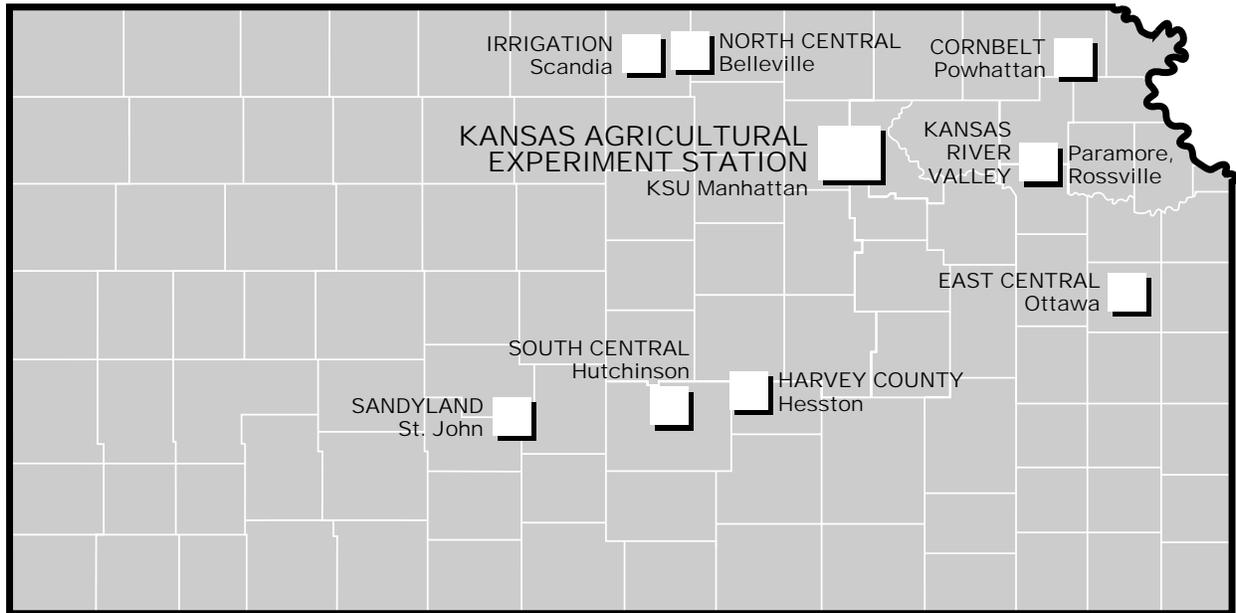


# Report of Progress 835

Kansas State University Agricultural Experiment Station and Cooperative Extension Service



# FIELD RESEARCH 1999



**Agronomy Experiment Fields**

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# CORNBELT EXPERIMENT FIELD

## Introduction

The Cornbelt Field was established in 1954 through the efforts of local interest groups, Kansas State University, and the state legislature. The objective then was to conduct research on the propagation, culture, and development of small-seeded legumes.

Emphasis since 1960 has been on fertilizer management; row spacings, planting rates and dates; variety testing; control of weeds and insects; cultural practices, including disease- and insect-resistant varieties; and cropping systems. Foundation seed of oat, wheat, and soybean cultivars are produced as needed to provide a source of quality seed of public varieties.

## Soil Description

The soils on the Experiment Field are silty, windblown, Pleistocene sediments called loess (pronounced luss). Grundy silty clay loam, the dominant soil, has a black silty clay loam surface, usually more than 15 inches thick, and a silty clay subsoil. It typically occupies ridge crests and tablelands of western and southeastern Brown County and is extensive in n o r t h e a s t e r n J a c k s o n ,

western Atchison, eastern Jefferson, and western Leavenworth counties in Kansas, as well as in western Richardson County, Nebraska. Grundy soil is similar to the Wymore soil of Nemaha and Marshall counties, Kansas and of Pawnee County, Nebraska.

The nearly level slopes have thick surface soil, which thins rapidly as slopes increase. Gradient terraces usually are needed to reduce sheet erosion, which is a serious hazard because the subsoil absorbs water slowly.

## 1998 Weather Information

Precipitation during the growing season in 1998 was below normal. However, subsoil moisture and near normal rainfall during June, July, and August resulted in good yields of corn and soybeans.

The last killing frost was on March 24 (normal April 23), and the first killing frost was on November 11 (normal October 15). The frost-free period was 52 days longer than the 170-day average.

Table 1. Precipitation at the Cornbelt Experiment Field, Powhattan, KS (inches).

Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Total
October, 1997 - September, 1998												
3.26	1.78	1.07	0.00	0.00	1.27	2.44	0.80	4.52	3.61	3.52	3.58	25.85
41-Year Average												
2.79	1.84	1.04	0.78	0.75	2.30	3.01	4.82	5.00	4.53	4.07	4.49	35.42

# CORN HERBICIDE PERFORMANCE TESTS

Larry D. Maddux and Scott A. Staggenborg

## Summary

Fourteen herbicide treatments were evaluated. Grass control was fairly good, with only two treatments having less than 80% control of green foxtail, and three treatments having less than 80% control of large crabgrass. All treatments gave excellent control of redroot pigweed, but seven treatments resulted in less than 80% control of velvetleaf.

## Introduction

Chemical weed control and cultivation have been used to reduce weed competition in row crops for many years. This test included 14 herbicide treatments and an untreated control. The major weeds in this test were large crabgrass, green foxtail, redroot pigweed, and velvetleaf.

## Procedures

This test was conducted on a Grundy silty clay loam soil previously cropped to soybeans with a pH of 6.7 and an organic matter content of 3.2 percent. Garst 8541 IT corn hybrid was planted on May 5 at 23,500 seeds/a in 30-inch rows. Anhydrous ammonia at 120 lbs N/a was applied preplant. Herbicides were applied preemergent (PRE) - May 5 and postemergent (POST) - June 2. The plots were not cultivated. The data reported here are for crop injury ratings on June 19 and for

weed control ratings on July 7. The first significant rainfall after PRE herbicide application was May 9 (0.45 inches). Plots were harvested on September 18 using a modified Gleaner E III plot combine.

## Results

Slight crop injury was observed with Buctril/Atrazine, Aim + Atrazine, and Aim + Atrazine + Banvel, but it was not significant at the 0.05% level of probability (Table 2). All treatments gave excellent control of redroot pigweed. Control of green foxtail was fairly good, with most treatments resulting in 80 - 90% control. The green foxtail control was poorest with Dual II, PRE + Scorpion III, POST - 70% and Aim + Atrazine + Banvel, POST - 73%. Crabgrass control was lower than 80% with only three treatments: Scorpion III + Accent, POST - 50%; Hornet + Basis Gold, POST - 57%; and Aim + Atrazine + Banvel, POST - 78%. Nearly complete control of velvetleaf was obtained with Aim + Atrazine + Banvel, POST, followed by: Axiom, PRE + Lightning, POST - 98%; Aim + Atrazine, POST - 97%; Axiom, PRE + Buctril/Atrazine, POST - 93%; Axiom + Balance, PRE - 90%; Python + Atrazine, PRE - 88%; and Hornet + Topnotch, PRE - 87%. The other seven treatments resulted in less than 80% velvetleaf control. Corn yield tended to follow the weed control ratings. The check plot yielded only 66 bu/a, whereas the herbicide-treated plots yielded 95 to 135 bu/a.

Table 2. Effects of herbicides on corn injury, weed control, and grain yield, Powhattan, KS 1998.

Treatment <sup>1</sup>	Rate	Appl Time <sup>2</sup>	Injury	Weed Control, 28 DAT <sup>3</sup>				Grain Yield
			14 DAT	Lgcg	Grft	Rrpw	Vele	
	prod./a		%			%		bu/a
Untreated check	---	---	0	0	0	0	0	66
Bicep II	2.0 qt	PRE	0	90	90	93	68	122
Python + Bicep II	1.0 oz 2.0 qt	PRE PRE	0	90	92	97	88	132
Bicep II + Hornet	2.0 qt 2.0 oz	PRE PRE	0	92	90	100	82	131
Hornet + Topnotch	3.2 oz 2.0 qt	PRE PRE	0	90	87	100	87	123
Axiom + Atrazine	16 oz 1.75 lb	PRE PRE	0	90	85	100	78	123
Axiom + Balance	8 oz 2.0 oz	PRE PRE	0	92	90	97	90	133
Axiom + Buctril/Atrazine	18 oz 1.75 lb	PRE POST	2	87	87	98	93	130
Axiom + Lightning	18 oz 1.28 oz	PRE POST	0	88	88	100	98	128
Hornet + Basis Gold + UAN + NIS	2.4 oz 14 oz 2.5+.25%	POST POST POST	0	57	85	100	82	116
Dual II + Hornet + Atrazine + UAN+ NIS	2.0 pt 1.6 oz 1.0 lb 2.5+.25%	PRE POST POST POST	0	87	80	100	75	110
Dual II + Hornet + Atrazine + UAN+ NIS	2.0 pt 2.4 oz 1.0 lb 2.5+.25%	PRE POST POST POST	0	87	87	100	78	132
Scorpion III + Accent + UAN+ NIS	4.0 oz 0.66 oz 2.5+.25%	PRE POST POST	0.0	50	83	100	58	95
Aim + Atrazine + NIS	0.33 oz 0.56 lb 0.25%	POST POST POST	2	82	82	98	97	135
Aim + Atrazine + Banvel + NIS	0.33 oz 0.56 lb 2.0 oz 0.25%	POST POST POST POST	2	87	73	100	100	124

<sup>1</sup> UAN = 28-0-0 fertilizer; NIS = nonionic surfactant.

<sup>2</sup> PRE = preemergence; POST = postemergence.

<sup>3</sup> Lgcg = large crabgrass; Grft = green foxtail; Rrpw = redroot pigweed; Vele = Velvetleaf, DAT = days after treatment application; Injury and weed control rated 6/29/98 & 7/7/98.

# SOYBEAN HERBICIDE PERFORMANCE TESTS

Larry D. Maddux and Scott A. Staggenborg

## Summary

Nine herbicide treatments were evaluated. Significant soybean injury was observed with FirstRate + Cobra + Select, applied postemergence. All treatments resulted in greater than 85% control of green foxtail and redroot pigweed, but only three gave greater than 85% control of large crabgrass. Seven treatments gave excellent control of velvetleaf (85% or greater).

## Introduction

Chemical weed control and cultivation are commonly used to control weeds and reduce yield losses in soybean. This test included nine chemical treatments and an untreated control for evaluation of weed control. The major weed species in this test were large crabgrass, green foxtail, redroot pigweed, and velvetleaf.

## Procedures

This test was conducted on a Grundy silty clay loam soil with a pH of 6.7 and organic matter content of 3.2% previously cropped to corn. Macon soybeans were planted on May 19 at 144,000 seeds/a in 30-inch rows. The herbicides were applied as follows: preplant, incorporated (PPI) and preemergence (PRE) - May 19 and postemergence (POST) - June 30. No significant rainfall was received after the PPI and PRE treatments until June 20

(1.39 inch). The plots were not cultivated. Ratings reported for crop injury were made on July 7 and 13, 8 and 14 days after application of the POST treatments. Ratings reported for weed control were made on July 13, 14 days after application of the POST treatments. Harvest was on October 26 using a modified Gleaner E III plot combine.

## Results

Significant soybean injury was observed with the FirstRate + Cobra + Select treatment (Table 3). Crabgrass control was better than 85% with only three of the nine treatments: Python + Prowl, PRE + FirstRate, POST - 92%; Authority Broadleaf, PRE + Roundup Ultra, POST - 87%; and Dual II, PRE + FirstRate + Flexstar, POST - 85%. All treatments gave 85% or greater control of green foxtail and redroot pigweed. The Authority Broadleaf, PRE + Roundup Ultra, POST and the FirstRate + Prowl, PRE treatments gave the poorest velvetleaf control (73 & 75%). The other seven treatments gave better than 85% control of velvetleaf. The control plot yielded only 12 bu/a, whereas the treated plots yielded from 24.5 to 40.5 bu/a. Soybean stands were thin and/or variable in some plots because of the poor soil moisture at planting time and affected some of the yields among treatments. Therefore, yield was not correlated highly with weed control.

Table 3. Effects of herbicides on soybean injury, weed control, and grain yield, Powhattan, KS, 1998.

Treatment <sup>2</sup>	Rate	Appl Time	Soybean Injury		Weed Control, 14 DAT <sup>1</sup>				Grain Yield
			7DAT	14DAT	Lacg	Grft	Rrp w	Vele	
	prod./a		%		%				bu/a
Untreated Check		---	0	0	0		0	0	12.0
FirstRate + Treflan	0.6 oz 2.0 pt	PPI PPI	0.0	0.0	70	88	87	87	36.7
FirstRate + Prowl	0.6 oz 3.0 pt	PRE PRE	0.0	0.0	75	90	90	75	28.7
Command + Authority Brdleaf	1.67 pt 6.8 oz	PRE PRE	0.0	0.0	62	87	98	98	30.8
Command + Authority Brdleaf	2.0 pt 5.33 oz	PRE PRE	0.0	0.0	77	88	88	87	24.8
Broadstrike+Treflan +FirstRate +UAN +NIS	2.0 pt 0.3 oz 2.5% 0.125%	PPI EP EP EP	0.0	0.0	77	93	97	98	36.1
Dual II +FirstRate +Flexstar +UAN +NIS	2.0 pt 0.3 oz 1.0 pt 2.5% 0.125%	PRE POST POST POST POST	1.7	0.0	85	95	95	92	34.2
Python +Prowl +FirstRate +UAN +NIS	1.3 oz 3.0 pt 0.3 oz 2.5% 0.125%	PRE PRE POST POST POST	0.0	0.0	92	92	100	90	34.8
FirstRate + Cobra + Select +UAN +NIS	0.3 oz 0.5 pt 6.0 oz 2.5% 0.125%	POST POST POST POST POST	15.0	0.0	70	92	93	97	30.8
Authority Broadleaf + Roundup Ultra	6.8 oz 1.5 pt	PRE POST	1.7	0.0	87	97	100	73	40.5

<sup>1</sup> Lacg = large crabgrass; Grft = green foxtail; Rrpw = redroot pigweed; Vele = velvetleaf; DAT = days after postemergence treatment application; Ratings: Injury - 7/7/98 & 7/13/98; Weed control - 7/13/98.

<sup>2</sup> UAN = 28-0-0 fertilizer; NIS = nonionic surfactant.

# PRECISION AGRICULTURE RESEARCH AND EXTENSION SITE BROWN COUNTY

Scott A. Staggenborg, Randall K. Taylor, Larry D. Maddux, John P. Schmidt,  
Ray E. Lamond, and Steve Furman

## Introduction

Current precision agriculture research and extension activities are conducted in cooperation with producers. Although this is an effective method, many desirable activities are limited by operating within the confines of the individual producer's management practices. For example, exploring the extreme ranges of nutrient inputs does not coincide with the economic interests of the producer, or intensive groundwater monitoring devices are difficult to implement in a farmer's field. Long-term control for an entire field allows better research on precision agriculture as a management method.

A recent report to the North Central Soybean Research Program suggested establishing demonstration plots that combine research, education, and training. The report was generated from focus group discussions at four locations. Farmers with experience in precision agriculture participated in the discussion. They suggested that one of the obstacles to adopting precision agriculture technologies was a lack of training programs and resources. A demonstration farm could meet those needs. With the establishment of this project, K-State would be the leader in this effort.

Developing such facilities at an existing research facility enhances both the research and extension aspects of such a facility as a result of the existing

research base, weather data information, and traditional research equipment. As a result of these needs, an area at the Cornbelt Experiment Field was identified to be used as a Precision Agriculture Research and Extension site.

## Procedures

Soil on the 53-acre area was sampled on a 5/8 acre (165 ft x 165ft) semi-random grid using DGPS on May 29, 1998. Soil samples were taken to a depth of 6 inches. Samples were analyzed for pH, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O and organic matter. Data were interpolated using an inverse distance-squared method in AgInfo GIS.

Prior to fall crop harvest, an Ag Leader PF3000 yield monitor was installed in an F2 Gleaner. Initial calibration curves were developed for corn, grain sorghum, and soybeans. All yield data were interpolated using an inverse distance-squared method in AgInfo GIS.

## Results

Soil pH, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O, and organic matter varied to different degrees for each variable measured (Table 4). Soil test results indicate that pH and P levels had sufficient variability to warrant variable-rate applications (Figure 1). Soil K<sub>2</sub>O levels did not have sufficient variability to warrant variable-rate applications (data not shown). Organic matter levels varied over a range of approximately 2 percentage points.

Soybean yields overall were quite low because of late-season drought and varied widely among terraces because of crop rotation differences (Table 5). Corn yields were lower than expected because of high temperatures during early ear development and low solar radiation levels during pollination and silking (Table 6).

### Acknowledgements

This project is supported by K-State Research and Extension and through the corporate sponsorship of the Brown County CO-OP.

Table 4. Soil pH, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O and organic matter at the Precision Ag Research & Extension site, Cornbelt Experiment Field, Powhattan, KS, 1998.

Variable	Max	Min	Avg.
pH	6.6	5.1	5.9
P <sub>2</sub> O <sub>5</sub> (ppm)	21.0	7.0	12.6
K <sub>2</sub> O (ppm)	315.0	87.0	201.0
O.M. (%)	4.1	2.2	3.1
Lime requirement (ton/acre)	9500.0	0.0	3942.0

Table 5. Soybean yields by terrace at the Precision Ag Research & Extension site in 1998.

Terrace	Grain Yield	Standard Deviation
		bu/a
B1 & B2	37.4	9.3
B3	12.9	7.4
B6	16.5	7.0
B7 & B8	25.2	6.2

Table 6. Corn yields by terrace at the Precision Ag Research & Extension site in 1998.

Terrace	Grain Yield	Standard Deviation
		bu/a
B4	114.4	24.8
B5	106.8	28.3

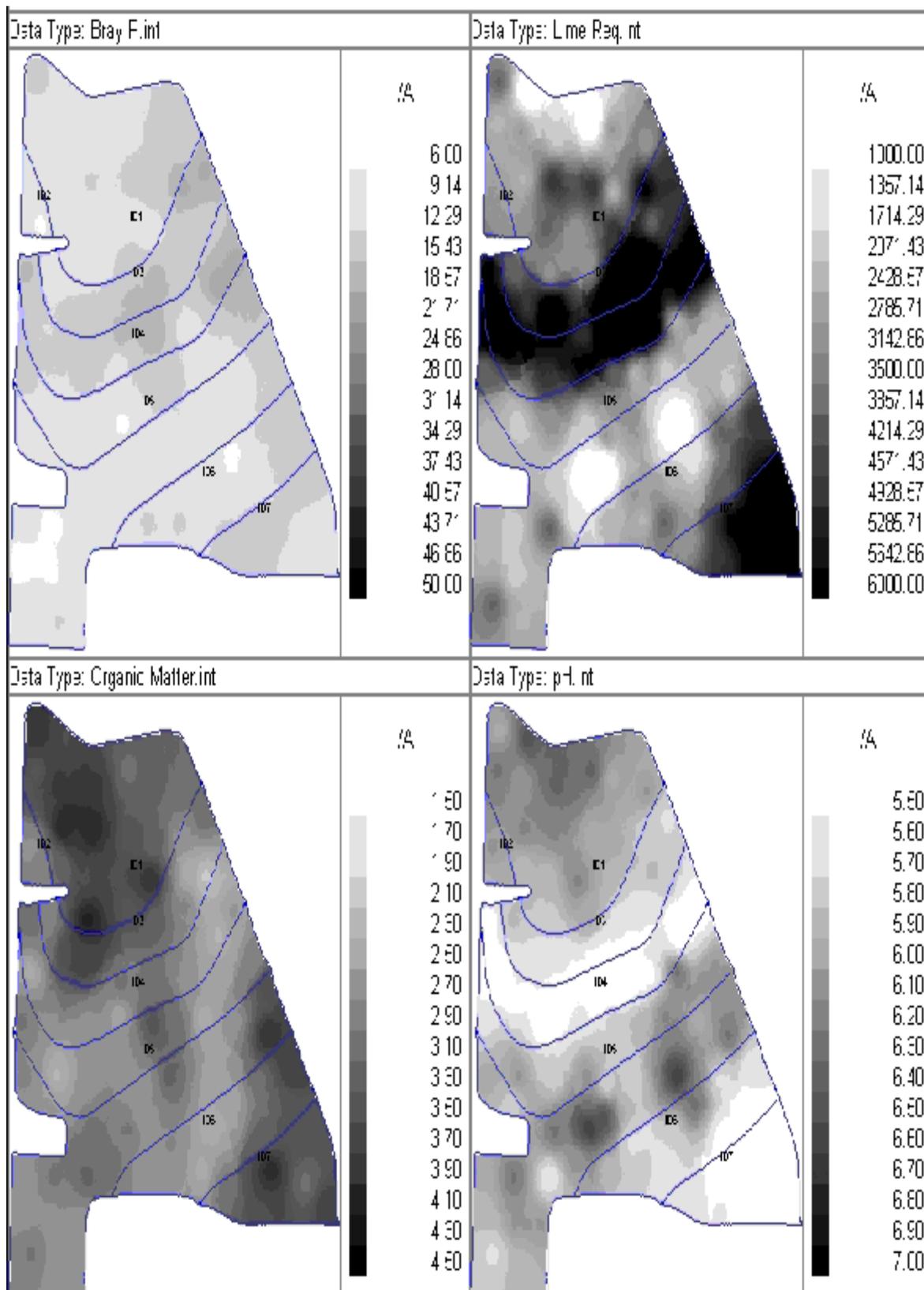


Figure 1. Interpolated soil test levels for Bray P, pH, organic matter, and lime requirements at the Precision Ag Research and Extension Site at the Cornbelt Experiment Field, Powhattan, KS. Soil samples were taken on May 29, 1998.

