance trial planted Mar. 22, 2004, in Colby, KS

Entry	Bloom	Stand	Shatter	Height	Yield	Test weight
	DAP[1]		%	ft	lb/a	lb/bu
CI3	67	4.0	11.7	2.8	417	41.7
CII3	67	4.3	11.7	2.8	368	40.0
Blue-01-001	62	4.0	11.7	2.7	283	39.0
Blue-01-002	63	4.3	16.7	2.9	171	32.6
Blue-01-003	61	5.0	23.3	2.9	275	33.9
W HyLite 292 CL	66	4.7	8.3	2.6	898	42.9
SW Patriot RR	65	4.7	15.0	2.8	868	42.7
Hyola 401	62	4.3	11.7	2.3	866	42.9
PHI-04-05	65	4.0	8.3	2.7	861	44.0
HyClass 905	68	4.7	8.3	2.9	607	42.4
HyClass 910	68	4.0	16.7	2.9	566	42.2
InVigor 4870	68	4.3	13.3	3.1	828	42.9
KAB 36	66	4.3	11.7	2.6	733	42.8
DK 223	61	4.0	11.7	2.4	908	43.3
DKL 3455	66	4.7	11.7	2.7	656	42.5
DKL 3585	67	4.3	10.0	2.6	676	43.0
PHI-04-01	62	4.7	23.3	3.2	141	29.4
PHI-04-02	61	5.0	23.3	3.1	137	28.7
PHI-04-03	61	4.7	28.3	3.1	187	33.8
PHI-04-04	66	4.0	6.7	2.6	479	40.5

[1] Days after planting.

Table 4. Spring *Camelina sativa* performance trial planted Mar. 22, 2004, in Colby, KS

Entry	Bloom	Stand	Shatter	Yield
	DAP[1]		%	lb/a
Hyola 401	60	4	30	1,435
Ames 22985	67	1	7	98
Ames 22986	65	1	5	109
Ames 26667	67	1	7	197
Ames 26668	65	1	7	73
Ames 26670	66	1	7	207
Ames 26677	67	1	8	218
Ames 26682	66	1	8	61
Ames 26684	66	1	10	263
Ames 26685	65	1	5	155
Ames 26686	66	1	7	182
Ames 26688	66	1	10	289
Ames 26689	67	1	10	76
PI 597833	67	1	5	89

[1] Days after planting.

Table 5. Spring *Brassica napus* and *Brassica juncea* performance trial planted Apr. 4, 2005, at Colby, KS

Line	Emergence rating	Emergence	50% bloom	Yield
		DAP[1]	DAP	lb/a at 8%
DKL3455	3.2	22	67	706
DKL3585	2.8	18	67	759
US040501	1.8	20	68	436
US040502	1.5	18	72	183
US040503	2	18	82	254
US040504	1.8	18	76	213
US050505	2.8	20	67	565
Hyola 357	2.2	16	62	1,079
Hyola 401	2.2	20	60	1,204
45H21	2.8	20	67	889
45H25	2.8	18	66	907
45H72	2.5	18	67	660
Marksman	2.5	20	67	802
Patriot	2.8	18	67	784
Blue01-001	2.5	22	66	615
Blue01-003	3.5	22	60	549
PKI0401	2.8	20	67	619
PHI-05-02	2.5	22	67	419
PHI-05-03	2.0	22	67	459
BSX-41010	2.0	20	67	1,034
BSX-42095	2.5	20	67	897

[1] Days after planting.

Table 6. Spring *Camelina sativa* performance trial planted Apr. 4, 2005, at Colby, KS

Line	Emergence rating	Emergence	50% bloom	Yield
		DAP[1]	DAP	lb/a at 8%
Hyola 401	2.2	20	63	1,216
BSX-G31	1.2	18	72	607
BSX-G31	1.0	14	70	360
BSX-G51	1.0	14	71	199
BSX-G52	1.0	18	71	260
BSX-G53	1.0	16	71	190
BSX-G61	1.0	14	72	279
BSX-G62	1.2	16	72	400
BSX-G63	1.0	16	72	351
BSX-G71	1.0	16	72	321
BSX-G72	1.0	14	70	275
BSX-G73	1.0	16	72	251
France	1.2	14	70	415
Austria	1.0	14	70	473

[1] Days after planting.