# STARTER FERTILIZER FOR NO-TILL CORN PRODUCTION

Scott A. Staggenborg, Brian H. Marsh, Larry D. Maddux, and David A. Whitney

## Summary

This no-till corn study was initiated to compare phosphorus (P) sources, rates, and methods of application at the Cornbelt Experiment Field. On this low-P testing soil, the highest yields were obtained from 10-34-0 at 30 lb/a of  $P_2O_5$  placed 2x2 or dual placed with anhydrous ammonia and 6-24-6 at 8 lb/a of  $P_2O_5$  in direct seed contact. These three treatments gave significantly higher yields than 30 lb/a of  $P_2O_5$  broadcast (no incorporation) and 8 lbs/a of  $P_2O_5$  with the seed. Phosphorus fertilizer broadcast and not incorporated was not effective in increasing yield. The data clearly show that placement was critical in getting a response. We hope to repeat this study in 1999.

## Introduction

No-till planting of corn and other spring-planted crops often takes place when the seedbed is cool and wet, raising questions about the needs for starter fertilizer. Research at the North Central Experiment Field has shown good response to starter fertilizer by corn and grain sorghum even on soil testing medium or higher in available phosphorus (P). The research also has shown that magnitude of response to the starter has varied among hybrids. The N-P ratio in the starter also has been a factor. Application of starter in direct seed contact using relatively low rates has been promoted by some companies. This study was initiated to evaluate direct seed placement of three P fertilizer materials and to compare direct seed placement to other methods of application.

## Procedures

The study was established at the Cornbelt Experiment Field near Powhattan on a Grundy silty clay loam soil. The site was in soybeans in 1997, and the corn hybrid DeKalb DK595 was no-till planted on May 5 at 24,000 seeds/a. A soil sample taken prior to planting showed pH of 5.9, Bray P-1 test of 7 ppm (low), and exchangeable K of 162 (H to VH). Weed control was handled by the experiment field technicians. The P sources used were all liquids - ammonium polyphosphate 10-34-0 and two Alpine products, 9-18-9 and 6-24-6. The three products were used in treatments applied in direct seed contact to supply 8 lb/a of  $P_2O_5$ . No attempt was made to balance N and  $K_2O$  supplied in the starter, but all treatments, except the no fertilizer check, were balanced for total N application at 120 lb/a using anhydrous ammonia applied after planting. In addition to the with-seed starter treatments, 10-34-0 was applied to supply 30 lb/a of  $P_2O_5$  either 2x2, broadcast, or dual placed with the anhydrous ammonia. Plots were four 30 in. rows by 30 ft replicated three times. Plots were harvested at maturity using a plot combine, and yields were adjusted to 15.5% moisture.

## Results

A tremendous response was obtained to N fertilization (Table 7). Although stand counts were not taken, the direct seed placement of P had no obvious visual effect on emergence or stand. This was not unexpected; because all these treatments included less than 10 lb/a of N plus  $K_2O$  in

direct seed contact, which is within current K-State guidelines for this method. The highest yields were obtained from the 10-34-0 dual and 2x2 placements and 6-24-6 in direct seed contact. These treatments gave significantly better yields than the broadcast

10-34-0 (not incorporated) and 8 lb/a of P<sub>2</sub>O<sub>5</sub> placed with the seed as 10-34-0. The data clearly show that starter or dual placement of the P is needed to expect a response on this low testing soil.

Table 7. Effects of phosphorus placement, rate, and source on corn yields at the Cornbelt Experiment Field, Powhattan, KS, 1998.

Rate		P Source	P Placement	Grain Yield
N*	P <sub>2</sub> O <sub>5</sub>			
lb/a		bu/a		
0	0	--	--	34
120	0	--	--	116
120	30	10-34-0	B'cast	111
120	30	10-34-0	Dual	133
120	30	10-34-0	2x2**	134
120	23	10-34-0	with seed	122
120	8	10-34-0	with seed	113
120	8	9-18-9	with seed	122
120	8	6-24-6	with seed	134
LSD (.05)				18

\* Anhydrous ammonia used as N source to balance treatments to 120 lb/a of N

\*\* A 30-30-0 UAN/10-34-0 starter used

# EAST CENTRAL KANSAS EXPERIMENT FIELD

## Introduction

The research program at the East Central Kansas Experiment Field is designed to enhance the area's agronomic agriculture. Specific objectives are: (1) to identify the top performing varieties and hybrids of wheat, corn, grain sorghum, soybean, oat, and canola; (2) to determine the amount of tillage necessary for optimum crop production; (3) to evaluate weed control practices using chemical, nonchemical, and combination methods; and (4) to test fertilizer rates and placement methods for crop efficiency and environmental effects.

## Soil Description

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

## 1998 Weather Information

Precipitation during 1998 totaled 49.17 inches, which was 11.56 inches above the 30-yr average (Table 1). Most of the extra moisture occurred during the later part of the growing season. Rainfall during August, September, October, and November exceeded normal rainfall by 14 inches. May was dry, with less than half the normal rainfall. Overall, moisture availability during the 1998 growing season was favorable.

The coldest temperatures in 1998 occurred in January, March, and December, with 10 days in the single digits or below. The very coldest day all year was December 22 when temperature was -2EF. The growing season was overall on the warm side, with 53 days exceeding 90 degrees. The hottest day was on July 20, when temperature reached 100 degrees.

The length of the 1998 growing season was longer than normal, with 207 frost-free days compared with the 185-day average. The last temperature 32EF or lower in the spring was on April 17 (average, April 18), and the first killing frost in the fall was on November 11 (average, October 21).

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

Month	1998	30-Year Avg.	Month	1998	30-Year Avg
January	0.67	1.00	July	3.82	3.66
February	0.93	1.22	August	5.29	3.63
March	4.07	2.67	September	9.14	3.91
April	3.38	3.47	October	6.78	3.56
May	2.32	5.23	November	6.61	2.54
June	4.68	5.24	December	1.48	1.48
Annual Total				49.17	37.61

# PERFORMANCE TRIAL OF DOUBLE-CROP SOYBEAN VARIETIES

Keith A. Janssen and Gary L. Kilgore

## Summary

Nine soybean varieties were evaluated for double-crop performance during 1998. Maturity groups were III, IV, and V. Growing conditions were not as favorable as in the past several years. Grain yields ranged from 9 to 16 bu/a. Group V maturities had the highest average yields because of an extended frost-free growing season.

## Introduction

Double-cropped soybean is a potentially profitable crop for east-central Kansas. However, it can be risky because of extremes of moisture at planting, dry summer conditions, and possible early frost. In the past, variety selection has been based mainly on full-season variety performance. This study evaluates soybean variety performance under double-crop conditions. Generally, soybean varieties that make the fullest use of the double-crop season, endure heat and moisture stress, set first pods fairly high, and tolerate cool night temperatures perform best.

## Procedures

In 1998, nine soybean varieties were evaluated for double-crop performance. The soybean varieties were planted following winter wheat on July 9 in 7-inch wide rows with a no-till drill. The wheat straw was burnt before planting to facilitate soil drying and planting. Soil at planting was still fairly

wet, which resulted in some hairpinning of the remaining straw and occasional poor closure in the row. As a result, some unevenness in stands occurred. No herbicides were applied for weed control. However, burning the straw adequately controlled volunteer wheat and weeds. Rainfall amounts after planting were: July 2.53 in., August 5.29 in., September 9.14 in.; and October 6.78 in. Rainfall during the July through October double-crop season exceeded normal amounts by 10.27 inches. The first frost was on November 11, nearly 3 weeks later than normal. Wet soil delayed harvest until the ground froze. Harvest was on December 31. There was no evidence of shattering.

## Results

Soybean yields ranged from 9 to 16 bu/a with a test average of 11 bu/a (Table 2). This was a 10 bu/a lower yield than in 1997 and 11 bu/a lower yield than in 1996. Soybean plant height in 1998 was shorter compared to the previous 2 years. Plant heights varied with variety from 16 to 20 inches. Pod height ranged from 2.5 to 4.5 inches. The group V soybean varieties, Manokin and KS5292, produced the highest yields. This was because of an unusually long frost-free growing season. Normally, group V soybean varieties are limited by frost. The soybean maturity groups that typically have performed best for the east-central part of Kansas have been late group III, IV, and possibly very early group V varieties.

Table 2. Double-crop soybean variety performance test, East Central Kansas Experiment Field, Ottawa, KS.

Variety	Maturity Group	Yield			1998		
		1998	2-yr Avg	3-yr Avg	Maturity <sup>1</sup>	Plant Height	Pod <sup>2</sup> Height
		bu/a @ 13%			month/day	inch	inch
Dyna-Gro DG-3395	III	8.8	--	--	10-14	16	2.5
Dyna-Gro DG-3444N	IV	9.0	--	--	10-29	16	3.2
Flyer	IV	9.3	15.4		10-18	17	3.0
KS4694	IV	10.7	17.2	18.3	10-17	17	2.5
KS5292	V	16.4	17.0	18.3	11-02	20	4.5
Manokin	V	16.3	18.6	19.3	10-29	20	4.2
Pioneer 93B71	III	9.6	--	--	10-12	17	2.5
Pioneer 93B82	III	8.7	--	--	10-13	16	2.5
Pioneer 9421	IV	11.4	16.2	--	10-20	17	3.2
LSD 0.05		2.9			2.0	2	0.6
CV %		18.0			6.7	7.0	12.4

<sup>1</sup>Maturity is the date on which 95% of the pods have ripened (browned).

<sup>2</sup>Distance from the ground to the bottom of the lowest pod.

# EFFECTS OF SUBSOILING ON YIELD OF CORN AND SOYBEAN

Keith A. Janssen

## Summary

Questions are being raised about the benefits of deep tillage on claypan soils. The effects of subsoil ripping, shallower chisel plowing, and no preplant tillage are being evaluated on corn and soybean at the East Central Experiment Field. Corn yields for 1998 ranged from 101 to 119 bu/a. Soybean yields ranged from 40 to 44 bu/a. Tillage effects on corn were not statistically significant. Soybean yields were lower for no-till and the every-third-year subsoil treatment compared with the more frequent subsoil and chisel treatments. Averaged over 3 years, all tilled soybean have 2-3 bu/a higher yield than no-till. For corn, no-till has performed nearly as well as the most frequent deep tillage treatments. Rainfall has been in excess of normal in all years of this study. This might be limiting some of the yield benefits of sub-soiling. More years of testing are needed under drier conditions to fully measure the benefits of subsoiling.

## Introduction

Extensive acreages of soils in the east-central and southeast areas of Kansas have dense clay subsoils. These slowly permeable clay subsoils restrict drainage, limit depth of rooting, and limit crop-available moisture. As a result, crop yields are affected negatively. Various deep tillage practices have been used to loosen these claypan soils. Some farmers deep chisel or subsoil their fields every year, others every other year, and some on a less regular basis. The benefits from these various tillage operations have not been fully evaluated. The clay in these soils is predominantly montmorillonite, which expands and contracts with wetting and drying. Also, in most winters, freeze-and-thaw cycles loosen these soils to a depth of 6 to 8 inches or more.

These shrink-swell, freeze-thaw processes should alleviate much of the surface compaction that results from fertilization, planting, spraying, and harvesting. Consequently, the need for deep tillage is being questioned. Another question is whether some crops are affected more than others by deep tillage. This study evaluates various frequencies of subsoil tillage with shallower chisel plow and no preplant tillage for effects on corn and soybean yields.

## Procedures

The experiment was started in 1996. Tillage treatments were no preplant tillage; chisel plowing every year (5-7 in. depth); and subsoil tillage at 8-12 in. depth yearly, every other year, and every 3 years. Treatments were established in two blocks, one for corn and one for soybean. Subsoil and chisel treatments were performed on November 26, 1997 for the 1998 growing season. All plots, except the no-till plots, were field cultivated before planting. Also, all plots were row-crop cultivated once for weed control. Corn (Pioneer 3563) was planted on May 8, 1998 and soybean (KS4694) on June 15, 1998. A mixture of 28-0-0 and 7-21-7 liquid fertilizer was coultter knifed on April 21, 1998 to provide 100 lb N, 34 lb P<sub>2</sub>O<sub>5</sub> and 11 lb K<sub>2</sub>O/a for corn. No fertilizer was applied for soybean.

## Results

The 1998 corn grain yields ranged from 101 to 119 bu/a, with a test average of 111 bu/a (Table 3). Although numerically different, the tillage effects on corn yield were not statistically significant. Yields averaged over 3 years show smaller and

nonconsistent yield differences. No symptoms of N deficiency were seen in the no-till corn in 1998 as were observed in 1996. In 1997, we increased the N rate for all treatments.

Soybean yields for 1998 ranged from 30.4 to 38.2 bu/a, with a test average of 35 bu/a. Soybean yield was affected by the tillage treatments. Yields were lower for no-till and the every-third-year subsoil treatments compared to the other treatments. These lower yields may have resulted from less large pore space in soil and more saturated soil conditions with no tillage. Past tillage studies has indicated that soybean is sensitive to wet conditions and lack of oxygen in the soil during pod fill. Rainfall during the 1998 growing season was 11.56 inches above normal. Most of this extra rainfall occurred during the soybean pod development period.

To date, the results from this study suggest that subsoil tillage is having only a small effect on yield. At most, the yield increases are enough to offset the cost of operation. Soybean appears to be more sensitive to tillage than corn. These results have been obtained under conditions of above-normal moisture, so the effects of subsoiling may be different under drier conditions. Additional years of testing with more normal moisture are needed to fully determine the effects of subsoiling. We plan to repeat this study in 1999.

### Acknowledgment

Appreciation is expressed to John Wray, Ottawa, KS for providing the tractor and subsoiler for establishing the subsoil treatments.

Table 3. Subsoiling effects on corn and soybean yields, East Central Kansas Experiment Field, Ottawa, KS.

Tillage System and Frequency	Yield			
	Corn		Soybean	
	1998	3-Yr Avg	1998	3-Yr Avg
	bu/a			
No-till <sup>1</sup>	113	126	30.4	40.0
Chisel <sup>2</sup> (every year)	108	128	36.2	42.7
Subsoil <sup>3</sup> (every year)	119	135	38.2	43.4
Subsoil (every other year)	101	127	37.0	43.7
Subsoil (every third year)	117	135	33.3	42.4
LSD.05	ns		2.45	
CV %	7.6		4.5	

<sup>1</sup>With one in-season cultivation.

<sup>2</sup>5-7 inch depth.

<sup>3</sup>8-10 inch depth.

# CROP RESIDUE REMOVAL AND FERTILIZER EFFECTS ON CROP YIELD AND SOIL SUSTAINABILITY

Keith A. Janssen and David A. Whitney

## Summary

Research was continued during 1998 to measure the long-term (18th year) effects of removal and return of varying levels of crop residues on crop yield and soil properties in a soybean-wheat-grain sorghum/corn rotation, fertilized with different levels of N, P, and K. In 1998, the residue treatments caused no statistically significant differences in grain or residue yields. Soybean grain yields, averaged across all fertilizer treatments, was 46.7 bu/a with residue removed, 47.2 bu/a with normal residue incorporated, and 46.2 bu/a with 2X normal residue incorporated. The fertilizer treatments (zero, low, normal, and high levels of N, P, and K) produced statistically significant yield differences. Yields of soybean, averaged across all residue treatments, ranged from 44.0 bu/a at the zero fertilizer rate to 49.5 bu/a at the highest level of fertilizer. Soil analyses showed that soil pH, exchangeable K, and soil organic matter are declining with crop residue removal.

## Introduction

Crop residues are being considered as a source of raw materials for various non-agricultural uses. But crop residues also are needed for soil erosion protection and to replenish organic matter in the soil. Grain producers currently harvest crop residues for livestock feed or other farm uses. Generally, this is not done every year from the same field. Also, some of these plant materials may be returned as animal wastes. With nonagricultural uses, this likely would not be the situation and the probability for more frequent harvests would increase. Harvesting crop residues continually would remove larger amounts of plant nutrients and accelerate the loss of soil organic matter. The

effects of fertilizer management in offsetting these losses is not well understood.

This study was established to determine the long-term effects of removal and additions of varying levels of crop residues on crop yields and soil properties in a soybean-wheat-grain sorghum/corn rotation, fertilized with variable rates of nitrogen (N), phosphorus (P), and potassium (K).

## Procedures

This study was established in the fall of 1980 on a nearly level, nonerosive (0-1% slope), Woodson silt loam soil at the East Central Kansas Experiment Field. The residue treatments were: (1) crop residue removed annually, (2) normal residue incorporated, and (3) twice (2X) normal residue incorporated (accomplished by evenly spreading the residue from the residue removal treatments). Superimposed over the residue treatments were fertilizer treatments; zero, low, normal, and high levels of N-P-K fertilizer as listed in Table 4. The cropping sequence was a soybean, wheat, grain sorghum rotation with corn substituted for grain sorghum beginning in 1994. Only one crop was grown each year. Grain yields and residue yields were measured each year. Soil samples (0 to 2-inch depth) were collected for chemical analysis after the 16th year.

## Results

Grain yields and residue yields are summarized in Tables 5 and 6 for the first 9 years of the study and in Tables 7 and 8 for the second 9 years. On the whole, no interaction ( $P < 0.05$ ) between the residue and

fertilizer treatments affected grain or residue yields. Consequently, only main effects of the treatments are presented.

Grain yields and residue yields varied with crop and year. Soybean yields ranged from 12 to 54 bu/a, with residue yields ranging from 0.29 to 1.08 tons/a; wheat yields ranged from 12 to 60 bu/a, with residue yields ranging from 0.50 to 1.98 tons/a; and grain sorghum and corn yields ranged from 47 to 136 bu/a, with residue yields ranging from 1.04 to 2.87 tons/a. These differences verify that crop residue yields, like those of grain, vary substantially with growing seasons.

The residue treatments, with the exception of 1987, caused no differences in grain or residue yield for any crop in any year. Neither the annual removal of crop residue nor the addition of 2X normal crop residue had a significant effect on grain or residue yields. In 1987, less residue yield was recorded for the 2X normal residue treatment than with normal residue. This may have been the result of nonuniform hail damage rather than an effect of treatment. Summed over all years, the totals of all grain and residue yields for all residue treatments differ by less than 2.5%. In contrast, the fertilizer treatments significantly affected grain and residue yields almost every year. Highest grain and residue yields were produced with the normal and high fertilizer treatments, and the lowest grain and residue yields with the zero and low fertilizer treatments. The normal and high fertilizer levels increased grain and residue yields on average 31% over no fertilizer. These data confirm that well fertilized crops will benefit not only in grain yield, but also in increased residue production.

Soil properties after the 16th year of residue and fertilizer treatments are shown in

Table 9. Unlike grain and residue yields, soil properties were affected significantly by the residue treatments. Soil pH, exchangeable K, and organic matter decreased with crop residue removal. Soil exchangeable K was affected the most. The removal of crop residue depleted exchangeable K in the soil by nearly 20%. Doubling crop residue increased exchangeable K by nearly the same amount. This is because of the high K content in crop residue.

Soil organic matter decreased with crop residue removal. Doubling crop residue increased soil organic matter. The fertilizer treatments caused the expected changes in soil properties. Soil pH decreased with fertilizer application. Available P, exchangeable K, and organic matter increased with fertilizer application.

These data suggest that on similar soils and with similar climate, and where crop residues are not needed for soil erosion protection, the occasional harvest of crop residues likely will have minimal impact on grain production. However, very long-term, continuous removal of crop residues remains questionable as a sustainable practice. It could cause further decreases in soil organic matter and eventually impact yield. The time line for this to occur is difficult to predict. The change resulting from removal of crop residue is a very slowly occurring process, which could take many years before stabilizing at a new level of equilibrium. With different environments and soil conditions, the effects of removing crop residues could be much different. This soil was initially quite high in soil organic matter and had high levels of fertility. Soil with lower organic matter and lower fertility likely would be affected more quickly by crop-residue removal.

Table 4. N-P-K fertilizer treatments for crops in rotation, East Central Kansas Experiment Field, Ottawa, KS.

Fertilizer treatments	Crop and Fertilizer Rate		
	Soybean	Wheat	Grain sorghum/corn
	N-P <sub>2</sub> O <sub>2</sub> -K <sub>2</sub> O		
	lbs/a		
Zero	0-0-0	0-0-0	0-0-0
Low	0-0-0	40-15-25	40-15-25
Normal	0-0-0	80-30-50	80-30-50
High	0-0-0	120-45-75	120-45-75

Table 5. Mean effects of crop residue and fertilizer treatments on grain yields (1981-1989), East Central Kansas Experiment Field, Ottawa, KS.

Treatment	Soy '81	Wht '82	GS '83	Soy '84	Wht '85	GS '86	Soy '87	Wht '88	GS '89	9-yr Total
	bu/a									
<u>Residue</u>										
Removed	52	29	52	13	51	58	23	47	92	417
Normal	53	30	54	14	49	56	22	49	93	420
2X normal	54	28	55	14	50	57	22	49	89	418
L.S.D. 0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS	
<u>Fertilizer</u>										
Zero	53	23	51	13	38	47	22	39	84	370
Low	53	29	54	12	47	56	22	48	94	415
Normal	53	30	54	13	55	62	22	51	92	432
High	53	34	55	16	60	63	23	56	96	456
L.S.D. 0.05	NS	4	NS	2	3	4	NS	3	5	

Table 6. Mean effects of crop residue and fertilizer treatments on residue yields (1981-1989), East Central Kansas Experiment Field, Ottawa, KS.

Treatment	Soy '81	Wht '82	GS '83	Soy '84	Wht '85	GS '86	Soy '87	Wht '88	GS '89	9-yr Total
tons/a										
<u>Residue</u>										
Removed	0.55	1.14	1.12	0.35	1.30	1.13	0.86	1.43	2.59	10.47
Normal	0.62	1.12	1.11	0.34	1.16	1.14	0.81	1.49	2.70	10.49
2X normal	0.64	1.19	1.11	0.33	1.14	1.16	0.74	1.48	2.68	10.47
L.S.D. 0.05	NS	NS	NS	NS	NS	NS	0.06	NS	NS	
<u>Fertilizer</u>										
Zero	0.60	1.04	1.04	0.33	0.87	1.11	0.75	0.89	2.34	8.97
Low	0.60	1.08	1.18	0.29	1.04	1.17	0.80	1.36	2.77	10.29
Normal	0.60	1.19	1.13	0.33	1.51	1.11	0.83	1.65	2.64	10.99
High	0.60	1.30	1.11	0.41	1.39	1.18	0.85	1.98	2.87	11.69
L.S.D. 0.05	NS	0.11	NS	0.08	0.27	NS	0.06	0.12	0.17	

Table 7. Mean effects of crop residue and fertilizer treatments on grain yields (1990-1998), East Central Kansas Experiment Field, Ottawa, KS.

Treatment	Soy '90	Wht '91	G.S. '92	Soy '93	Corn '94	Wht '95	Soy '96	Corn '97	Soy '98	18-yr Total
bu/a										
<u>Residue</u>										
Removed	29	34	128	21	104	21	42	89	47	1071
Normal	29	37	127	22	108	19	46	88	47	1085
2X normal	27	39	130	21	107	17	48	82	46	1073
L.S.D. 0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS	
<u>Fertilizer</u>										
Zero	27	26	120	19	89	12	43	46	44	919
Low	28	35	123	20	103	17	43	76	46	1048
Normal	28	41	135	22	114	22	47	99	47	1130
High	30	44	136	25	120	24	48	123	50	1208
L.S.D. 0.05	1	2	7	2	5	2	2	9	2	

Table 8. Mean effects of crop residue and fertilizer treatments on residue yields (1990-1998), East Central Kansas Experiment Field, Ottawa, KS.

Treatment	Soy '90	Wht '91	G.S. '92	Soy '93	Corn '94	Wht '95	Soy '96	Corn '97	Soy '98	18-yr total
tons/a										
<u>Residue</u>										
Removed	0.54	0.92	1.80	0.38	1.63	1.22	0.48	1.46	1.00	23.92
Normal	0.54	1.00	1.85	0.39	1.73	1.22	0.52	1.49	1.03	24.45
2X normal	0.47	1.04	1.92	0.39	1.56	1.24	0.54	1.39	1.03	24.21
L.S.D. 0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS	
<u>Fertilizer</u>										
Zero	0.50	0.65	1.83	0.34	1.38	0.50	0.46	1.09	0.95	19.90
Low	0.50	0.93	1.74	0.35	1.46	1.02	0.52	1.35	0.97	23.26
Normal	0.52	1.10	1.95	0.40	1.91	1.71	0.53	1.57	1.07	26.04
High	0.55	1.27	1.90	0.45	1.81	1.67	0.54	1.78	1.08	27.59
L.S.D. 0.05	0.04	0.11	0.17	0.03	0.26	0.16	0.04	0.19	0.06	

Table 9. Mean soil test values after 16 years of residue and fertilizer treatments, East Central Kansas Experiment Field, Ottawa, KS.

Treatment	Soil pH	Soil Available P	Soil Exchangeable K	Soil Organic Matter	Soil NO <sub>3</sub> -N
		ppm	ppm	%	ppm
<u>Residue</u>					
Removed	6.0	29	163	3.0	33
Normal	6.1	30	201	3.3	27
2X Normal	6.2	37	249	3.7	21
L.S.D.)05	0.1	2	20	0.2	NS
<u>Fertilizer</u>					
Zero	6.4	23	147	3.0	27
Low	6.2	26	177	3.3	26
Medium	6.0	36	236	3.5	30
High	5.8	42	259	3.5	26
L.S.D. 0.05	0.1	3	22	0.2	NS

# HARVEY COUNTY EXPERIMENT FIELD

## Introduction

Research at the Harvey County Experiment Field deals with many aspects of dryland crop production on soils of the Central Loess Plains and Central Outwash Plains of central and south central Kansas and is designed to benefit directly the agricultural industry of the area. Focus is primarily on wheat, grain sorghum, and soybean, but also includes alternative crops such as corn and oats. Investigations include variety and hybrid performance tests, chemical weed control, tillage methods, fertilizer use, and planting practices, as well as disease and insect resistance and control.

## Soil Description

The Harvey County Experiment Field consists of two tracts. The headquarters tract, 75 acres immediately west of Hesston on Hickory St., is all Ladysmith silty clay loam with 0-1% slope. The second tract, located 4 miles south and 2 miles west of Hesston, is comprised of 142 acres of Ladysmith, Smolan, Detroit, and Irwin silty clay loams, as well as Geary and Smolan silt loams. All have 0-3% slope. Soils on the two tracts are representative of much of Harvey, Marion, McPherson, Dickinson, and Rice Counties, as well as adjacent areas.

These are deep, moderately well to well-drained, upland soils with high fertility and good water-holding capacity. Water run-off is slow to moderate. Permeability of the Ladysmith, Smolan, Detroit, and Irwin series is slow to very slow, whereas permeability of the Geary series is moderate.

## 1997-1998 Weather Information

The wheat growing season began with ample fall rains that ensured the development of good stands. Precipitation remained above normal from December through March. April brought normal rainfall, before a much drier period set in during grain filling. Fall wheat growth was affected by below-normal temperatures, particularly cold in mid-November. Minimum temperatures averaged 6 °F above normal during December, January, and February. Monthly maximum and minimum temperature averages were well below normal in March and April but above normal thereafter. Dry weather and warm temperatures in May and June reduced a potentially very high wheat yield. Wheat diseases generally were minimal.

Spring rains caused planting delays in some row crop experiments and stand reductions in others as a result of severe soil crusting. The prominent weather features of the row crop season were excellent early growing conditions following emergence, mid-season drouth, abundant late-season rains, and the absence of a fall frost.

Very dry conditions throughout August and the first 18 days of September coincided with high temperatures that reached or exceeded 100° F on 9 days during this period. As a result, soybean seed development terminated early in some experiments and grain filling was affected adversely in sorghum as well.

Frost occurred last in the spring on April 17 and first in the fall on November 10. This frost-free season of 207 days was about 39 days longer than normal.

Table 1. Monthly precipitation totals, inches - Harvey Co. Experiment Field, Hesston, KS.<sup>1</sup>

Month	N Unit	S Unit	Normal	Month	N Unit	S Unit	Normal
	1997				1998		
October	3.12	3.39	2.55	March	3.67	3.18	2.42
November	0.24	0.58	1.73	April	2.73	2.86	2.71
December	2.43	2.51	1.16	May	1.36	1.76	4.41
				June	3.58	3.15	4.67
	1998			July	4.07	6.79	2.90
January	1.16	1.03	0.67	August	0.32	0.61	3.11
February	0.40	0.44	0.87	September	5.30	5.63	3.63
Twelve-month total					28.38	31.93	30.83
Departure from normal					-2.45	1.10	

<sup>1</sup> Hairy vetch cover crop studies, the grain sorghum cold tolerance study, and soybean weed control experiments were located at the South Unit. All other on-station experiments reported here were conducted at the North Unit.

# REDUCED TILLAGE AND CROP ROTATION SYSTEMS WITH WHEAT, GRAIN SORGHUM, CORN, AND SOYBEAN

Mark M. Claassen

## Summary

Tillage system effects on continuous wheat, continuous grain sorghum, and annual rotations of wheat with row crops were investigated. Despite less cheat control in no-till, tillage systems had no significant effect on continuous wheat yield. Prior tillage for row crop did not meaningfully affect no-till wheat in rotations. Soybean and corn rotations improved wheat yields by an average of 6.5 bu/a in comparison with continuous wheat. Wheat after grain sorghum produced yields comparable to those of continuous wheat. Tillage systems did not meaningfully affect yields of continuous sorghum or row crops in rotation with wheat. However, wheat rotation increased sorghum yields by 10.7 bu/a.

## Introduction

Crop rotations facilitate reduced-tillage practices, while enhancing control of diseases and weeds. Long-term research at Hesston has shown that winter wheat and grain sorghum can be grown successfully in an annual rotation. Although subject to greater impact from drought stress than grain sorghum, corn and soybean also are viable candidates for crop rotations in central Kansas dryland systems that conserve soil moisture. Because of their ability to germinate and grow under cooler conditions, corn and soybean can be planted earlier in the spring and harvested earlier in the fall than sorghum, thereby providing opportunity for soil moisture replenishment as well as a wider window of time within which to plant the succeeding wheat crop. This study was initiated at Hesston on Ladysmith silty clay loam to evaluate the consistency of corn and soybean production versus grain sorghum in

an annual rotation with winter wheat and to compare these rotations with monoculture wheat and grain sorghum systems.

## Procedures

Three tillage systems were established for continuous wheat; two for each row crop (corn, soybean, and grain sorghum) in annual rotation with wheat; and two for continuous grain sorghum. Each system, except no-till, included secondary tillage as needed for weed control and seedbed preparation. Wheat in rotations was planted after each row-crop harvest without prior tillage. The following procedures were used.

### Wheat after corn

WC-NTV = No-till after V-blade  
(V-blade, sweep-treader, mulch treader)  
for corn

WC-NTNT = No-till after No-till corn

### Wheat after sorghum

WG-NTV = No-till after V-blade  
(V-blade, sweep-treader, mulch treader)  
for sorghum

WG-NTNT = No-till after No-till sorghum

### Wheat after soybean

WS-NTV = No-till after V-blade  
(V-blade, sweep-treader, mulch treader)  
for soybean

WS-NTNT = No-till after No-till soybean

### Continuous wheat

WW-B = Burn (burn, disk, field cultivate)  
WW-C = Chisel (chisel, disk, field  
cultivate)

WW-NT = No-till

### Corn after wheat

CW-V = V-blade (V-blade, sweep-treader, mulch treader)

CW-NT = No-till

### Sorghum after wheat

GW-V = V-blade (V-blade, sweep-treader, mulch treader)

GW-NT = No-till

### Soybean after wheat

SW-V = V-blade (V-blade, sweep-treader, mulch treader)

SW-NT = No-till

### Continuous sorghum

GG-C = Chisel (chisel, sweep-treader, mulch treader)

GG-NT = No-till

Continuous wheat no-till plots were sprayed on August 1, September 1, and October 21 with Roundup Ultra + ammonium sulfate (AS). Roundup Ultra rates were 1 qt/a, 1 pt/a, and 1 pt/a, respectively, in combination with 2.6 lb/a or 3.4 lb of AS. Variety 2137 was planted on October 22 in 8 in. rows at 90 lb/a with a CrustBuster no-till drill equipped with double disk openers. Wheat was fertilized with 120 lb N/a and 32 lb P<sub>2</sub>O<sub>5</sub>/a, applied as preplant, broadcast ammonium nitrate and in-furrow diammonium phosphate at planting. No herbicides were required for broadleaf weed control in wheat during the growing season. Wheat was harvested on June 27, 1998.

No-till corn after wheat plots received the same Roundup treatments as WW-NT in early August and September. CW-NT plots also were sprayed with 1 lb ai/a atrazine in late October for control of cheat and winter annual broadleaf weeds. Because of wet soil, weeds were controlled in CW-V plots by mowing, Roundup + 2,4-D application, and fall chiseling. Two spring tillage operations with a mulch treader

controlled remaining weeds and prepared the seedbed. Corn was fertilized with 111 lb/a N as ammonium nitrate broadcast prior to planting. An additional 14 lb/a N and 37 lb/a P<sub>2</sub>O<sub>5</sub> were banded 2 inches from the row at planting. A White no-till planter with double-disk openers on 30-in. centers was used to plant Golden Harvest H-2404 at approximately 23,000 seeds/a on April 14, 1998. Weeds were controlled with a preemergence application of Partner 65 DF + AAtrex 90 DF (3.85 + 0.28 lb/a). Row cultivation was not required. Corn was harvested on September 9.

Plots of no-till sorghum after wheat were treated with Roundup Ultra as noted for WW-NT, with a subsequent fall application of 1.1 lb/a AAtrex 90 DF and with a spring preplant application of 1 pt/a Roundup Ultra. GG-NT plots were sprayed with Roundup Ultra + 2,4-D<sub>LVE</sub> + AS (1 qt/a + 0.33 pt/a + 3.4 lb/a) just prior to planting. GW-V plots were managed like CW-V areas during the fallow period between wheat harvest and mid-April. A sweep-treader was used for the final preplant tillage operation in GW-V. GG-C plots were tilled once each with a chisel, mulch treader, and a sweep-treader between crops. Sorghum was fertilized like corn, but with 115 lb/a total N. Pioneer 8500 treated with Concep III safener and Gaucho insecticide was planted at 38,100 seeds/a in 30-inch rows on May 14. Preemergence application of Partner 65 DF at 3.85 lb/a + AAtrex 90 DF at 0.56 lb/a (rotation) or 1.1 lb/a (continuous sorghum) controlled weeds during the season without row cultivation.

Fallow weed control for no-till soybean after wheat consisted of Roundup Ultra + AS applications on August 1, September 1, April 17, and May 14. SW-V field procedures were basically the same as for GW-V. However, soybean received only starter fertilizer, and weeds were controlled after planting with preemergence Partner 65 DF + Scepter 70 DG (3.85 lb/a + 2.8 oz/a). Resnik soybeans were

planted at 8 seeds/ft in 30-in. rows on May 14 and harvested on September 8.

## Results

### Wheat

Crop residue covers after planting averaged 69, 75, and 47% in no-till wheat after corn, sorghum, and soybean, respectively (Table 2). In continuous wheat, residue cover ranged from 2% in burned plots to 68% with no-till. Wheat stands were good but slightly lower in WC-NTNT and WG-NTNT. Weed control was generally excellent. However, cheat control was somewhat poorer in WW-NT. Heading date tended to be delayed slightly in WC-NTNT, WG-NTNT, and WW-C, and more notably in WW-NT.

Precipitation pattern during the fall and winter months was favorable for wheat, particularly in rotations. Higher seeding rate and higher N rate for the 1998 crop contributed to less difference than previously noted between wheat following corn or soybean and wheat after sorghum or no-till continuous wheat. Whole-plant N in wheat did not differ significantly among rotations, but tended to be higher in continuous no-till than in no-till/ V-blade systems with sorghum and soybean. Wheat after soybean and corn produced the highest yields that were nearly equal. Yields of continuous wheat and wheat after sorghum did not differ. These systems produced an average of 42.5 bu/a, i.e., 6.5 bu/a less than the average for wheat following soybean or corn. Tillage system did not

significantly affect continuous wheat, wheat after sorghum, or wheat after soybean. Although WC-NTNT produced 6.5 bu/a more than WC-NTV, this was not considered meaningful in light of 1997 results. Test weights were comparable for most treatments. No-till continuous wheat had significantly lower test weight at least partly because of the presence of cheat.

### Row Crops

Crop residue covers for row crops following wheat averaged 33% for V-blade and 73% for no-till systems (Table 3). Tillage effects on corn were minor and of limited significance. A slight corn yield advantage for no-till versus V-blade systems was inconsistent with previous results.

Continuous sorghum as well as sorghum and soybean after wheat generally were not significantly affected by tillage system. The only exception was a delay in the number of days from planting to half bloom in no-till sorghum versus sorghum in chisel or V-blade systems. The delays averaged 2 and 5 days in sorghum after wheat and continuous sorghum, respectively.

Crop sequence significantly affected sorghum in several ways. In comparison with monoculture sorghum, rotation with wheat decreased the time to reach half bloom by 2 days, increased leaf N content, slightly increased the number of heads/plant, and increased yields by 10.7 bu/a.

Table 2. Effects of row crop rotation and tillage on wheat, Harvey County Experiment Field, Hesston, KS, 1998.

Crop Sequence <sup>1</sup>	Tillage System	Crop Residue Cover <sup>2</sup>	Yield <sup>3</sup>	Test Wt	Stand	Heading <sup>4</sup>	Plant N <sup>5</sup>	Cheat Control <sup>6</sup>
		%	bu/a	lb/bu	%	date	%	%
Wheat-corn (No-till)	V-blade	65	51.3	57.8	98	11	1.24	100
	No-till	72	44.8	57.7	96	13	1.23	97
Wheat-sorghum (No-till)	V-blade	76	42.5	58.0	98	12	1.13	100
	No-till	74	41.7	58.2	96	13	1.33	96
Wheat-soybean (No-till)	V-blade	46	48.8	57.8	99	11	1.17	100
	No-till	49	50.8	57.2	100	11	1.42	100
Continuous wheat	Burn	2	42.2	58.2	100	11	1.36	100
	Chisel	22	42.2	58.0	100	13	1.16	100
	No-till	68	44.0	56.6	98	14	1.22	86
LSD .05		6	5.5	0.66	2.0	1.0	NS	5
Main effect means:								
<u>Crop Sequence</u>								
Wheat-corn		69	48.0	57.8	97	12	1.24	98
Wheat-sorghum		75	42.1	58.1	97	12	1.23	98
Wheat-soybean		47	49.8	57.5	100	11	1.30	100
Continuous wheat		45	43.1	57.3	99	13	1.19	93
LSD .05		4	4.1	0.48	1.5	0.8	NS	3.5
<u>Rotation Tillage system</u>								
No-till/V-blade		62	47.5	57.9	99	11	1.18	100
No-till/no-till		65	45.7	57.7	97	12	1.33	97
LSD .05		NS	NS	NS	1.2	0.7	0.13	NS

<sup>1</sup> All wheat planted no-till after row crops. Crop sequence main effect means exclude continuous wheat-burn treatment. Tillage main effect means exclude all continuous wheat treatments.

<sup>2</sup> Crop residue cover estimated by line transect after planting.

<sup>3</sup> Means of four replications adjusted to 12.5% moisture.

<sup>4</sup> Date in May on which 50% heading occurred.

<sup>5</sup> Whole-plant N levels at late boot to early heading.

<sup>6</sup> Visual rating of cheat control in June.

Table 3. Effects of wheat rotation and reduced tillage on corn, grain sorghum, and soybean, Harvey County Experiment Field, Hesston, KS, 1998.

Crop Sequence	Tillage System	Crop Residue Cover <sup>1</sup>	Yield <sup>2</sup>	Test Wt	Stand	Maturity <sup>3</sup>	Ears or Heads/Plant	Leaf N <sup>4</sup>
		%	bu/a	lb/bu	1000's/a			%
Corn-wheat	V-blade	36	47.8	61.5	20.0	87	1.02	2.75
	No-till	73	52.0	61.8	20.0	83	0.98	2.56
LSD .05		17	NS	NS	NS	NS	NS	NS
LSD .15		--	3.9	NS	NS	NS	0.03	NS
Sorghum-wheat	V-blade	29	105.6	61.5	34.3	57	1.67	3.04
	No-till	68	108.1	61.7	35.9	59	1.66	3.07
Contin. sorghum	Chisel	38	97.6	61.7	36.2	59	1.45	2.93
	No-till	78	94.6	61.5	31.1	64	1.53	2.83
LSD .05 <sup>5</sup>		11	11.6	NS	NS	1.8	NS	0.11
LSD .15 <sup>5</sup>		--	----	NS	NS	--	0.18	----
Soybean-wheat	V-blade	31	22.2	----	----	112	----	----
	No-till	70	21.8	----	----	112	----	----
LSD .05		9	NS			NS		
LSD .15		--	NS			NS		
Main effect means for sorghum:								
<u>Crop sequence</u>								
	Sorghum-wheat	48	106.8	61.6	35.1	58	1.66	3.06
	Contin. sorghum	58	96.1	61.6	33.6	61	1.49	2.88
	LSD .05	8	8.2	NS	NS	1.3	NS	0.08
	LSD .10	--	---	NS	NS	---	0.15	----
<u>Tillage system</u>								
	V-blade/chisel	33	101.6	61.6	35.3	58	1.56	2.99
	No-till/no-till	73	101.3	61.6	33.5	62	1.59	2.95
	LSD .05	8	NS	NS	NS	1.3	NS	NS
	LSD .10	--	NS	NS	NS	---	NS	NS

<sup>1</sup> Crop residue cover estimated by line transect after planting.

<sup>2</sup> Means of four replications adjusted to 12.5% moisture (corn, sorghum) or 13% moisture (soybean).

<sup>3</sup> Maturity expressed as follows: corn - percentage of plants silked on June 26; grain sorghum - number of days from planting to half bloom; soybean - number of days from planting to occurrence of 95% mature pod color.