Table 7. Spring *Brassica napus* and *Brassica juncea* performance trial planted Apr. 5, 2006, at Colby, KS

Cultivar	Emergence at 30 days after planting	Flowering at 62 days after planting	Yield
		%	lb/a
Hyola 401	4.5	80	91
Hyola 357 Mag. RR	4.8	75	325
IS 3465 RR	4.5	80	81
IS 7145 RR	5.0	20	128
Hylite 1618 CL	5.0	80	60
Hyclass 431 RR	4.0	60	28
Hyclass 767 SWRR	5.0	45	62
Hyclass 712 RR	5.0	25	107
Hyclass 905 RR	4.2	25	81
SW Titan RR	5.0	70	81
SW Marksman RR	5.0	75	56
SW Patriot RR	5.0	70	41
Arid	5.0	80	37
Dahinda	4.5	75	84
DKL 34 - 55	4.8	80	100
DKL 38 - 25	5.0	10	54
DKL 52 - 10	5.0	30	220
Farmer	4.8	75	72
Crambe	1.0	50	8

Table 8. Spring *Camelina sativa* performance trial planted Apr. 5, 2006, at Colby, KS

Cultivar	Emergence at 30 days after planting	Flowering at 62 days after planting	Yield
		%	lb/a
BSX-G21	0	40	34
BSX-G51	1	50	21
BSX-G52	1.5	50	18
BSX-G53	2	45	4
BSX-G61	1.5	55	38
BSX-G62	0.5	40	44
BSX-G63	2	50	28
BSX-G71	1	45	48
BSX-G72	1	60	20
BSX-G73	1	40	77
Calena	3	60	93
Ligena	2	50	16
NE Exp 682	1.5	45	31
NE Exp 684	1	50	36
NE Exp 684B	1	35	36
NE Exp 985	1	30	29

Canola Harvest Methods

R. Aiken, R. Wolf, L. Dible, and A. Oien

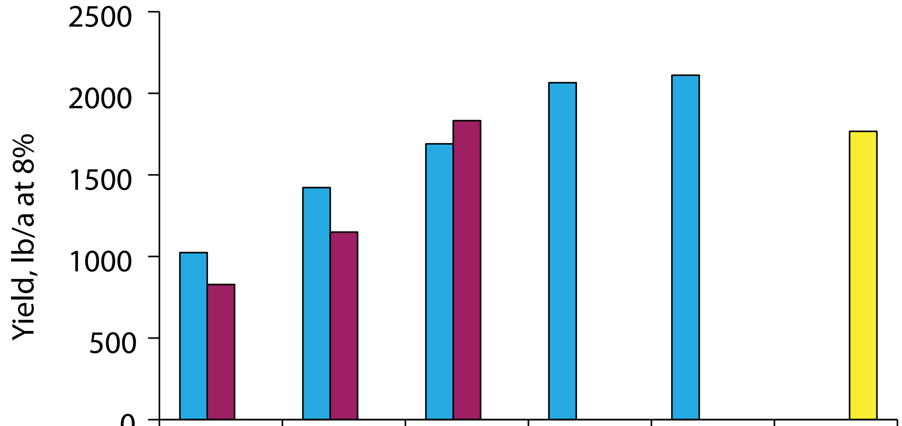
Summary
Harvest losses in spring oilseed crops can result from nonuniform development and maturation of seed pods. Swathing canola 3 to 8 days before normal combine harvest and curing for 5 days increased oilseed harvest by 19% in 2005; swathing canola 10 days before normal combine harvest and curing for 10 days increased oilseed harvest by 15% in 2007. Swathing canola more than 10 days before normal combine harvest reduced oilseed harvest in both growing seasons.