<sup>4</sup> Corn upper ear leaf at late silking, sorghum flag leaf at late boot to early heading.

<sup>5</sup> LSD's for comparisons among means for continuous sorghum and sorghum after wheat treatments.

# COLD TOLERANCE OF GRAIN SORGHUM

Mark M. Claassen, Victor L. Martin, and Mitchell R. Tuinstra

## Summary

Response of grain sorghum to cold temperatures was evaluated by comparing the performance of 46 hybrids with April versus June planting dates. Yield of sorghum planted early averaged 25 bu/a more than that of sorghum planted in late June. Asgrow A570, DeKalb DK-45, DeKalb DK-53, and MSG O 256 produced the highest yields in the early planting. Only four hybrids produced lower yields when planted early than when planted late, and this decline was generally not significant. Early planting reduced stands in some hybrids, with an average difference of 15% between the two dates. Stands of hybrids in the top yield group of the early planting ranged from 74 to 84%. Grain yields of sorghum planted in April were not related consistently to early plant vigor scores or seedling dry matter yield at 30 days after planting.

## Introduction

Experiments at Hesston have shown the potential for increased yield of sorghum planted approximately 1 month earlier than typical June dates in south central Kansas. Early sorghum planting may spread the risk of drouth, reduce the risk of chinch bug injury, avoid damage from early fall frost, eliminate grain moisture dockage at harvest, increase profitability associated with better harvest season prices, spread field work load, and facilitate rotation to wheat in the fall.

Because of differences in hybrid response to cool conditions, more information is needed to characterize sorghum response to early planting. Investigations to evaluate growth and yield of a number of early-planted grain sorghum hybrids were initiated in 1998 at several locations, including Hesston. Hybrids were selected from

among those being evaluated in the standard Kansas performance tests.

## Procedures

Forty-six sorghum hybrids were planted in three replications on two dates corresponding to early (April 23) and late (June 26) timing. The experiment site was on a Geary silt loam soil that had been cropped to spring oats in 1997. Reduced tillage practices were used for seedbed preparation. The area was fertilized with 116 lb N/a and 35 lb P<sub>2</sub>O<sub>5</sub> broadcast and incorporated in late April. Sorghum was planted at 48,790 seeds/a in 30-inch rows with 7 lb/a Temik 15G insecticide applied in furrow. All sorghum seed was safened with Concep III. Immediately after planting, the respective areas were sprayed with 1 qt/a Dual + 1.1 lb/a AAtrex 90 DF. Grain harvesting for the respective planting dates was completed on September 3 and October 24.

## Results

Grain sorghum planted in late June was affected adversely by fall army worms and drouth stress. Grain yield from the early planting averaged 25 bu/a more than from the late planting (Table 4). Only four hybrids produced lower yields when planted early, and this decline was generally not significant. Asgrow A570 produced the top yield of 128 bu/a in the early planting. DeKalb DK-45, DeKalb DK-53, and MSG O 256 had yields not differing significantly from that.

Final sorghum stands tended to be lower in the early planting, with a range from 14 to 86% versus 44 to 95% of the planting rate in the late planting. The average difference in stand between the two planting dates was 15%. Stands of hybrids in the top yield group

of the early planting ranged from 74 to 84%. Asgrow A570 had the highest plant vigor score at 19 days after early planting. Nine other hybrids had comparable vigor scores. Three of the four hybrids in the top yield group had below-average vigor scores.

At 30 days after planting, dry matter yield averaged only 0.22 g/plant in the early planting but increased to 13.08 g/plant in the late planting (data not shown). Two of the top four grain-producing hybrids in the early planting had less than average seedling dry matter yield/plant. However, these differences were not statistically significant.

All hybrids required a significantly longer period of time to reach half bloom when planted early. This increase ranged from 14 to 26 days, with an average increase of 20 days. Maturity of most of the hybrids in the top yield group was delayed by less than the 20- day average. However, Asgrow A570 was delayed in maturity by 26 days when planted early. Plant heights were not affected significantly by planting date. No lodging occurred in the early planting. However, lodging averaged 14% and ranged from 0 to 68% in the late planting.

This project was funded partially by the Kansas Grain Sorghum Commission.

Table 4. Cold tolerance of grain sorghum hybrids, Harvey County Experiment Field, Hesston, KS, 1998.<sup>1</sup>

Sorghum Brand Hybrid	Yield <sup>2</sup>		Plant Vigor <sup>3</sup>	Stand <sup>4</sup>		Half Bloom <sup>5</sup>		Plant Height		Lodg- ing <sup>6</sup>
	Early	Late		Early	Late	Early	Late	Early	Late	
	bu/a		score	%		days		inch		%
Agripro AP 2660	84	66	2.70	73	72	79	59	41	40	19
Agripro AP 2800	81	71	3.27	68	66	80	58	40	39	2
Agripro AP 2838	103	56	2.30	75	91	79	60	40	41	8
Agripro AP 2233	73	67	3.57	80	85	72	53	32	38	3
Agripro 2468	86	64	2.60	76	84	80	57	39	38	5
Asgrow A459	86	60	2.57	81	91	78	60	43	46	13
Asgrow A504	91	61	3.10	62	67	82	60	43	43	8
Asgrow A570	128	64	2.23	84	82	85	59	46	46	37
Asgrow A571	83	67	3.40	64	83	87	61	43	42	14
Asgrow Seneca	87	63	2.37	75	84	72	56	37	38	18
Cargil 627	92	70	3.33	63	85	75	61	40	43	10
Cargil 647	91	72	3.10	78	87	75	58	40	45	3
Cargil 737	91	66	2.83	79	95	76	59	37	38	8
Cargil 770Y	73	47	3.60	51	67	80	60	43	41	11
DeKalb DK-35	87	74	2.97	71	86	73	57	37	40	8
DeKalb DK-43A	80	68	3.90	63	70	81	60	41	40	4
DeKalb DK-44	99	69	3.27	79	86	78	61	41	43	1
DeKalb DK-45	112	68	3.20	74	89	78	61	46	45	0
DeKalb DK-47	73	59	3.73	52	59	78	60	40	44	16
DeKalb DK-53	111	34	3.60	74	78	80	65	45	43	9
DeKalb DK-54	87	38	3.33	78	80	85	64	45	46	7
DeKalb DK-56	89	37	3.40	51	77	86	65	47	45	4
DeLange DSA 115C	93	65	3.53	52	63	77	59	39	40	10

(Continued)

Table 4. Cold tolerance of grain sorghum hybrids, Harvey County Experiment Field, Hesston, KS, 1998.<sup>1</sup>

Sorghum Brand Hybrid	Yield <sup>2</sup>		Plant Vigor <sup>3</sup>	Stand <sup>4</sup>		Half Bloom <sup>5</sup>		Plant Height		Lodg- ing <sup>6</sup>
	Early	Late		Early	Late	Early	Late	Early	Late	
	bu/a		score	%		days		inch	%	
DeLange DSA 123Y	77	55	3.23	58	63	84	59	39	37	13
DeLange DSA 133	93	65	3.53	38	61	79	59	40	43	34
DeLange DSA 144	102	48	3.00	66	83	86	63	45	42	16
Golden World GW5960	85	60	3.17	67	73	74	56	40	42	52
Garst 5616	69	81	3.87	46	75	78	59	39	41	0
Hoegemeyer 6055	103	72	2.67	86	92	74	55	40	43	21
Hoegemeyer 671	75	79	3.43	57	79	82	57	41	44	5
Hoegemeyer 6884	76	68	2.97	65	79	79	59	41	40	6
MSG O 256	104	59	3.37	51	80	77	61	44	48	4
Mycogen 444E	97	72	3.73	53	77	78	59	41	41	4
NC+ 5B74E	60	65	3.50	60	85	72	53	31	38	7
NC+ 6B70	75	62	3.17	65	85	78	55	40	39	5
NC+ 7B29	89	62	2.30	76	79	79	58	39	38	7
NC+ 6B50	98	84	2.43	85	92	74	55	40	44	17
NC+ 7R83	99	65	2.53	75	87	86	60	44	43	11
Pioneer 8505	83	74	3.70	54	80	74	57	40	42	2
TX3042 x TX2737	85	53	3.40	63	86	73	56	45	45	68
RS610	37	59	3.83	14	44	73	58	37	44	33
TX2752 x TX430	98	61	3.47	57	77	83	61	42	41	15
TX2752 x TX2783	70	45	3.20	54	85	85	60	43	45	49
Triumph TR432	76	64	3.60	53	75	73	58	35	39	34
Triumph TR445	83	49	3.07	61	75	75	60	40	42	32
Triumph TR481	90	47	3.40	45	77	83	64	46	45	1
LSD .05 (within same planting date)	25	23	0.55	14	15	2.6	1.8	3.0	3.0	23
LSD .05 (between different planting dates)		28	---		27		5		NS	--
Means for planting date	87	62	3.18	64	79	79	59	41	42	14
LSD .05		19	---		---		4		NS	--
LSD .15		---			14		---		NS	

<sup>1</sup> Early = April 23 planting; Late = June 26 planting.<sup>2</sup> Yields adjusted to 12% moisture.<sup>3</sup> Plant vigor at 19 days after early planting: 1 = normal, vigorous growth; 5 = slow, disuniform growth.<sup>4</sup> Stands expressed as a percentage of 48,790 seeds/a planted.<sup>5</sup> Days from planting to half bloom.<sup>6</sup> Lodging in late-planted sorghum at harvest.

# EFFECTS OF AMPLIFY-D ON GRAIN SORGHUM

Mark M. Claassen, Victor L. Martin, and Mitchell R. Tuinstra

## Summary

Amplify-D applied to sorghum seed at 4 oz/50 lb had no significant effect on seedling vigor, dry weight at 31 days after planting, plant height, heads/plant, bushel weight, and grain yield. Grain sorghum stands in some hybrids tended to be slightly lower with Amplify-D than without the seed treatment.

## Introduction

Amplify-D is a product developed by Conklin Company to enhance early vigor of seedlings and, potentially, to increase plant stand. Not a pesticide, Amplify-D is intended to provide germinating seed with an exogenous source of AMP (adenosine monophosphate), a precursor of ATP (adenosine triphosphate), which provides energy to plant cells. Positive results with Amplify-D have been documented in cotton. This experiment was conducted at Hesston and several other locations to determine if grain sorghum planted at early and conventional dates would respond to Amplify-D seed treatment.

## Procedures

Twelve sorghum hybrids were planted in three replications on two dates corresponding to early (April 24) and conventional (June 12) timing. The experiment site was on a Ladysmith silty clay loam soil that had been cropped to wheat in 1997. Reduced tillage practices were used for seedbed preparation. The area was fertilized with 114 lb N/a and 32 lb P<sub>2</sub>O<sub>5</sub> broadcast and incorporated in mid-

April. Amplify-D was applied to Concep III-treated seed at 4 oz/50 lb. Sorghum was planted at 48,790 seeds/a in 30-inch rows with 7 lb/a Temik 15G insecticide applied in furrow. Areas for the respective planting dates were sprayed shortly after planting with 1 qt/a Dual II + 0.56 lb/a or 0.28 lb/a AAtrex

90 DF. Ten plants/plot were harvested at 31 days after planting to determine dry matter accumulation. Sorghum from the early planting was harvested for grain on September 1, 1998. No yields were determined for the second planting because of very severe lodging in mid-September.

## Results

Stands of some grain sorghum hybrids tended to be slightly lower with Amplify-D than without the seed treatment (Table 5). In the April planting, the average difference in stand was 4%. A similar trend in the June planting was not statistically significant (Table 6). Early vigor (April planting), dry weight at 31 days after planting, plant height, and heads/plant were not affected by Amplify-D. Half bloom was delayed slightly (1 day) with Amplify-D in some hybrids in one or both planting dates.

Grain yield from the early planting differed significantly among hybrids. Average yields for sorghum with Amplify-D were 7 bu/a lower than these for sorghum without treatment. However, this effect was significant only at  $P \leq 0.11$ . Bushel weight was not affected significantly by Amplify-D.

This project was funded partially by the Kansas Grain Sorghum Commission.

Table 5. Effects of Amplify-D and April planting on grain sorghum hybrids, Harvey County Experiment Field, Hesston, KS, 1998.

<u>Sorghum</u>		Amplify-D	Grain Yield <sup>1</sup>	Test Wt	Plant Vigor <sup>2</sup>	Stand	Plant Weight <sup>3</sup>	Half Bloom <sup>4</sup>	Plant Ht	Heads/plant
Brand	Hybrid									
			bu/a	lb/bu	score	%	g/plant	days	in	
Asgrow	A425	With	66	54.5	2.4	75	0.64	74	41	1.7
		Without	69	54.2	2.0	87	0.59	74	41	1.6
Asgrow	X6126	With	68	57.0	3.0	38	0.43	87	55	2.1
		Without	79	59.8	3.1	43	0.48	87	56	1.8
Cargill	576	With	58	50.3	2.2	90	0.43	68	33	1.3
		Without	70	54.4	2.3	91	0.54	66	34	1.4
Cargill	730	With	91	55.4	2.7	86	0.51	75	40	1.5
		Without	98	55.3	2.4	91	0.47	75	43	1.4
DeKalb	DK-40y	With	79	54.0	3.1	63	0.36	74	41	1.9
		Without	82	54.5	3.2	68	0.27	74	42	1.8
Mycogen	1506	With	108	56.5	2.8	80	0.44	74	50	1.7
		Without	106	57.7	2.5	79	0.47	73	44	1.6
Mycogen	3636	With	68	51.4	2.7	69	0.39	72	35	1.8
		Without	67	53.4	2.7	80	0.49	71	35	1.6
NC+	371	With	73	54.9	2.2	93	0.50	76	39	1.4
		Without	89	57.3	2.3	94	0.52	75	41	1.4
Pioneer	84G62	With	99	56.8	2.7	87	0.44	77	42	1.5
		Without	102	56.3	2.3	93	0.49	76	42	1.4
Pioneer	8500	With	87	54.8	2.3	82	0.47	70	40	1.7
		Without	95	57.6	2.2	89	0.50	71	42	1.5
Pioneer	87G57	With	66	49.5	2.8	84	0.41	65	37	2.1
		Without	78	53.9	2.5	84	0.51	65	36	2.0
Triumph	TR447	With	65	51.2	2.3	75	0.59	72	39	1.6
		Without	70	51.1	2.2	79	0.58	72	38	1.5
LSD .05 among hybrids within treatment			20.9	3.5	0.42	11.3	0.12	1.2	2.9	0.25
LSD .05 within hybrid between treatments			NS	NS	NS	11.2	NS	1.2	NS	NS
Main effect means <sup>4</sup> :										
<u>Amplify-D</u>										
With			77	53.9	2.6	77	0.47	74	41	1.7
Without			84	55.5	2.5	81	0.49	73	41	1.6
LSD .05			NS	NS	NS	3.6	NS	0.4	NS	NS

<sup>1</sup> Yield adjusted to 12.5% moisture.

<sup>2</sup> Visual rating May 14 on a scale of 1 to 5: 1 is best and 5 is poorest.

<sup>3</sup> Plant dry weight on May 25 (31 days after planting).

<sup>4</sup> Days from planting to half bloom.

Table 6. Effects of Amplify-D and June planting on grain sorghum hybrids, Harvey County Experiment Field, Hesston, KS, 1998.

<u>Sorghum</u>		Amplify-D	Stand	Plant Weight <sup>1</sup>	Half Bloom <sup>2</sup>	Plant Ht
Brand	Hybrid					
			%	g/plant	days	in
Asgrow	A425	With	62	13.5	65	44
		Without	68	13.1	65	48
Asgrow	X6126	With	37	9.9	74	47
		Without	35	12.2	73	49
Cargill	576	With	69	9.8	61	40
		Without	70	9.3	60	43
Cargill	730	With	69	10.4	64	44
		Without	69	14.3	64	44
DeKalb	DK-40y	With	46	8.0	64	41
		Without	50	10.3	63	44
Mycogen	1506	With	67	9.7	66	50
		Without	69	11.9	65	55
Mycogen	3636	With	59	8.0	62	38
		Without	59	7.6	61	41
NC+	371	With	67	9.3	65	42
		Without	70	10.2	65	44
Pioneer	84G62	With	80	10.5	66	47
		Without	79	12.4	65	49
Pioneer	8500	With	69	11.4	61	46
		Without	75	13.2	61	47
Pioneer	87G57	With	61	11.0	55	46
		Without	77	12.2	54	44
Triumph	TR447	With	54	9.6	63	40
		Without	56	11.7	61	41
LSD .05 among hybrids within treatment			10.2	4.2	0.9	3.4
LSD .05 within hybrid between treatments			NS	NS	1.1	NS
Main effect means:						
<u>Amplify-D</u>						
With			62	10.1	64	44
Without			65	11.5	63	45
LSD .05			NS	NS	0.6	NS

<sup>1</sup> Plant dry weight on July 13, (31 days after planting).

<sup>2</sup> Days from planting to half bloom.

# EFFECTS OF TERMINATION METHOD OF HAIRY VETCH WINTER COVER CROP AND NITROGEN RATE ON GRAIN SORGHUM

Mark M. Claassen

## Summary

At the end of the first cycle in a vetch-sorghum-wheat rotation, fall residual soil nitrate nitrogen (N) was 4 lb/a higher than in a sorghum-wheat rotation. At the beginning of the second cycle of the rotation, hairy vetch planted in mid-September and terminated on May 14 produced an average dry matter yield of 1.64 ton/a. The corresponding potential N contribution was 94 lb/a for the succeeding sorghum crop. Seasonal environmental factors caused increased variation in treatment effects. Vetch significantly increased sorghum leaf N levels and tended to increase grain yields as well. However, the yield response was not significant. In the absence of fertilizer N, sorghum after vetch yielded about 12 bu/a more than sorghum without a preceding cover crop. The apparent yield enhancement following vetch was equivalent to at least 30 lb/a of fertilizer N. Method of vetch termination did not influence leaf N level or yield of sorghum. Fertilizer N rate affected leaf N level significantly, but not sorghum yield.

## Introduction

Interest in the use of legume winter cover crops has been rekindled by concerns for soil and water conservation, dependency on commercial fertilizer, and maintenance of soil quality. Hairy vetch is a good candidate for the cover crop role because it can be established in the fall when water use is reduced, it has winterhardiness, and it can fix substantial N. This experiment was conducted to investigate the effect of hairy vetch and N fertilizer rates on the supply of N to the succeeding grain sorghum crop as well as to assess sorghum yield response when the vetch is terminated by tillage versus by herbicides.

## Procedures

The experiment was established on a Geary silt loam soil with the initial planting of hairy vetch following winter wheat in the fall of 1995. Sorghum was grown in 1996 after vetch had been terminated, and the comparison was made with sorghum in annual rotation with wheat alone. No-till winter wheat without fertilizer was recropped following sorghum. Reduced-tillage practices with a disk and field cultivator were used to control weeds and prepare a seedbed. In the second cycle of the rotation, hairy vetch plots were planted at 20 lb/a in 8-in. rows with a grain drill equipped with double-disk openers on September 16, 1997.

Volunteer wheat was controlled by an April application of Fusilade DX + crop oil concentrate (10 oz/a + 1% v/v). One set of vetch plots was terminated by disking on May 14. Hairy vetch in a second set of plots was terminated at that time with Roundup Ultra + 2,4-D<sub>LVE</sub> (1 qt + 1.5 pt/a).

Vetch forage yield was determined by harvesting a 1 sq m area from each plot on May 13, 1998. Nitrogen fertilizer treatments were broadcast as ammonium nitrate on June 11, 1998. All plots received 35 lb/a of P<sub>2</sub>O<sub>5</sub>, which was banded as 0-46-0 at planting. Pioneer 8505 grain sorghum treated with Concep III safener and Gaucho insecticide was planted after a rain delay at approximately 42,000 seeds/a on June 29, 1998. Weeds were controlled with a preemergence application of Microtech + AAtrex 90 DF (2.5 qt/a + 0.28

lb/a). Grain sorghum was combine harvested on October 24.

## Results

Initial soil nitrate N (0 to 2 ft) averaged 24 lb/a in the sorghum-wheat rotation and 28 lb/a in the vetch-sorghum-wheat system. Because of poor germination, hairy vetch establishment in the fall was limited, with disuniformity in some plots. Average ground cover on November 13, 1997 was 12%. (Table 7). Hairy vetch was beginning to bloom at the time of termination in May. Vetch dry matter yield averaged 1.64 ton/a, and N content was 2.94%. The average potential amount of N to be mineralized for use by the sorghum crop was 94 lb/a.

Disking to terminate hairy vetch growth did not adversely affect soil moisture at the surface because of subsequent rains, which ultimately delayed planting. Sorghum stands averaged 38,370 plants/a and were relatively uniform across treatments. Fall armyworms caused considerable damage to sorghum leaves. Drouth stress occurred from mid-August through mid-September. At the zero N rate, leaf N at boot to early heading stage was higher in sorghum after vetch than in sorghum without a prior vetch cover crop.

This increase was equivalent to that with 30 lb/a of fertilizer N. Method of vetch termination had no effect on leaf N. The overall effect of N rate on leaf N was significant. In sorghum not following vetch, leaf N increased mostly with the first increment (30 lb/a) of fertilizer N, whereas in sorghum after vetch, leaf N increased inconsistently with N rates.

Grain sorghum maturity (days to half bloom) was not affected by any of the treatments. With zero fertilizer N, sorghum after vetch yielded about 12 bu/a more than sorghum without a preceding cover crop. The apparent yield enhancement following vetch was equivalent to at least 30 lb/a of fertilizer N. Nevertheless, when averaged over N rates, the effects of vetch and termination method on sorghum yield were not statistically significant. Yield of sorghum without a prior vetch crop increased by 11 to 14 bu/a with fertilizer N, but most of this occurred with the 30 lb/a rate. Sorghum yields following vetch showed no response to N fertilizer. The overall effect of N rate on yield was not significant.

This project was funded partially by the Kansas Rural Center through the Covered Acres Cluster of south central Kansas.

Table 7. Effects of hairy vetch cover crop, termination method, and N rate on grain sorghum after wheat, Harvey County Experiment Field, Hesston, 1998.

Cover Crop/ Termination	N Rate <sup>1</sup>	Initial Soil NO <sub>3</sub> -N <sup>2</sup>	Fall Ground Cover <sup>3</sup>	Vetch Yield <sup>4</sup>		Grain Sorghum			
				Forage	N	Stand	Half <sup>5</sup> Bloom	Leaf N <sup>6</sup>	Grain Yield
	lb/a	lb/a	%	ton/a	lb	1000's/ a	days	%	bu/a
None	0	25	--	--	--	38.8	57	2.45	66.6
	30	25	--	--	--	37.9	56	2.62	77.9
	60	25	--	--	--	37.5	56	2.63	80.3
	90	22	--	--	--	38.4	56	2.67	79.1
Vetch/Disk	0	27	15	1.89	119	39.1	56	2.67	79.6
	30	25	10	1.36	78	38.5	56	2.65	66.6
	60	30	18	1.95	106	38.0	56	2.85	77.9
	90	29	13	1.57	77	37.8	56	2.66	79.8
Vetch/No-till	0	29	10	1.88	110	39.2	56	2.62	77.1
	30	27	14	1.75	107	37.1	56	2.82	72.5
	60	33	10	1.56	85	38.7	56	2.65	81.4
	90	28	13	1.35	77	38.5	56	2.78	70.4
LSD .05		NS	NS	NS	NS	1.3	NS	0.13	NS
Means:									
<u>Cover Crop/ Termination</u>									
None		24	--	--	--	38.1	56	2.59	76.0
Vetch/Disk		28	14	1.69	95	38.3	56	2.71	76.0
Vetch/No-till		29	12	1.63	95	38.4	56	2.72	75.4
LSD .05		3	NS	NS	NS	NS	NS	0.07	NS
<u>N Rate</u>									
0		27	13	1.88	115	39.0	56	2.58	74.5
30		26	12	1.56	93	37.9	56	2.70	72.3
60		29	14	1.75	96	38.1	56	2.71	80.0
90		26	13	1.46	77	38.2	56	2.70	76.4
LSD .05		NS	NS	NS	NS	0.75	NS	0.08	NS

<sup>1</sup> N applied as 34-0-0 on June 11, 1998.

<sup>2</sup> Mean nitrate nitrogen at 0 - 2 ft. depth on Sept. 16, 1997, 1 day before hairy vetch planting.

<sup>3</sup> Estimated by 6 in. intersects on one 40 ft. line transect per plot on November 13, 1997.

<sup>4</sup> Oven dry weight and N content on May 13, 1998.

<sup>5</sup> Days from planting (June 29, 1998) to half bloom.

<sup>6</sup> Flag leaf at late boot to early heading.

# RESIDUAL EFFECTS OF HAIRY VETCH WINTER COVER CROP AND NITROGEN RATE ON NO-TILL WINTER WHEAT AFTER SORGHUM

Mark M. Claassen

## Summary

Response of wheat in annual wheat-sorghum and wheat-vetch-sorghum rotations was compared at N fertilizer rates of 0 to 90 lb/a. Prior hairy vetch cover crop as well as N rates significantly affected soil nitrate N concentration at the time of wheat planting. Notably, soil nitrate N levels significantly increased only at N rates of 60 and 90 lb/a and only in the rotation involving vetch. Both hairy vetch and N rate significantly increased wheat yield. When averaged over N rates, wheat following vetch-sorghum produced 9 bu/a more than wheat in the rotation without hairy vetch. The residual vetch benefit was equivalent to 28 lb/a of fertilizer N. Wheat after vetch-sorghum appeared to be nearer a maximum yield at 90 lb/a of N than did wheat without a prior hairy vetch crop.

## Introduction

Hairy vetch can be planted in September following wheat and used as a winter cover crop ahead of grain sorghum in an annual wheat-sorghum rotation. Soil erosion protection and N contribution to the succeeding crop(s) are potential benefits of including hairy vetch in this cropping system. The amount of N contributed by hairy vetch to grain sorghum has been under investigation. The longer term benefit of vetch in the rotation is also of interest. This experiment concludes the first cycle of the crop rotation in which the residual effects of vetch as well as N fertilizer rates were measured in terms of soil N as well as N uptake and yield of wheat.

## Procedures

The experiment was established on a Geary silt loam soil with the initial planting of hairy vetch following winter wheat in the fall of 1996. Sorghum was grown in 1997 with or without the preceding cover crop. Variety 2137 winter wheat was no-till planted in 8-inch rows into sorghum stubble on November 8, 1997 at 90 lb/a with 32 lb/a of P<sub>2</sub>O<sub>5</sub> fertilizer banded in the furrow. Fertilizer N was broadcast as 34-0-0 on April 6, 1998 at rates equal to those applied to the prior sorghum crop. Wheat was harvested on June 26.

## Results

Hairy vetch terminated on April 25 and May 14, 1997, respectively produced 2.66 and 2.99 ton/a of dry matter, yielding 147 and 188 lb/a of N potentially available to the sorghum that followed (Table 8). However, the contribution of vetch to the yield of sorghum was equivalent to only 70 and 89 lb/a of fertilizer N. Prior hairy vetch cover crop as well as N rates significantly affected soil nitrate N (0 to 2 ft) at the time of wheat planting. In wheat after sorghum, soil nitrate N averaged only 7 lb/a. By comparison, wheat after vetch-sorghum averaged 21 lb/a of nitrate N because of carryover from the highest fertilizer N rates. Date of vetch termination had no effect on soil N. Also, N rates in sorghum without vetch had no effect on residual soil nitrate N. But, rates of 60 and 90 lb/a of N resulted in soil nitrate N levels of 22 and 43 lb/a following sorghum after vetch.

Residual effect of hairy vetch on wheat yield was positive and significant, but vetch termination date did not influence wheat yield significantly. When averaged over N rates, wheat yield following vetch-sorghum averaged 38 bu/a, about 9 bu/a more than for wheat with no prior cover crop. In wheat after sorghum without vetch, each 30 lb/a increment of fertilizer N significantly increased yield. This trend suggested that yields were below maximum at the 90 lb/a rate of fertilizer N. In wheat after vetch-sorghum, yields also increased with increasing

fertilizer N, but appeared to be closer to a maximum at 90 lb/a of N. The yield of wheat after vetch-sorghum at the zero N rate indicated a residual vetch benefit equivalent to 28 lb/a of fertilizer N.

Vetch had no significant residual effect on wheat test weight, whole-plant N content at heading, or grain N level. Fertilizer N significantly increased plant N and grain N, with highest levels occurring at the 90 lb/a rate. Wheat test weight decreased somewhat with N rate.

Table 8. Residual effects of hairy vetch cover crop, termination date, and N rate on no-till wheat after grain sorghum, Harvey County Experiment Field, Hesston, KS, 1998.

Cover Crop/ Termination <sup>1</sup>	N Rate <sup>2</sup>	Vetch Yield <sup>3</sup>		Sorghum Yield	Initial Soil NO <sub>3</sub> - N <sup>4</sup>	Wheat			
		Forage	N			Yield	Bushel Wt	Plant N <sup>5</sup>	Grain N
	lb/a	ton/a	lb	bu/a	lb/a	bu/a	lb	%	%
None	0	--	--	90.8	6	14.8	59.0	1.04	1.75
	30	--	--	97.3	7	21.8	58.5	1.11	1.62
	60	--	--	101.8	7	35.8	57.9	1.35	1.65
	90	--	--	107.0	9	44.0	58.1	1.52	1.78
Vetch-April 25	0	2.75	145	103.3	7	22.4	59.2	1.10	1.73
	30	2.85	157	108.3	9	29.3	58.7	1.12	1.62
	60	2.45	148	101.8	26	46.7	57.7	1.50	1.72
	90	2.58	138	105.4	45	48.8	57.5	1.69	1.89
Vetch-May 14	0	3.11	215	106.4	7	24.5	59.2	1.08	1.72
	30	3.08	155	110.5	16	34.9	58.6	1.25	1.64
	60	3.28	210	111.4	17	43.6	58.1	1.48	1.71
	90	2.47	173	107.0	40	51.1	57.1	1.77	1.86
LSD .05		0.53	68	8.8	13	5.5	0.50	0.25	0.10
Means:									
<u>Cover Crop/ Termination</u>									
None		--	--	99.2	7	29.1	58.4	1.25	1.70
Vetch-April 25		2.66	147	104.7	22	36.8	58.3	1.35	1.74
Vetch-May 14		2.99	188	108.8	20	38.5	58.2	1.40	1.73
LSD .05		0.27	34	4.4	6	2.8	NS	NS	NS
<u>N Rate</u>									
0		2.93	180	100.2	7	20.6	59.1	1.07	1.73
30		2.97	156	105.4	11	28.7	58.6	1.16	1.62
60		2.87	179	105.0	17	42.1	57.9	1.44	1.69
90		2.53	155	106.4	32	48.0	57.6	1.66	1.84
LSD .05		NS	NS	NS	7	3.2	0.3	0.14	0.06

<sup>1</sup> Hairy vetch planted in mid-September, 1996, and terminated the following spring.

<sup>2</sup> N applied as 34-0-0 June 23, 1997 for sorghum and April 6, 1998 for wheat.

<sup>3</sup> Oven dry weight and N content just prior to termination.

<sup>4</sup> Mean nitrate nitrogen at 0 - 2 ft. depth in mid-November, 1997.

<sup>5</sup> Whole-plant N concentration at heading.

# GRASS HERBICIDE EFFECTS ON EARLY-PLANTED GRAIN SORGHUM

Shannon Claborn, Mark M. Claassen, and David L. Regehr

## Summary

Chloroacetamide herbicides were applied preemergence at normal and double use rates to eight sorghum hybrids treated with Concep III safener and planted in late April. At 19 days after planting, minor sorghum injury occurred only with double rates of Frontier and Dual II Magnum. No interactions between hybrids and herbicides were detected in the injury ratings. Herbicide treatments did not significantly affect sorghum stands or yields.

## Introduction

In prior research at Hesston, grain sorghum planted early in May outperformed that planted at the conventional time in June during years with favorable seasonal weather patterns. In those experiments, unsafened sorghum seed was planted, and Ramrod (propachlor) was applied for preemergence grass control. Stronger grass herbicides such as Dual, Partner, and Frontier were avoided here to reduce the possibility of injury to stand establishment under stressful conditions of cool soil temperatures. Over time, grass control became a greater concern in early-planted grain sorghum because of a slower development of plant canopy and late emergence of weeds. This experiment was conducted to assess the effects of five grass herbicides applied at normal and double rates on eight early-planted grain sorghum hybrids.

## Procedures

Grain sorghum hybrids were selected for this study on the basis of genetic diversity, general use by growers, previous investigations on cold

tolerance, and endosperm color. Grain sorghum was grown on the site in 1997. The area was fertilized with 114 lb N/a and 32 lb P<sub>2</sub>O<sub>5</sub>/a broadcast and incorporated in mid-April. The seedbed was prepared with a field cultivator and mulch treader. Sorghum seed treated with Concep III safener and Gaucho insecticide was planted about 1.25 inches deep at 2.8 seeds/ft in 30-in. rows on April 24, 1998. Immediately after planting, all herbicide treatments were applied in 20 gal/a of water with XR8003 flat-fan nozzles. Injury ratings and stand counts were taken at 19 and 32 days after planting. Plots were harvested on August 31 and September 1.

## Results

Seedbed condition was fair. Soil temperatures at seed depth stayed cool after planting until May 6. Light rains fell at 5, 8, and 11 days after planting. More substantial rainfall events occurred at 3, 4, and 15 days after planting in which amounts of 0.78, 1.13, and 0.44 inch were recorded, respectively. Sorghum emergence began about May 7 and reached 94% of the final average stand 7 days later.

Injury ratings were made on the basis of the specific herbicide injury symptoms such as leaf malformations and discoloration. The injury percentage ratings were calculated by dividing the number of injured sorghum seedlings by the total number of plants. On May 13, sorghum injury averaged 2% (Table 9). Significant injury at this time was noted only with double rates of Frontier and Dual II Magnum, at 8 and 3%, respectively. No interactions between hybrids and herbicides were detected in the injury ratings. On May 26, average injury decreased to less than 1%,

with no significant differences among treatments.

Hybrid effects on injury, however, were significant on both evaluation dates. Initially, greatest injury was noted in DeKalb DK-40y, a hybrid with yellow endosperm; Mycogen 1482; NC+ 6B50; and Northrup King KS 710. Ratings did not differ significantly among the remaining hybrids. At the second evaluation approximately 2 weeks later, DeKalb DK-40y continued to have the highest level of injury (2%), whereas DeKalb DK-35, Mycogen 1506, NC+ 6B50, and Pioneer 8699 showed the least injury.

Sorghum populations on May 13 averaged 38,400 plants/a or 73% of the planting rate. Final populations on May 26 increased to 40,900 plants/a, i.e., 78% of the number of seed planted. Herbicide treatments did not significantly affect sorghum stands. Hybrids

differed considerably in population. NC+ 6B50 had the highest and Northrup King KS 710 had the lowest stand percentages. Double rates of Frontier, Harness CR, and Dual II Magnum caused a small but statistically significant increase in the number of days to half-bloom in comparison with the control (atrazine alone). All double herbicide rates, except for Ramrod, caused a slight increase in plant height when compared with the control. Herbicide treatments had no significant effects on yield or bushel weight of grain produced (Table 10). However, significant yield differences occurred among hybrids. Mycogen 1506 produced the top yield of 86 bu/a. Northrup King KS 710 recovered well from initial injury and low stand percentages to produce a comparably high yield of 83 bu/a. DeKalb DK-35, with the least herbicide injury, had the lowest yield of 66 bu/a.

Table 9. Effects of grass herbicides and hybrids on injury, stand, and plant height of early-planted grain sorghum, Harvey County Experiment Field, Hesston, KS, 1998.

Herbicide Treatment <sup>1</sup>	Rate lb ai/a	Sorghum	Injury		Stand		Plant Height
		Brand Hybrid	5/13	5/26	5/13	5/26	
Main effects means:			%		%		in.
1 Dual II Magnum + Atraz	1.25 + 1.0		.8	.5	76	80	43
2 Dual II Magnum + Atraz	2.5 + 1.0		3.2	.7	74	79	44
3 Partner + Atraz	2.5 + 1.0		1.5	.6	74	78	43
4 Partner	5.0 + 1.0		2.6	1.0	74	79	44
5 Ramrod + Atraz	4.0 + 1.0		.8	1.3	75	79	43
6 Ramrod + Atraz	8.0 + 1.0		.4	.7	73	79	43
7 Frontier + Atraz	1.25 + 1.0		2.1	.8	73	77	43
8 Frontier + Atraz	2.5 + 1.0		8.0	2.1	70	78	44
9 Harness CR + Atraz	1.8 + 1.0		1.0	.8	72	77	43
10 Harness CR + Atraz	3.6 + 1.0		2.5	1.0	74	78	44
11 Atrazine	1.0		.6	.8	73	78	43
LSD .05			2.3	NS	NS	NS	0.7
		DeKalb DK-35	1.3	.5	79	85	40.8
		DeKalb DK-40y	2.9	1.9	64	70	44.2
		Mycogen 1482	2.4	1.2	69	75	42.4
		Mycogen 1506	1.7	.9	67	72	49.4
		NC+ 6B50	2.5	.5	86	89	43.5
		N. King KS 710	2.6	1.1	56	61	41.4
		Pioneer 8699	2.0	.4	85	88	43.1
		Pioneer 8500	1.7	1.1	81	87	41.6
		LSD .05	0.9	0.6	.03	.03	0.10

<sup>1</sup>Note: Harness and Harness CR are not currently labeled for grain sorghum. Formulations: Aatrex 90 DF, Dual II Magnum 7.64 EC, Frontier 6.0 EC, Harness CR 3.8 L, Partner 65 DF, and Ramrod 4L.

Table 10. Effects of grass herbicides and hybrids on maturity and yield of early-planted grain sorghum, Harvey County Experiment Field, Hesston, KS, 1998.

Herbicide Treatment <sup>1</sup>	Rate lb ai/a	Sorghum		Bushel Weight	Half Bloom	Heads/Plant
		Brand Hybrid	Yield			
Main effects means:			bu/a	lb	DAP <sup>2</sup>	
1 Dual II Magnum + Atraz	1.25 + 1.0		70	56.4	75	1.2
2 Dual II Magnum + Atraz	2.5 + 1.0		78	58.2	75	1.2
3 Partner + Atraz	2.5 + 1.0		78	57.7	75	1.2
4 Partner	5.0 + 1.0		76	58.2	75	1.2
5 Ramrod + Atraz	4.0 + 1.0		76	57.9	74	1.2
6 Ramrod + Atraz	8.0 + 1.0		70	57.4	74	1.2
7 Frontier + Atraz	1.25 + 1.0		80	58.3	75	1.3
8 Frontier + Atraz	2.5 + 1.0		75	57.5	76	1.2
9 Harness CR + Atraz	1.8 + 1.0		75	58.0	75	1.2
10 Harness CR + Atraz	3.6 + 1.0		81	57.4	76	1.2
11 Atrazine	1.0		79	57.8	74	1.2
LSD .05			NS	NS	1.1	NS
		DeKalb DK-35	66	55.8	72	1.2
		DeKalb DK-40y	73	57.7	77	1.2
		Mycogen 1482	73	57.5	76	1.1
		Mycogen 1506	86	58.6	77	1.3
		NC+ 6B50	79	57.0	74	1.0
		N. King KS 710	83	58.9	79	1.6
		Pioneer 8699	76	58.5	73	1.2
		Pioneer 8500	73	57.7	70	1.2
		LSD .05	6.2	0.43	0.5	0.1

<sup>1</sup>Note: Harness and Harness CR are not currently labeled for grain sorghum.

Formulations: Aatrex 90 DF, Dual II Magnum 7.64 EC, Frontier 6.0 EC, Harness CR 3.8 L, Partner 65 DF, and Ramrod 4L.

<sup>2</sup> Days after planting.

# HERBICIDES FOR WEED CONTROL IN SOYBEAN

Mark M. Claassen

## Summary

Twenty-four herbicide treatments were evaluated for crop tolerance and weed control efficacy in soybean. Although Cobra caused some foliar burn, none of the treatments produced lasting injury to soybean. Broadstrike + Dual, Authority First + Classic, and Authority First + Prowl provided excellent preemergence (PRE) control of Palmer amaranth and redroot pigweed. PRE grass herbicides were less effective than usual because of initial dry conditions followed by heavy rainfall. Weather interference caused late application of postemergence (POST) herbicides. Best control of large crabgrass occurred with POST treatments involving Roundup Ultra or Assure II. Various late POST treatments provided good to excellent control of oversized pigweeds. Drouth stress obscured treatment effects on soybean yield.

## Introduction

Successful soybean production is dependent upon effective weed control. Growers may choose from a number of herbicide options that can accomplish this objective. In recent years, the number of herbicides available for weed control in soybean has increased notably. This experiment was conducted to evaluate new herbicides and herbicide combinations for weed control efficacy as well as soybean tolerance.

## Procedures

Spring oats were grown on the experiment site in 1997. The soil was a Smolan silt loam with pH 6.7 and 2.4% organic matter. To promote uniformity of weed populations,

pigweed and crabgrass seed were broadcast and incorporated with a field cultivator as the last preplant tillage. Asgrow 3601 Roundup Ready + STS soybean was planted at 142,000 seeds/a in 30-inch rows on June 11, 1998. Seedbed condition was good, but soil moisture was insufficient for soybean emergence. All herbicide treatments were broadcast in 20 gal/a of water, with three replications per treatment. These were applied with XR8003 flat fan nozzles at 20 psi PRE on June 11 or 18 psi POST on July 14 (Table 11). POST 2 herbicides were applied as follows: treatment 14 on July 15 and treatments 11 and 12 on August 11. Because of weather delay, POST treatments actually were applied when soybean was 6 to 9 inches tall with three fully expanded trifoliolate leaves; pigweeds mostly ranged from 6 to 32 inches; and large crabgrass height was 1.5 to 7 inches. POST 2 Synchrony STS in treatment 14 was applied to relatively few pigweeds ranging up to 12 inches in height on the day following POST application of Assure II for grass control. POST 2 herbicides in treatments 11 and 12 were applied later when soybean was 26 to 33 inches tall; pigweeds were few and ranged from 2 to 18 inches; and large crabgrass was 1 to 8 inches in height.

Crop injury and weed control were evaluated at various times during the growing season. Soybean was harvested on October 27, 1998.

## Results

Three weeks of dry weather preceded planting. Seedbed condition was good, but soil moisture was insufficient for soybean emergence. Hard rains 11 days later caused soil crusting. Rainfall totaled 3.01 inches for the period 11 to 15 days after planting.