Introduction
Spring oilseed crops can be planted from mid-February through April and flower in late May for a mid-July harvest. Available water, stand establishment, and heat avoidance are significant factors affecting spring oilseed yields in the central High Plains. Nonuniform maturation of seed pods in spring oilseed crops can reduce harvest efficiency. Swathing and curing can lead to more uniform maturation of seed pods.

The objective of this study was to evaluate effects of swathing, timing, and curing on harvest efficiency for spring canola.

Procedures
Brassica napus 'Hyola 357RR' was direct seeded in replicated (five times) plots. Five swathing dates occurred at 3-day intervals. The swathed crop was threshed with a plot combine after a 5- or 10-day curing period. The first three swaths were machine harvested either 5 or 10 days after swathing. The fourth swath was harvested after 5 days, and the fifth swath was harvested after 3 days, corresponding with direct combine harvest. The direct combine harvest of unswathed canola occurred 105 days after planting. In 2007, the same *B. napus* line was direct seeded in replicated plots, and a similar swathing and curing schedule was followed before the crop was threshed with a plot combine. Two direct combine harvests were used in 2007. Field observations included emergence and stand ratings, 50% bloom date, and maturity date. Seed was harvested and analyzed for water content, test weight, and yield.

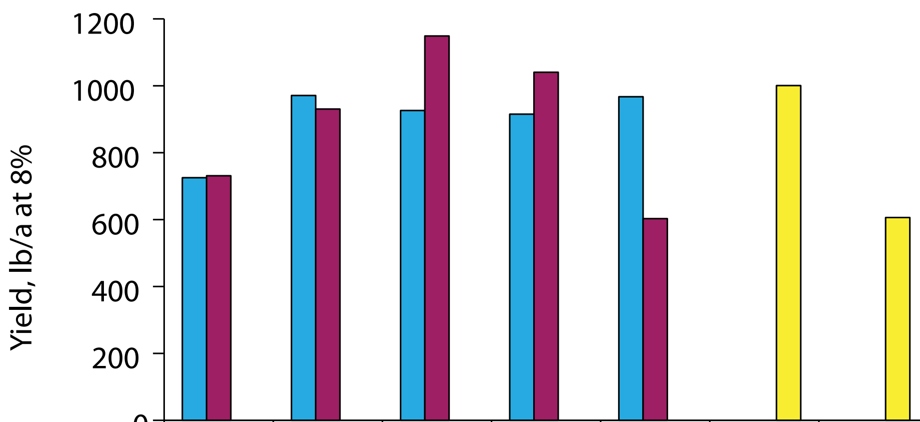
Results
Harvested oilseed yields from the 2005 (Figure 1) and 2007 (Figure 2) growing seasons showed that oilseed yields increased after the first two swathing dates. In 2007, oilseed yield was maximized by swathing 10 days before direct combine harvest and curing for 10 days. Results indicate a harvested yield advantage to swathing and curing for 5 to 10 days before normal combine harvest.



	89	92	96	99	102	105
Cured 5 days	1024	1422	1690	2065	2111	
Cured 10 days	828	1150	1832			
Direct combine						1767

Days after planting

Figure 1. Harvested oilseed yield from *Brassica napus* 'Hyola 357RR' planted on Mar. 31, 2005, in Colby, KS.
The crop was swathed or direct cut with a plot combine on the indicated date. The swathed crop was cured for either 5 or 10 days before being threshed with a plot combine.



	71	74	77	80	83	87	91
Cured 5 days	725	971	926	915	967		
Cured 10 days	731	931	1149	1041	603		
Direct combine						1001	606

Days after planting

Figure 2. Harvested oilseed yield from *Brassica napus* 'Hyola 357RR' planted on Apr. 30, 2007, in Colby, KS.
The crop was swathed or direct cut with a plot combine on the indicated date. The swathed crop was cured for either 5 or 10 days before being threshed with a plot combine.

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SRP 1030 April 2010