Soybean populations averaged approximately 99,320 plants/a. Dense pigweed (primarily Palmer amaranth with some redroot pigweed) and large crabgrass populations developed.

Unforecasted heavy rains in early July prevented the first scheduled POST applications. A prolonged hot and wet period that followed allowed pigweed growth to explode. Consequently, weeds were much larger than intended at the time these treatments were made. Light rain fell about 4 hours after the POST 2 applications in treatments 11 and 12, but did not affect weed control.

Broadstrike + Dual as well as Authority First + Classic provided excellent PRE control of Palmer amaranth and redroot pigweed. For this reason, little improvement in pigweed control occurred when these treatments were followed with POST herbicides. Expert alone POST failed to control Palmer amaranth. Pursuit POST with or without PRE Prowl performed unsatisfactorily because of the advanced stage of pigweed growth at application. Late season evaluation of Palmer amaranth indicated that the Pursuit + Pinnacle combination significantly improved control,

whereas Pursuit + Cobra did not enhance control in comparison with Pursuit alone. Raptor also was superior to Pursuit alone in the late August rating of Palmer amaranth control. Single as well as sequential Roundup Ultra applications effectively controlled Palmer amaranth and redroot pigweeds. Large crabgrass control was fair to good with Dual or Broadstrike + Dual, poor with Prowl, fair with Pursuit or Raptor, and poor with Pursuit + Pinnacle or Pursuit + Cobra following Prowl. Best control of large crabgrass occurred with treatments involving Roundup Ultra or Assure II Post.

Soybean injury occurred as leaf necrosis with treatments involving Cobra and as slight stunting with Pursuit + Pinnacle following Prowl. Drouth stress caused low soybean yields averaging only 11.9 bu/a across herbicide treatments and resulted in within-site yield variation. Consequently, no significant differences in soybean yield occurred among herbicides. Untreated check plots were not harvestable by combine because of extreme weed infestation and would have had an estimated yield of less than 3 bu/a.

Table 11. Weed control in soybean, Harvey County Experiment Field, Hesston, KS 1998.

Herbicide Treatment <sup>1</sup>	Rate	Timing <sup>2</sup>	Injury	Lacg <sup>3</sup>	Paam <sup>4</sup>	Yield
			7/28	Control 8/28	Control 8/28	
	oz ai/a		%	%	%	bu/a
1 Broadstrike + Dual	30.7	PRE	0	79	94	12
2 Expert + NIS	1.128 + 0.25%	EP	0	22	43	8
3 Broadstrike + Dual	30.7	PRE	0	85		
Expert + NIS	1.128 + 0.25%	POST			93	10
4 Broadstrike + Dual	30.7	PRE	0	79		
Expert + Action + NIS	1.128 + 0.057 + .25%	POST			99	9

(Continued)

Table 11. Weed control in soybean, Harvey County Experiment Field, Hesston, KS 1998.

Herbicide Treatment <sup>1</sup>	Rate	Timing <sup>2</sup>	Injury 7/28	Lacg <sup>3</sup> Control 8/28	Paam <sup>4</sup> Control 8/28	Yield
	oz ai/a		%	%	%	bu/a
5 Broadstrike + Dual Expert + Cobra + COC + UAN	30.7 1.128 + 1.0 + 1 pt + 1 pt	PRE POST	20	81	95	11
6 Broadstrike + Dual Expert + Reflex + COC + UAN	30.7 1.128 + 2.0 + 1 pt + 1 pt	PRE POST	0	87	96	12
7 Broadstrike + Dual Expert + Roundup Ultra	30.7 1.128 + 12.0	PRE POST	0	100	100	13
8 Broadstrike + Dual Roundup Ultra	30.7 12.0	PRE POST	0	100	100	17
9 Expert + Roundup Ultra	1.128 + 12.0	POST	0	96	99	13
10 Roundup Ultra	12.0	POST	0	84	97	12
11 Expert + Roundup Ultra Expert + Roundup Ultra	0.571 + 6.0 0.571 + 6.0	POST POST 2	0	94	99	11
12 Roundup Ultra Roundup Ultra	8.0 8.0	POST POST 2	0	94	100	16
13 Authority First + Classic Roundup Ultra+ Classic + NIS + AMS	1.87 + 0.375 12 + 0.0825 0.25% + 2 lb	PRE POST	0	98	100	14
14 Authority First + Prowl Assure II + COC Synchrony STS + COC + AMS	3.375 + 16.5 0.88 + 1% 0.21 + 1% + 4 lb	PRE POST POST 2	0	95	100	16
15 Authority First + Classic Assure II + COC	3.2 + 0.64 1.1 + 1%	PRE POST	0	97	94	14
16 Dual Synchrony STS + COC + AMS	32 0.21 + 1% + 4 lb	PRE POST	0	71	90	9
17 Roundup Ultra+ AMS	12 + 3.4 lb	POST	0	83	94	14
18 Roundup Ultra+ Classic NIS + AMS	12 + 0.0825 + 0.25% + 2 lb	POST	0	87	98	13

(Continued)

Table 11. Weed control in soybean, Harvey County Experiment Field, Hesston, KS 1998.

Herbicide Treatment <sup>1</sup>	Rate	Timing <sup>2</sup>	Injury 7/28	Lacg <sup>3</sup> Control 8/28	Paam <sup>4</sup> Control 8/28	Yield
	oz ai/a		%	%	%	bu/a
19 Prowl	16.5	PRE	5	76		11
Pursuit + COC + UAN	1.0 + 2 pt + 4 pt	POST			79	
20 Prowl	16.5	PRE	8			
Pursuit + Pinnacle + COC + UAN	1.0 + 0.047 + 2 pt + 4 pt	POST		57	90	7
21 Prowl	16.5	PRE	7			
Pursuit + Cobra + COC + UAN	1.0 + 1.5 + 1 pt + 2 pt	POST		65	74	9
22 Pursuit + Sun-It II + UAN	1.0 + 1.5 pt + 2 pt	POST	0	73	65	12
23 Raptor + Sun-It II + UAN	0.624 + 1.5 pt + 2 pt	POST	3	81	90	9
24 No treatment			0	0	0	--
LSD .05			5	14	9	NS

<sup>1</sup> Herbicide formulations: Action 0.91 L, Assure II 0.88 EC, Authority First 75 DF, Expert 57 WG, Broadstrike + Dual 7.67 E, Classic 25 DF, Cobra 2 SC, Dual II 7.8 EC, Pinnacle 25 DF, Prowl 3.3 EC, Pursuit 70 DG, Reflex 2 EC, Roundup Ultra 4 SC, Synchrony STS 42 DF. COC = Farmland Crop Oil Plus. NIS = Pen-A-Trate II nonionic surfactant. UAN = 28% urea ammonium nitrate fertilizer. UAN in treatment 5 and AMS in treatment 17 applied immediately after tank mix.

<sup>2</sup> PRE= preemergence to soybeans and weeds on June 11; POST = postemergence to 6 to 32 in. pigweeds and 1.5 to 7 in. large crabgrass on July 14; POST 2 = second postemergence application to 2 to 12 in. pigweeds on July 15 (treatment 14) or 2 to 18 in. pigweeds and 1 to 8 in. large crabgrass on August 11 (treatments 11 and 12).

<sup>3</sup> Lacg = large crabgrass.

<sup>4</sup> Paam = Palmer amaranth. Weed population included some redroot pigweeds.

# WEED CONTROL IN SOLID-SEEDED VERSUS ROW-PLANTED ROUNDUP READY SOYBEAN

Mark M. Claassen and Phillip W. Stahlman

## Summary

Late postemergence (LP) and sequential (SEQ) applications of three Roundup Ultra rates were compared with standard preemergence (PRE) and postemergence herbicide treatments in 8-inch and 30-inch row soybean. Initial dry conditions adversely affected PRE Prowl. Squadron provided excellent PRE control of pigweeds as well as a level of large crabgrass control similar to that achieved with single, LP applications of Roundup Ultra. All Roundup Ultra treatments provided excellent control of pigweeds with generally small differences among rates. SEQ tended to provide better results than LP Roundup Ultra, particularly on large crabgrass. Roundup Ultra rates performed similarly in both LP and SEQ applications. Pigweed control with LP Pursuit was inferior to that with Roundup Ultra because of unusually large weed size at application. Row spacing had no observable effect on weed control. Soybean yields were very low and variable because of drought stress. Among treatments with Roundup Ultra alone, 30-inch rows produced 3.9 bu/a more than 8-inch rows. This yield advantage for 30-inch rows was 3.7 bu/a more with SEQ than with LP Roundup Ultra.

## Introduction

Roundup has been used widely for nonselective weed control in fallow periods between crops and in no-till production prior to crop emergence. The development of Roundup-resistant soybean makes it possible to use this herbicide for broad spectrum postemergence weed control during the growing season. Questions remain concerning the optimum rate and time of Roundup application as well as the

impact of row spacing on weed control efficacy. This study focused on these issues, the use of a preemergent herbicide ahead of Roundup postemergence, and the relative effectiveness of the Roundup program versus a total preemergence weed control program or standard postemergence treatments.

## Procedures

The experiment site was cropped to oats in 1997. The soil was a Smolan silt loam with pH 6.7 and 2.4% organic matter. Pigweed and large crabgrass seed were broadcast prior to the last preplant tillage operation to promote uniformity of weed populations. Asgrow 3601 RR + STS and Asgrow 3704 STS soybean were planted on June 10, 1998, in 8-inch and 30-inch rows at 142,000 and 154,000 seeds/a, respectively. Seedbed condition was excellent.

PRE applications, just after planting, as well as postemergence treatments, were made in 20 gal/a of water with XR8003 nozzles at 18 or 20 psi. Subsequent treatments were scheduled for early postemergence (EP) and LP, corresponding to weed heights of 1 to 3 inches and 4 to 6 inches. SEQ treatments were planned for two successive applications at EP.

Because of weather interference, EP was never applied. LP as well as the first of the SEQ treatments were made to 3- to 27-inch pigweeds and 1.5- to 8-inch large crabgrass. The second application in SEQ treatments was made to 4- to 9-inch pigweeds and 1.5- to 7-inch tall large crabgrass.

All treatments were replicated three times. Crop injury and weed control were rated at

various times during the growing season. Soybean was harvested on October 27, 1998.

## Results

Three weeks of dry weather preceded planting. Although soil physical condition at planting was excellent, soil moisture was insufficient for soybean emergence. Hard rains 11 days later caused soil crusting and resulted in uneven soybean stands in narrow-row plots. Rainfall totaled 3.01 inches for the period 11 to 15 days after planting. Soybean populations averaged approximately 45,740 plants/a in 8-inch rows and 99,320 in 30-inch rows. Dense pigweed (mixture of redroot and Palmer amaranth) and large crabgrass populations developed. In late June, densities of 4 to 10 pigweeds/sq ft and 4 to 33 large crabgrass plants/sq ft were observed across the site.

Unforecasted heavy rains in early July prevented the scheduled EP Roundup Ultra application. A prolonged hot and wet period that followed allowed pigweed growth to explode. Consequently, meaningful timing comparisons with Roundup Ultra were limited to LP and SEQ treatments.

No apparent differences occurred between redroot pigweed and Palmer amaranth responses to herbicides. Because of their relative distribution across the site, both were included in a single control evaluation for pigweeds. PRE Squadron gave excellent control of pigweeds and fair to good control of large crabgrass (Table 12). However, PRE Prowl was not effective in controlling these species under existing conditions. As a result, Prowl did not provide much assistance in holding down weed development ahead of either Roundup Ultra or Pursuit postemergence applications. All Roundup

Ultra treatments provided excellent control of pigweeds and good to excellent control of large crabgrass. Roundup Ultra rates of 1.5 or 2.0 pt/a tended to be more effective than 1 pt/a on these species, but differences among rates were generally small. The effect of Roundup Ultra application time on pigweeds was relatively small but significant. Timing effect was more notable in large crabgrass control. In both cases, SEQ providing better results than LP Roundup Ultra. No interactions occurred between Roundup Ultra rate and time of application. Row spacing had no observable effect on weed control. Pursuit following PRE Prowl did not provide acceptable pigweed control because of late application.

No herbicide injury of consequence was observed. Drouth stress caused low soybean yields averaging only 9.4 bu/a across herbicide treatments. Untreated check plots were not harvestable by combine because of extreme weed infestation. Among treatments with Roundup Ultra alone, the only significant main effect on yield was that of row spacing, with 30-inch rows producing 3.9 bu/a more than 8-inch rows (Table 13). The time of application by row spacing interaction was significant in that the yield advantage for 30-inch rows was 3.7 bu/a more with SEQ than with LP Roundup Ultra treatments. Lowest yields in 30-inch rows occurred with LP Roundup Ultra at 1 pt/a alone or following Prowl. Yields of non-Roundup Ready soybean with Squadron or Prowl Pre plus Pursuit LP were inferior to those of Roundup Ready soybean with the best Roundup Ultra treatments.

This project was funded partially by the Kansas Soybean Commission.

Table 12. Effects of herbicide and row spacing on weeds and soybean, Harvey County Experiment Field, Hesston, KS, 1998.

Herbicide Treatment/ Row Spacing/Variety <sup>1</sup>	Rate/a Product	Timing <sup>2</sup>	Injury 7/28 %	Lacg Control <sup>3</sup> 8/28 %	Pigweed Control <sup>4</sup> 8/28 %	Yield bu/a
1 Roundup Ultra 8 RR	1.0 pt	LP	0	82	94	7.4
2 Roundup Ultra 30 RR	1.0 pt	LP	0	83	98	9.4
3 Roundup Ultra 8 RR Roundup Ultra	1.0 pt 1.0 pt	SEQ	0	93	100	8.0
4 Roundup Ultra 30 RR Roundup Ultra	1.0 pt 1.0 pt	SEQ	0	93	100	11.9
5 Roundup Ultra 8 RR	1.5 pt	LP	0	82	95	8.6
6 Roundup Ultra 30 RR	1.5 pt	LP	0	83	98	11.2
7 Roundup Ultra 8 RR Roundup Ultra	1.5 pt 1.5 pt	SEQ	0	97	100	5.1
8 Roundup Ultra 30 RR Roundup Ultra	1.5 pt 1.5 pt	SEQ	0	98	100	12.2
9 Roundup Ultra 8 RR	2.0 pt	LP	0	85	99	10.1
10 Roundup Ultra 30 RR	2.0 pt	LP	0	84	98	11.6
11 Roundup Ultra 8 RR Roundup Ultra	2.0 pt 2.0 pt	SEQ	0	97	100	7.1
12 Roundup Ultra 30 RR Roundup Ultra	2.0 pt 2.0 pt	SEQ	0	99	100	13.2
13 Prowl 8 RR Roundup Ultra	2.5 pt 1.0 pt	PRE LP	0	88	98	8.7
14 Prowl 30 RR Roundup Ultra	2.5 pt 1.0 pt	PRE LP	0	85	97	10.0
15 Prowl 8 RR Roundup Ultra	2.5 pt 1.5 pt	PRE LP	0	89	99	8.6
16 Prowl 30 RR Roundup Ultra	2.5 pt 1.5 pt	PRE LP	0	84	98	11.2
17 Squadron 8 RR	3.0 pt	PRE	0	81	100	10.6
18 Squadron 30 RR	3.0 pt	PRE	0	81	98	9.0
19 Squadron 8 N	3.0 pt	PRE	0	77	98	7.2
20 Squadron 30 N	3.0 pt	PRE	0	80	99	10.2

(Continued)

Table 12. Effects of herbicide and row spacing on weeds and soybean, Harvey County Experiment Field, Hesston, KS, 1998.

Herbicide Treatment/ Row Spacing/Variety <sup>1</sup>	Rate/a Product	Timing <sup>2</sup>	Injury 7/28 %	Lacg Control <sup>3</sup> 8/28 %	Pigweed Control <sup>4</sup> 8/28 %	Yield bu/a
21 Prowl 8 N Pursuit + Sun-It II + UAN	2.5 pt 1.4 oz + 1 qt + 1 qt	PRE LP	0	32	64	8.4
22 Prowl 30 N Pursuit + Sun-It II + UAN	2.5 pt 1.4 oz + 1 qt + 1 qt	PRE LP	0	37	73	6.0
23 Untreated 8 N			0	0	0	---
24 Untreated 30 N			0	0	0	---
LSD .05			NS	6	9	2.9

<sup>1</sup> Herbicide formulations: Prowl 3.3 EC, Pursuit 70 DG, Roundup Ultra 4 SC, Squadron 2.33 EC.

UAN = 28% urea ammonium nitrate fertilizer.

RR = Asgrow AG 3601 Roundup Ready + STS soybeans. N = Asgrow A3704 STS soybeans.

<sup>2</sup> Pre = preemergence to soybeans and weeds on June 10.

LP = Late postemergence to 3 to 27-in. pigweeds and 1.5 to 8-in. large crabgrass on July 14;

Seq = two sequential applications of base herbicide rate: LP followed by later postemergence treatment to 4 to 9-in. weeds and 1.5 to 7-in. large crabgrass on August 11.

<sup>3</sup> Lacg = large crabgrass.

<sup>4</sup> Mixed population of redroot pigweed and Palmer amaranth.

Table 13. Effects of Roundup Ultra and row spacing on weeds and soybean, Harvey County Experiment Field, Hesston, KS, 1998.

Treatment Means <sup>1</sup>	Rate/a Product	Timing	Row Spacing	Lacg Control 8/28	Pigweed Control 8/28	Yield
				%	%	bu/a
Rate	1.0 pt			88	98	9.2
	1.5 pt			90	98	9.3
	2.0 pt			91	99	10.5
	LSD .05			2	NS	NS
Timing		LP		83	97	9.7
		SEQ		96	100	9.6
		LSD .05		2	1	NS
Row Spacing			8"	89	98	7.7
			30"	90	99	11.6
			LSD .05	NS	NS	1.3
Rate x Timing	1.0 pt	LP		83	96	8.4
		SEQ		93	100	9.9
	1.5 pt	LP		83	97	9.9
		SEQ		98	100	8.6
	2.0 pt	LP		84	99	10.8
		SEQ		98	100	10.2
	LSD .05			NS	NS	NS
	Rate x Row Spacing	1.0 pt		8	88	97
			30	88	99	10.7
1.5 pt			8	90	98	6.9
			30	91	99	11.7
2.0 pt			8	91	100	8.6
			30	91	99	12.4
LSD .05				NS	NS	NS
Timing x Row Spacing			LP	8	83	96
		30		83	98	10.7
		SEQ	8	96	100	6.7
			30	97	100	12.4
		LSD .05		NS	NS	1.9

<sup>1</sup> See information in footnotes with Table 12.

# SPRING OAT VARIETIES

Mark M. Claassen and Kraig L. Roozeboom

## Summary

Forage and grain yield potential of 17 spring oat varieties were evaluated. Barley yellow dwarf disease was severe in some varieties. Weather conditions were adverse during the grain filling stage. I1862081, Prairie, and Rodeo produced the highest forage yields as well as the top grain yields.

## Introduction

Spring oats can serve a useful roll as a rotational crop when weather or soil conditions prevent implementation of a particular crop sequence. They also can provide a significant grain or forage resource in a diversified crop-livestock operation. Performance tests with oats were conducted here to evaluate both forage and grain yield potential and other agronomic characteristics of varieties currently available.

## Procedures

Seventeen spring oat varieties were seeded on March 3, 1998 at 64 lb/a on a site cropped to winter wheat in 1997. Experimental design was a split plot with four replications.

Fertilizer (90 lb/a of N and 32 lb/a of P<sub>2</sub>O<sub>5</sub>) was broadcast and incorporated before planting. Bronate at 1.5 pt/a was applied for weed control on May 7, 1998. Plots were harvested for forage on June 16 and for grain on July 1.

## Results

Cold and wet weather followed oat planting. Emergence occurred in late March. Brawn had only 73% stand, but the remaining varieties had 92 to 100% stands. Warm, dry weather in May and June was unfavorable for oat grain development. Also, barley yellow dwarf disease had a significant impact, with severe symptoms in some varieties. Jerry, Rio Grande, and Eli were moderately susceptible to susceptible and had the poorest BYVD scores (Tables 14, 15).

Lodging and shattering were minor. Top forage yields of 2.21 to 2.36 ton/a dry matter were produced by I1862081, Prairie, and Rodeo. These varieties also had the highest grain yields, which averaged only about 56% of their 1997 yields. Lowest forage and grain yields were recorded for Brawn and Eli.

Table 14. Performance of spring oat varieties (forage yield), Harvey County Experiment Field, Hesston, KS, 1998.

Variety	Origin	Dry Matter <sup>1</sup>	Harvest Mois.	Grain Maturity <sup>2</sup>	Stand	Plant Ht	Lod-ing	BYVD <sup>3</sup>
		ton/a	%	score	%	in	%	score
Bates	KS FDN	1.91	56	4	100	28	5	5.5
Bay	Wisconsin	2.03	66	1	100	26	0	1.8
Brawn	Illinois	1.12	63	1	73	24	3	5.5
Don	KS FDN	1.80	58	3	100	28	1	6.0
Eli	-----	1.23	59	2	92	28	2	9.0
Gem	Wisconsin	2.08	64	1	98	30	1	5.8
IL862081	Illinois	2.36*	57	3	100	31	1	2.5
IL891730	Illinois	2.11	60	2	100	29	1	3.5
IN09201	Indiana	1.70	63	2	99	27	2	4.0
Jerry	N. Dakota	1.83	63	2	97	29	4	7.3
Jim	Minnesota	2.15	57	3	100	30	1	4.3
Larry	KS FDN	1.90	61	3	99	26	3	5.8
Ogle	KS FDN	2.02	59	2	99	28	1	4.3
Prairie	Wisconsin	2.21*	61	2	100	28	1	3.3
Rio Grande	Colorado	1.93	65	1	100	26	0	8.3
Rodeo	Illinois	2.21*	60	3	100	30	1	3.5
Troy	S. Dakota	2.08	66	1	99	30	0	6.0
Test Avg.		1.92	61	--	97	28	2	5.2
LSD .05		0.18	2	--	6	1	2	1.1

<sup>1</sup> Average of four replications. \* = upper LSD group.

<sup>2</sup> Grain maturity score at forage harvest on a scale of 1 to 5: 1=milk stage; 3=soft-dough stage; 5=hard-dough stage. Observations made on one replication only.

<sup>3</sup> BYDV = Barley yellow dwarf virus score on a scale of 1 to 9: 1=Resistant; 2=Resistant/Moderately resistant; 3=Moderately resistant; 4=Moderately resistant/Intermediate; 5=Intermediate; 6=Intermediate/Moderately susceptible; 7=Moderately susceptible; 8=Moderately susceptible/Susceptible; 9=Susceptible. Ratings by Bob Bowden.

Table 15. Performance of spring oat varieties (grain yield), Harvey County Experiment Field, Hesston, KS, 1998.

Variety	Origin	Yield <sup>1</sup>				Test Wt	Maturity <sup>2</sup>	Plant Ht	Lodging	BYDV <sup>3</sup>
		1998	1997	1996	1995					
			bu/a			lb/bu	days	in	%	score
Bates	KS FDN	29	67	86	36	31.0	0	27	5	5.8
Bay	Wisconsin	33	82	64	--	29.3	7	26	0	4.5
Brawn	Illinois	19	75	114*	49*	28.5	8	24	0	5.3
Don	KS FDN	35	66	92	42	32.2	0	26	13	5.8
Eli	-----	11	--	--	--	29.3	3	30	9	9.0
Gem	Wisconsin	31	83	85	--	29.2	5	30	4	2.8
IL862081	Illinois	50*	98*	--	--	31.3	1	30	13	2.3
IL891730	Illinois	39	79	--	--	31.8	3	28	2	3.3
IN09201	Indiana	39	84	--	--	31.5	1	28	6	4.3
Jerry	N. Dakota	22	76	--	--	29.9	4	29	3	7.3
Jim	Minnesota	36	85	--	--	31.3	1	28	6	4.0
Larry	KS FDN	33	57	75	18	31.7	0	26	2	6.3
Ogle	KS FDN	40	87	77	42	29.0	3	28	7	4.5
Prairie	Wisconsin	49*	74	91	33	30.2	3	27	8	3.3
Rio Grande	Colorado	25	76	--	--	26.4	9	27	0	8.5
Rodeo	Illinois	46*	88	--	--	30.9	3	29	7	4.0
Troy	S. Dakota	27	78	--	--	28.2	8	30	1	4.8
Test Avg.		33	76	82	32	30.1	3	28	5	5.2
LSD .05		6	8.8	6	3	1.4	0.7	1	4.8	1.2

<sup>1</sup> Average of four replications adjusted to 12.5% moisture. \* = upper LSD group.

<sup>2</sup> Days later than Bates, which reaching 50% heading on May 25.

<sup>3</sup> BYDV = Barley yellow dwarf virus score on a scale of 1 to 9: 1=Resistant; 2=Resistant/Moderately resistant; 3=Moderately resistant; 4=Moderately resistant/Intermediate; 5=Intermediate; 6=Intermediate/Moderately susceptible; 7=Moderately susceptible; 8=Moderately susceptible/Susceptible; 9=Susceptible. Ratings by Bob Bowden.

# IRRIGATION AND NORTH CENTRAL KANSAS EXPERIMENT FIELDS

## Introduction

The 1952 Kansas legislature provided a special appropriation to establish the Irrigation Experiment Field in order to serve expanding irrigation development in north-central Kansas. The original 35-acre field was located 9 miles northwest of Concordia. In 1958, the field was relocated to its present site on a 160-acre tract near Scandia in the Kansas-Bostwick Irrigation District. Water is supplied by the Miller Canal and stored in Lovewell Reservoir in Jewell County, Kansas and Harlen County Reservoir at Republican City, Nebraska. A 5-acre site in the Republican River Valley on the Mike Brazon Farm also is utilized for irrigated-crop research. In 1997, there were 125,000 acres of irrigated cropland in north-central Kansas. Current research on the field focuses on managing irrigation water and fertilizer in reduced-tillage and crop-rotation systems.

The 40-acre North Central Kansas Experiment Field, located 2 miles west of Belleville, was established on its present site in 1942. The field provides information on factors that allow full development and wise use of natural resources in north-central Kansas. Current research emphasis is on

fertilizer management for reduced-tillage crop production and management systems for dryland production corn, sorghum, and soybean.

## Soil Description

The predominate soil on both fields is a Crete silt loam. The Crete series consists of deep, well-drained soils that have a loamy surface underlain by a clayey subsoil. These soils developed in loess on nearly level to gently undulating uplands. The Crete soils have slow to medium runoff and slow internal drainage and permeability. Natural fertility is high. Available water holding capacity is approximately 0.19 inch of water per inch of soil.

## 1998 Weather Information

The 1998 growing season was characterized by above-normal rainfall in April but below-normal rainfall in May and June (Table 1). Rainfall in July was ideal but below normal in August and September. Temperatures were near normal throughout the spring and early summer but were much above normal in August and September.

Table 1. Weather data for the Irrigation and North Central Kansas Experiment Fields, Scandia and Belleville, KS 1998.

Month	Rainfall, inches			Temperature <sup>o</sup> F			
	Scandia 1998	Average	Belleville 1998	Daily Mean	Average Mean	Growth Units	
						1998	Average
April	4.2	2.4	4.2	51	53	211	242
May	0.7	3.7	0.7	68	64	537	427
June	3.9	4.8	3.9	72	74	644	718
July	5.5	3.3	4.8	82	79	932	835
August	0.7	3.3	1.4	79	77	781	748
Sept.	1.1	3.5	2.0	71	67	590	518
Total	16.1	20.9	17.0	71	69	3694	3487

# EFFECTS OF CROPPING SYSTEM AND NITROGEN FERTILIZATION ON NO-TILLAGE GRAIN SORGHUM PRODUCTION

W. Barney Gordon, David A. Whitney, and Dale L. Fjell

## Summary

When averaged over nitrogen (N) rates, 1982-1995 yields were 23 bu/a greater in sorghum rotated with soybeans than in continuous sorghum. When no N was applied, rotated sorghum yielded 32 bu/a more than continuous sorghum. In the continuous system, grain sorghum yield continued to increase with increasing N rate up to 90 lb/a. In the soybean rotation, sorghum yields increased with increasing N rate only up to 60 lb/a. When averaged over N rate, no-tillage grain sorghum rotated with soybeans reached mid-bloom 7 days sooner than continuous grain sorghum. Two knife-applied N sources (anhydrous ammonia and 285 UAN) were evaluated during 1982-1989. No grain sorghum yield differences resulted from N source. The 17-year soybean yield average was 36 bu/a. Soybean yields were not affected by N applied to the previous grain sorghum crop. In 1996, four additional N rates (120, 150, 180, and 210 lb/a) were added to the experiment. When averaged over the period 1996-1998, yields were greater in the rotated system than in the continuous sorghum at all levels of N. Yields in the continuous system continued to increase with increasing N rate up to 90 lb/a. Yields in the rotated system were maximized with application of 60 lb/a N.

## Introduction

Crop rotations were necessary to maintain soil productivity before the advent of chemical fertilizers. Biological fixation of atmospheric N is a major source of N for plants in natural systems. Nitrogen fixation through legume-

*Rhizobium* associations is utilized extensively in agricultural systems. Using a legume in a crop rotation system can reduce the N requirement for the following nonlegume crop. Other benefits of legume rotations include breaking disease and insect cycles, helping weed control programs, and decreasing the toxic effects of crop residues. This study evaluates N rates for continuous grain sorghum and grain sorghum grown in annual rotation with soybeans in a no-tillage production system.

## Procedures

This study was established in 1980 at the North Central Kansas Experiment Field, located near Belleville, on a Crete silt loam soil. Data are reported starting in 1982. Treatments included cropping system (continuous grain sorghum and grain sorghum rotated with soybeans) and N rates (0, 30, 60, and 90 lb/a). In 1982-1989, the two N sources anhydrous ammonia and urea-ammonium nitrate solution (28% UAN) were evaluated. Both N sources were knife applied in the middle of rows from the previous year's crop. After 1989, anhydrous ammonia was used as the sole N source. In each year, N was knife applied 7-14 days prior to planting. Grain sorghum was planted at the rate of 60,000 seed/a, and soybeans were planted at the rate of 10 seed/ft. in 30-inch rows. Soybean yields were not affected by N applied to the previous sorghum crop and, therefore, are averaged over all N rates. In 1996, four additional N rates (120, 150, 180, and 210 lb/a) were added to the experiment in order to further define N response.

## Results

In the continuous grain sorghum system, grain yields (1982-1995) continued to increase with increasing N rate up to 90 lb/a (Table 2). Sorghum yields in the rotated system were maximized with an application of 60 lb/a N. When no N was applied, rotated sorghum yielded 32 bu/a more than continuous sorghum. When four additional N rates were added, sorghum yields were greater in the soybean rotation than in the continuous system at all levels of N (Table 3). Addition of N alone did not make up yield losses in a

continuous sorghum production system. Over the 17-year period (1982-1998), soybean yields averaged 36 bu/a and were not affected by N applied to the previous sorghum crop (Table 4). Two knife-applied N sources, anhydrous ammonia and 28% UAN, were evaluated from 1982-1989. When averaged over cropping system and N rate, yields were 60 and 59 bu/a for anhydrous ammonia and UAN, respectively. When averaged over N rates, the number of days from emergence to mid-bloom was 7 days shorter in the rotated system than in the continuous system (Table 2).

Table 2. Long-term effects of cropping system and nitrogen rate on grain sorghum yields and number of days from emergence to mid-bloom, North Central Kansas Expt. Field, Belleville, KS.

N Rate	Cropping System	Grain Yield 1982-1995	Days to Mid-Bloom 1992-1995
lb/a		bu/a	
0	Continuous	43	64
	Rotated	75	56
30	Continuous	59	61
	Rotated	84	55
60	Continuous	70	59
	Rotated	92	53
90	Continuous	80	58
	Rotated	92	53
<u>System means</u>			
	Continuous	63	61
	Rotated	86	54
<u>N Rate Means</u>			
0		59	60
30		72	58
60		81	56
90		86	56
LSD(0.05)		9	1

Table 3. Effects of cropping system and Nitrogen rate on grain sorghum yields, Belleville, KS 1996-1998.

N Rate	Cropping Systems	1996	1996	1998	Avg.
lb/a				bu/a	
0	Continuous	92	51	55	66
	Rotated	120	88	87	98
30	Continuous	110	71	75	85
	Rotated	137	108	115	120
60	Continuous	131	110	118	120
	Rotated	164	128	142	145
90	Continuous	143	121	126	130
	Rotated	163	141	144	149
120	Continuous	148	122	128	133
	Rotated	162	144	145	150
150	Continuous	148	120	127	132
	Rotated	162	143	145	150
180	Continuous	148	121	128	132
	Rotated	162	144	145	150
210	Continuous	148	122	128	133
	Rotated	162	145	145	151
<u>System Means</u>					
	Continuous	134	105	111	117
	Rotated	154	130	134	139
<u>N Rate Means</u>					
0		106	70	71	82
30		124	90	95	103
60		148	119	130	132
90		153	131	135	140
120		155	133	137	142
150		155	132	136	141
180		155	133	137	142
210		155	134	137	142
LSD(0.05)		8	6	6	

Table 3. Effects of cropping system and Nitrogen rate on grain sorghum yields, Belleville, KS 1996-1998.

N Rate	Cropping Systems	1996	1996	1998	Avg.
lb/a				bu/a	
0	Continuous	92	51	55	66

Table 4. Yields of soybeans grown in rotation with grain sorghum, North Central Kansas Experiment Field, Belleville, KS, 1982-1998.

Year	Yield	Year	Yield
	bu/a		bu/a
1982	38	1991	12
1983	15	1992	58
1984	20	1993	56
1985	28	1994	32
1986	48	1995	41
1987	48	1996	61
1988	18	1997	36
1989	25	1998	38
1990	30	Average	36

# EFFECTS OF PLACEMENT, RATE, AND SOURCE OF STARTER FERTILIZER CONTAINING POTASSIUM ON CORN AND SOYBEAN PRODUCTION

W. Barney Gordon

## Summary

Field studies were conducted at the Irrigation Experiment Field, located near Scandia, on a Crete silt loam soil. Starter fertilizer (7-21-7) included two sources of potassium (K): sulfate of potassium (SOP) and potassium chloride (KCL). The test also included two placement methods (in-furrow with the seed and 2 inches to the side and 2 inches below the seed at planting) and five application rates (50, 75, 100, 150, 200 lb/a of 7-21-7). A no-starter check plot also was included in the experiment. Sulfur rates were balanced so that all plots received the same amount, regardless of K source. Experiments were conducted with both corn and soybeans. For the corn experiment, nitrogen (N) as urea-ammonium nitrate solution (28% UAN) was applied immediately after planting so that all plots received 200 lb/a N. Soybeans received no additional N. When liquid 7-21-7 starter fertilizer containing KCL was placed in-furrow, grain yield, plant stand, and early season dry matter were reduced in both the corn and soybean experiments. In the corn experiment, starter fertilizer containing KCL applied at the 100 lb/a rate reduced yield by 12 bu/a compared to the same rate applied 2 x 2. Corn yield was reduced 40 bu/a when starter fertilizer containing KCL was applied in-furrow at the 200 lb/a rate. When starter fertilizer containing SOP was placed in-furrow, no yield reduction was seen except at the 200 lb/a rate. When starter fertilizer containing KCL as the K source was placed in-furrow with soybean seed, yields and plant populations were reduced regardless of rate. Yields and populations of soybean declined when in-furrow rates of 7-21-7 starter fertilizer containing SOP exceeded 100 lb/a.

## Procedures

This irrigated ridge-tilled experiment was conducted at the Irrigation Experiment Field, near Scandia, on a Crete silt loam soil. Analysis by the KSU Soil Testing Lab showed that in the corn experimental area, initial soil pH was 6.4; organic matter content was 2.4%; and Bray-1 P and exchangeable K in the top 6 inches of soil were 43 and 380 ppm, respectively. In the soybean area, soil pH was 6.5, organic matter content was 2.2%, Bray-1 P was 45 ppm, and exchangeable K was 350 ppm in the top 6 inches of soil. The experimental design was a randomized complete block with three factors. Both the corn and soybean tests included starter fertilizer (7-21-7) made with two K sources applied either in-furrow or 2 x 2 at five different rates. A no-starter check also was included. The two sources of K were sulfate of potassium (SOP) and potassium chloride (KCL). A liquid 7-21-7 fertilizer was made using ammonium polyphosphate (10-34-0) and either SOP or KCL and was applied at 50, 75, 100, 150, and 200 lb/a. Sulfur was balanced so that all plots received the same amount. Nitrogen as 28% UAN also was balanced on all corn plots to give a total of 200 lb/a. The soybean experiment received no additional N. The corn hybrid Dekalb 632 was planted on 22 April at the rate of 31,000 seed/a. The soybean variety Dekalb CX370RR was planted on 12 May at the rate of 200,000 seed/a in 30-inch rows. Both the corn and soybeans were grown in a ridge-tillage production system. Stand counts were taken 3 weeks after emergence. Whole plant samples (20 plants/plot) were taken at the V-6 stage. The center two rows of each four row plot were harvested for yield determination.

## Results

Corn grain yields were affected by a starter fertilizer x placement x rate interaction (Table 5). When SOP was used as the K source in the 7-21-7 starter fertilizer and placed in-furrow with the seed, grain yields were not different than those with fertilizer placed 2 x 2, except at the 200 lb/a rate. When 200 lb/a of 7-21-7 starter fertilizer was applied in-furrow, yields were 14 bu/a less than when the same rate was applied 2 x 2. Plant population and whole-plant dry weight at the V-6 stage were reduced by an in-furrow application of 200 lb/a 7-21-7 containing SOP. When KCL was used as the K source for 7-21-7 starter fertilizer placed in-furrow, yields were reduced at all application rates compared to the 2 x 2 placement. A 50 lb/a in-furrow application of 7-21-7 containing KCL reduced grain yield by 12 bu/a and plant population by 3,198 plants/a. At the 200 lb/a rate, yields were reduced by 40

bu/a with in-furrow application of starter fertilizer containing KCL.

When starter fertilizer containing KCL was placed in-furrow with the soybean seed, yield and plant population were reduced regardless of rate (Table 6). At the 50 lb/a rate of 7-21-7 containing KCL, yields were 9 bu/a less when fertilizer was placed in-furrow as compared to 2 x 2. At the 200 lb/a rate of 7-21-7 placed in-furrow, yields were reduced 21 bu/a. Yields and population of soybean declined when in-furrow rate of 7-21-7 starter fertilizer containing SOP exceeded 100lb/a.

In both corn and soybean experiments, in-furrow applications of starter fertilizer containing SOP resulted in less salt injury than those containing KCL. Even at low application rates, in-furrow applications of fertilizer containing KCL reduced plant population and yield.

Table 5. Effects of placement, rate, and K source of 7-21-7 starter fertilizer on grain yield, population, and V-6 stage whole-plant dry matter uptake of corn, Irrigation Experiment Field, Scandia, KS, 1998.

Source	Placement	Rate of 7-21-7 lb/a	Yield, 1998 bu/a	Yield, 1997	Population, 1998 plants/a	V6 Dry Wt. 1998 lb/a
SOP**	In-furrow	0*	165	185	31405	166
		50	180	222	31399	305
		75	192	225	31401	325
		100	195	226	31320	322
		150	191	227	30612	320
	2 x 2	200	182	221	27423	228
		50	181	217	31410	320
		75	190	224	31422	369
		100	196	227	31397	370
		150	198	232	31425	380
		200	196	232	31415	378

(Continued)

Table 5. Effects of placement, rate, and K source of 7-21-7 starter fertilizer on grain yield, population, and V-6 stage whole-plant dry matter uptake of corn, Irrigation Experiment Field, Scandia, KS, 1998.

Source	Placement	Rate of 7-21-7	Yield, 1998	Yield, 1997	Population, 1998	V6 Dry Wt. 1998
		lb/a	bu/a		plants/a	lb/a
KCL***	In-furrow	50	170	200	28200	180
		75	168	195	25469	165
		100	165	191	24875	159
		150	164	189	23567	160
		200	158	184	21496	149
	2 x 2	50	182	220	31398	328
		75	188	226	31408	331
		100	195	226	31379	348
		150	198	228	31415	356
		200	198	227	31377	347
CV%		2.0	2.3	1.5	4.0	
LSD (0.05)****		8	9	485	22	

\*No-starter check plot was not included in statistical analysis.

\*\*7-21-7 Starter fertilizer made using sulfate of potassium (SOP) as the K source.

\*\*\*7-21-7 Starter fertilizer made using potassium chloride (KCL) as the K source.

\*\*\*\* Three-way interaction LSD (placement x rate x K source).

Table 6. Effects of placement, rate, and K source of 7-21-7 starter fertilizer on yield, population, and V-6 stage whole-plant dry matter of soybeans, Irrigation Experiment Field, Scandia, KS 1998.

Source	Placement	Rate of 7-21-7	Yield, 1998	Yield, 1997	Population, 1998	V-6 Dry Wt., 1998
		lb/a		bu/a	plants/a	lb/a
		0*	55	61	195543	220
SOP**	In-furrow	50	59	72	196056	310
		75	60	72	195840	315
		100	58	69	191987	289
		150	50	54	150897	268
		200	45	52	148642	240
	2 x 2	50	58	73	198631	315
		75	58	74	198386	320
		100	57	73	197980	326
		150	57	74	198164	330
		200	56	72	197690	327
KCL***	In-furrow	50	51	56	167854	227
		75	45	51	158975	215
		100	42	51	146896	200
		150	41	51	126785	188
		200	37	51	122189	162
	2 x 2	50	60	67	197896	322
		75	61	73	198325	341
		100	59	73	197964	327
		150	59	73	197836	322
		200	58	72	198253	324
CV%			4.8	5.1	4.0	4.1
LSD (0.05)****			7.0	8.0	9580	25

\*No-starter check plot was not included in statistical analysis.

\*\*7-21-7 Starter fertilizer made using sulfate of potassium (SOP) as the K source.

\*\*\*7-21-7 Starter fertilizer made using potassium chloride (KCL) as the K source.

\*\*\*\*Three-way interaction LSD (placement x rate x K source).

# RESPONSES OF CORN HYBRIDS TO STARTER FERTILIZER COMBINATIONS

W. Barney Gordon and Gary M. Pierzynski

## Summary

In previous research at the North Central Kansas Experiment Field, we found that some corn hybrids grown under reduced-tillage conditions responded to starter fertilizer containing nitrogen (N) and phosphorus (P) and others did not. Little information is available concerning variability in responsiveness among corn hybrids to starter fertilizer containing a complete complement of nutrients. This study evaluated the responses of four corn hybrids (Pioneer 3563, Pioneer 3346, Dekalb 591, and Dekalb 646) to starter fertilizer combinations containing N, P, potassium (K), sulfur (S), and zinc (Zn). The experiment was conducted on a Carr sandy loam soil located in the Republican River Valley near Scandia, KS. Starter fertilizer containing N and P increased V-6 stage dry weight compared to the no-starter check treatment for all corn hybrids tested. Grain yield of two of the corn hybrids (Pioneer 3563 and Dekalb 646) did not respond to starter fertilizer, regardless of elemental composition. Starter fertilizer containing N and P increased grain yield of Pioneer 3346 and Dekalb 591 by 24 and 15 bu/a, respectively, compared to the no-starter check. The addition of 10 lb/a S to the starter fertilizer mix resulted in further yield increases for Pioneer 3346 and Dekalb 591. Additions of K and Zn to the starter fertilizer mix did not increase yield benefit.

## Procedures

The ridge-tilled, furrow-irrigated corn study was conducted on a farmer's field in the Republican River Valley near Scandia, KS on a Carr sandy loam soil. Analysis by the KSU Soil Testing Lab showed that initial soil pH was 7.2,

organic matter content was 1%, Bray-1 P was 21 ppm, and exchangeable K was 280 in the surface 6 inches of soil. The site had been in ridge-tillage for 4 years prior to the establishment of this study. Corn hybrids used were: Pioneer 3563, Pioneer 3346, Dekalb 591, and Dekalb 646. The liquid starter fertilizer treatments used in both experiments are given in Table 7. Starter fertilizer was applied 2 inches to the side and 2 inches below the seed at planting. Corn was planted on 23 April at the rate of 30,000 seed/a. Immediately after planting, N was balanced on all plots to give a total of 200 lb/a. The N source used in the experiment was urea-ammonium nitrate solution (28% UAN), the P source was ammonium polyphosphate (10-34-0), the K source was KCL, the S source was ammonium thiosulfate, and the Zn source was a liquid Zn-NH<sub>3</sub> complex.

## Results

Starter fertilizer containing N and P improved V-6 stage dry matter production of all hybrids tested (Table 8). Additional response was achieved when the starter fertilizer mix contained S. Additions of K and Zn did not result in any further dry matter increase.

Two hybrids (Pioneer 3563 and Dekalb 646) did not show any yield response to starter fertilizer (Table 9). This is consistent with the results of previous studies using these hybrids. Starter fertilizer containing N and P increased grain yield of Pioneer 3346 and Dekalb 591 by 24 and 15 bu/a, respectively. Addition of S to the starter fertilizer mix resulted in further yield increases of 12 bu/a for Pioneer 3346 and 11 bu/a for Dekalb 591.

Starter fertilizer improved early-season growth in all hybrids included in the experiment. However, this did not translate into increased grain yield for all hybrids. Results of this work suggest that responses to

starter fertilizer can be economical for some hybrids even on soils not low in available nutrients, particularly when corn is planted in a high-residue production system.

Table 7. Starter fertilizer treatments, Scandia, KS 1998.

Treatment	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	S	ZN
1	0	0	0	0	0
2	30	30	0	0	0
3	30	30	20	0	0
4	30	30	0	10	0
5	30	30	0	0	1
6	30	30	20	10	1

Table 8. Mean effects of starter fertilizer combination on V-6 stage whole-plant dry weight of corn hybrids, Scandia, KS, 1998.

Hybrid		V-6 Whole Plant Dry Weight				
		lb/a				
Pioneer 3563		340				
Pioneer 3346		332				
Dekalb 591		317				
Dekalb 646		352				
LSD (0.05)		19				
Starter Combination						
N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	S	Zn		
-----lb/a-----						
0	0	0	0	0	150	
30	30	0	0	0	340	
30	30	20	0	0	365	
30	30	0	10	0	398	
30	30	0	0	1	362	
30	30	20	10	1	395	
LSD(0.05)		22				

Table 9. Effects of starter fertilizer combinations on grain yield of corn hybrids, Scandia, KS.

Hybrid	Starter Fertilizer					Yield, 1998	Yield, 1996-1998
	lb/a						
Pioneer 3563	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	S	Zn		
	0	0	0	0	0	162	188
	30	30	0	0	0	165	190
	30	30	20	0	0	164	191
	30	30	0	10	0	164	189
	30	30	0	0	1	165	192
Pioneer 3346	30	30	20	10	1	163	190
	0	0	0	0	0	152	149
	30	30	0	0	0	176	185
	30	30	20	0	0	172	182
	30	30	0	10	0	188	199
	30	30	0	0	0	175	185
Dekalb 591	30	30	20	10	0	190	199
	0	0	0	0	0	155	152
	30	30	0	0	0	170	190
	30	30	20	0	0	171	190
	30	30	0	10	0	181	202
	30	30	0	0	1	174	191
Dekalb 646	30	30	20	10	1	183	203
	0	0	0	0	0	162	184
	30	30	0	0	0	165	184
	30	30	20	0	0	164	183
	30	30	0	10	0	165	184
	30	30	0	0	1	163	186
LSD(0.05)	30	30	20	10	1	166	184
						7	8

# WHITE FOOD-CORN PERFORMANCE TEST

W. Barney Gordon

## Summary

Yield of 30 white corn hybrids averaged 170 bu/a and 11 hybrids had yields of more than 180 bu/a. Lodging averaged 4.3% and grain moisture at harvest averaged 16.5%.

## Introduction

Increased marketing opportunities and profit potential have created interest among area farmers to convert acres to white food-corn production. White corn hybrids have distinctive genetic traits for specific end-use purposes. Dry millers grind food corn into a range of degermed corn products including flaking grits, corn flour, brewer grits, germ, and meal. These products are used for breakfast cereals and snack foods. The best quality dry-milling corn has large-sized kernels, low kernel-size variability, harder kernel texture, and higher protein content. Harder type dent is desired because dry millers prefer larger flaking grits vs. a kernel that is easily crumbled. Breakfast cereal manufacturers pay a premium for large pieces of unbroken corn endosperm that can produce larger corn flakes. Wet millers separate corn into basic components (starch, protein, fiber, and germ), with the principal component being starch. The general qualities for wet milling corn include low moisture, no mold or mycotoxins, minimum broken kernels, and low incidence of stress cracks. Masa millers cook the food corn with lime in order to soften the kernel and remove the pericarp. This process is known as *nixtaamalization* and the resulting corn is known as *nixtamal*. The *nixtamal* is ground with stones into *masa* which then is made into tortillas, tortilla chips, or other Mexican snack foods.

This test is one of 13 locations included in a regional white corn performance test conducted by Dr. L. L. Darrah with the USDA-ARS at the University of Missouri-Columbia. The 1998 test included 30 white corn hybrids and 3 yellow hybrid checks.

## Procedures

Anhydrous ammonia was applied on 18 April at the rate of 200 lb/a. The test was planted on 22 April at the rate of 30,000 plants/a. Starter fertilizer ( 30 lb N + 30 lb P<sub>2</sub>O<sub>5</sub>/a) applied 2 inches to the side and 2 inches below the seed at planting. Furrow- irrigations were applied on 1 July, 8 July, and 20 July. Three inches of water were applied at each irrigation. The test was harvested on 20 October using a modified E Gleaner combine.

## Results

Overall grain yield in this test was 171 bu/a and ranged from 138 to 199 bu/a (Table 10). Yield of white corn hybrids (30 hybrids) averaged 170 bu/a. The average of the three yellow corn hybrids included in the test (Pioneer 3245, Pioneer 3394, and B73xMo17) was 176 bu/a. Eleven of the 30 commercial white corn hybrids (Asgrow RX901W, Garst N6278W, Novartis N71-T7, Pioneer 3203W, Pioneer 32H39, Pioneer 32Y65, Pioneer X1167BW, Pioneer X1177PW, Vineyard Vx4596, Wilson 1780W, and Wilson E8051) yielded more than 180 bu/a. Stalk lodging averaged 4.3% and ranged from 0 to 10.6%. Grain moisture at harvest averaged 16.5%. Grain quality information of all entries (average of five test locations) is given in Table 11.

Table 10. Grain yield, stalk lodging, ear height, days to mid-silk, and grain moisture at harvest of white corn hybrids, Irrigation Experiment Field, Scandia, KS.

Entry	Yield, 1998	Yield, 1997	Stalk Lodged	Ear Height	Days to Mid-Silk	Moist.
	bu/a	bu/a	%	inches		%
Asgrow RX901W	195.4		0	35.7	82.7	16.6
Dekalb DK665W	141.3		10.2	36.0	78.0	16.1
Dekalb EXP868W	144.4		1.6	36.7	77.3	15.2
Garst 8419W	146.9		2.8	35.3	78.0	16.3
Garst 8490W	142.0	166.4	5.7	37.7	78.3	16.4
Garst N6278W	181.6		8.2	40.3	79.0	15.9
IFSI 90-1	138.0	201.4	8.1	32.0	80.7	16.7
IFSI 95-1	170.0	150.7	4.9	32.3	82.3	17.9
IFSI 98-1	150.8		7.7	39.0	74.7	16.1
LG Seeds NB749W	159.9	145.7	8.1	39.7	80.7	17.1
NC+6989W	173.1		1.2	38.0	79.0	16.3
NC+RE652W	175.2		4.1	37.7	82.7	18.3
Novartis N71-T7	184.3		4.3	37.3	78.0	15.7
Pioneer 3203W	186.2	155.5	0.8	38.0	80.0	16.6
Pioneer 32H39	187.3	262.4	0.4	35.3	77.3	16.5
Pioneer 32Y65	181.0		0.0	30.7	77.3	16.5
Pioneer X1167BW	199.8		0.0	42.0	78.0	17.4
Pioneer X1177PW	185.3		4.8	30.3	77.0	16.5
Tennessee TN 98-1	161.2		9.7	41.7	82.7	18.5
Vineyard Vx4337	160.8		2.1	33.7	78.3	15.7
Vineyard Vx4517	176.2		0.0	39.0	82.7	18.0
Vineyard Vx4596	180.1		1.2	32.0	78.3	17.7
Whisnard 50AW	171.7	194.9	6.5	39.0	78.3	16.3
Whisnard 51AW	177.0	164.2	10.6	37.3	78.7	15.9
Wilson 1789W	189.1	196.0	9.3	37.3	77.0	15.9
Wilson E8051	193.4		0.8	38.3	82.3	17.3
Zimmerman Z62W	153.9	185.0	8.4	32.0	82.3	16.0
Zimmerman Z64W	180.9	187.2	7.0	39.7	81.7	17.5
Zimmerman Z74W	157.2		4.0	34.7	80.0	15.6
Zimmerman Z75W	155.4		3.8	38.0	82.7	15.6
Yellow check B73xMo17	165.1	157.1	6.8	36.3	78.7	15.4
Yellow check Pioneer 3245	191.2	187.5	0.0	34.0	78.0	15.5
Yellow check Pioneer 3394	172.5	223.4	0.4	38.7	78.7	15.7
Mean	170.6	183.2	4.3	36.5	79.4	16.5
LSD (0.05)	8.8	18.5	5.3	1.0	2.0	1.0
CV%	3.2	6.2	74.3	1.7	1.5	3.7

Table 11. Grain quality data from the 1998 Late White Corn Performance Test (Average of Five Locations).

Entry	Test Weight	100-Kernel Weight	Kernel Size	Thins	Kernel Density	Horny Endosperm
	lb/bu	gram	cc	%	g/cc	%
Asgrow RX901W	63.3	30.3	0.23	42.3	1.33	91
Dekalb DK665W	63.4	36.3	0.27	15.8	1.33	90
Dekalb EXP868W	59.6	36.4	0.28	8.4	1.30	86
Garst 841W	63.7	34.7	0.26	21.9	1.33	90
Garst 8490	61.3	32.3	0.25	31.7	1.30	88
Garst N6278W	62.3	30.5	0.23	35.2	1.31	90
IFSI 90-1	63.3	33.1	0.25	23.1	1.33	91
IFSI 95-1	62.9	30.3	0.23	36.4	1.34	92
IFSI 98-1	61.8	34.2	0.26	16.9	1.32	88
LG Seeds NB749W	62.7	31.1	0.23	32.3	1.32	88
NC+6989W	63.4	29.3	0.22	33.0	1.34	94
NC+ RE652W	61.7	33.8	0.25	21.5	1.33	88
Novartis N71-T7	62.2	29.2	0.22	45.1	1.32	87
Pioneer 3203W	60.7	33.8	0.26	19.0	1.30	89
Pioneer 32H39	62.1	30.9	0.23	38.8	1.33	91
Pioneer 32Y65	62.1	32.7	0.25	33.7	1.32	92
Pioneer X1167BW	62.3	35.3	0.26	17.3	1.33	91
Pioneer X1177PW	62.0	32.7	0.25	20.6	1.33	90
Tennessee TN98-1	60.0	36.3	0.28	6.9	1.30	86
Vineyard x4337	61.2	33.5	0.26	53.7	1.31	87
Vineyard Vx4517	62.8	32.2	0.24	39.2	1.33	93
Vineyard Vx4596	63.4	34.2	0.26	23.4	1.33	91
Whisnard 50AW	62.7	32.5	0.24	28.4	1.33	89
Whisnard 51AW	63.3	32.5	0.24	27.5	1.34	90
Wilson 1780W	60.8	30.6	0.24	17.0	1.30	86
Wilson E8051	60.9	35.3	0.27	6.3	1.33	90
Zimmerman Z62W	60.8	34.9	0.26	8.4	1.32	89
Zimmerman Z64W	60.1	33.0	0.25	14.7	1.32	90
Zimmerman Z74W	63.0	36.8	0.28	11.9	1.34	95
Zimmerman Z75W	60.7	43.0	0.26	14.8	1.30	94
Yellow check Pioneer 3245	62.3	36.8	0.27	21.9	1.33	94
Yellow check Pioneer 3394	59.9	35.1	0.27	19.4	1.30	86
Mean	61.9	33.2	0.25	24.5	1.32	90
LSD (0.05)	1.1	2.9	0.02	11.6	0.02	3.5
CV%	1.4	6.9	6.7	37.5	1.0	3.1

# USE OF EARLY-SEASON SOYBEAN PRODUCTION SYSTEMS IN CROP ROTATIONS

W. Barney Gordon, Scott A. Staggenborg, and Dale L. Fjell

## Summary

Eighteen soybean varieties in maturity Groups I-IV were grown in rotation with grain sorghum. Yields of Group II soybeans were equal to yields of Group III and superior to yields of Group IV. Yields of Group I soybeans were not as good as those of Group III but still greater than those of Group IV. Late Group I and early Group II soybeans matured 25 and 19 days earlier, respectively, than Group IV soybeans, thus allowing for earlier harvest and a longer fall period of soil water recharge. Seed quality was poorer in Group I and Group II soybeans than in Groups III and IV.

## Introduction

The recent passage of new farm legislation gives farmers the flexibility to plant the most profitable crop rather than plant to maintain base acres of a farm program crop. This encourages crop rotations. Opportunities exist for expanding soybean acres in central Kansas. Grain sorghum is grown on a large number of dryland acres in central Kansas. In the past, much of this sorghum was grown either in a continuous system or in occasional rotation with wheat.

A dryland grain sorghum-soybean rotational study was established at the North Central Kansas Experiment Field at Belleville in 1981. Results show that yield of grain sorghum was 25% greater when grown in annual rotation with soybeans. Nitrogen fertilizer required to achieve maximum sorghum yield was reduced by 30 lb/a by rotation with soybeans. Soybean yield averaged over the period 1982-1997 was 35 bu/a. Soybean yields ranged from a low of 12 bu/a to a high of 58 bu/a. Producer acceptance

of soybean production in the 24- to 28-inch annual rainfall area of Kansas has been somewhat slow. This may be due to large year-to-year variation in soybean yields and the perception that sorghum following soybean may yield less because of water use by soybean during the preceding crop year. The traditional late Group III and early Group IV maturity soybeans grown in the area can use significant amounts of water in August and early September. Earlier maturing soybeans (late Group I through early Group III) use the maximum amount of water earlier in the growing season when it is more likely to be available, thus potentially providing greater year-to-year yield stability and leaving a longer period for soil water recharge for the following crop.

This research is designed to investigate the yield potential, seed quality, and water use of early maturing soybeans and to assess the effects of soybean maturity group on yield of a following grain sorghum crop.

## Procedures

Research was conducted at the North Central Kansas Experiment Field located near Belleville on a Crete silt loam soil. The experiment consisted of 18 soybean varieties that range in maturity from late Group I to early Group IV. Soybean varieties included in the experiment are listed in Table 11. The soybeans were grown in rotation with grain sorghum. A continuous grain sorghum treatment also was included. Soybeans were planted on 15 May at the rate of 10 seed/ft into grain sorghum stubble without additional tillage. Group I and II soybeans were harvested on 28 September, and Groups III

and IV were harvested on 14 October. At maturity, 10 plants from each plot were selected at random for yield component analysis and plant height measurements. Seed samples were tested for germination by the Kansas Crop Improvement Association Seed Testing Lab. Gravimetric soil water measurements were made at planting and again at maturity to a depth of 36 inches. The continuous sorghum and sorghum/soybean rotation blocks used in this experiment were established on the field in 1996.

### Results

Rainfall in July was above average, but August and September were much drier than normal. Yields of all three Group I varieties were greater than yields of varieties in Group IV (Table 13). Seed yields of later maturing soybeans probably were reduced by the late-season drought. When averaged over the three

varieties in each category, yield of Group II soybeans was equal to yield in Group III (Table 14). Yield of Group I soybeans was not as good as that of Group III but was still better than that of Group IV. Late Group I and early Group II soybeans matured 25 and 19 days earlier than Group IV soybeans, respectively. Earlier soybean harvest allows producers to spread out fall harvest work load and plant wheat in a timely manner. Soybeans in Group II used 2 inches less water during the growing season than soybeans in Group IV. Soybeans in Group I were shorter in height than soybeans in latter groups. The short stature limited pod sites and reduced yields. Seed quality was poorer in Group I and II soybeans than in Group III and Group IV. Seed of early season varieties mature during a time when temperatures are still very warm, whereas seed of later maturing varieties matures in September when temperatures are normally cooler.

Table 12. Soybean varieties grown in rotation with grain sorghum, North Central Kansas Experiment Field, Belleville, KS, 1998.

Group	Midland	Dekalb	Pioneer
Late I	X188	173	9172
Early II	X229	228	9233
Late II	8286	289	9281
Early III	8312	313	9306
Mid III	8355	351	9352
Early IV	8410	415	9421

Table 13. Yield of early-season soybean varieties in rotation with grain sorghum, North Central Kansas Experiment Field, Belleville, KS, 1998

Variety	Group	Yield, bu/a
Midland X188	Late I	41
Dekalb 173	Late I	39
Pioneer 9172	Late I	39
Midland X229	Early II	44
Dekalb 228	Early II	44
Pioneer 9233	Early II	47
Midland 8286	Late II	43
Dekalb 289	Late II	41
Pioneer 9281	Late II	45
Midland 8312	Early III	46
Dekalb 313	Early III	44
Pioneer 9306	Early III	43
Midland 8355	Mid III	44
Dekalb 351	Mid III	46
Pioneer 9352	Mid III	43
Midland 8410	Early IV	36
Dekalb 415	Early IV	35
Pioneer 9421	Early IV	34
LSD (0.05)		3

Table 14. Seed yield, maturity, plant height, water use, and germination of soybean groups, North Central Kansas Experiment Field, Belleville, KS 1998.

Maturity Group	Yield	Days to Maturity	Plant Height	Water Use*	Seed Germination
	bu/a	days	inches	inches	%
Late I	40	110	25	13.2	62
Early II	44	116	31	13.8	73
Late II	43	121	33	14.5	77
Early III	44	126	31	14.7	81
Mid III	44	129	32	15.0	88
Early IV	35	135	36	15.5	92

\* water use= rainfall plus stored soil water.

# EFFECTS OF PLANTING DATE AND ROW SPACING ON GRAIN SORGHUM YIELD

W. Barney Gordon and Scott A. Staggenborg

## Summary

In 1997, yield of grain sorghum was reduced by 25 bu/a by delaying planting until late June. Yield of grain sorghum was improved by planting in narrow rows at a late planting date, but yields were not affected by row spacing at a normal planting date. In 1998, yield was not affected by planting date. Yield of the full-season hybrid Pioneer 8310 was reduced by narrower row spacing. Yields of early and mid-season hybrids were not affected by row spacing. When grain sorghum is planted in late May, yields are not improved by narrowing row spacing. When planting is delayed past the optimum time, yields can be improved in some years by planting in rows narrower than the conventional 30 inches.

## Introduction

Crop density can be manipulated by varying row width or within-row density. Densities can be maintained, but the development of cover and the pattern of crop water use are altered by planting crops in wider rows. These effects operate through interaction between root systems within the soil volume available for rooting. Use of soil stored moisture by annual crops depends on the rate at which roots expand into the available soil volume. Planting pattern can be manipulated to control the time when the crop reaches moisture. Uniform spacing (narrow row width with longer intervals between plants in the same row) allows for the shortest time for roots to reach the perimeter of the available space. Crowding plants in wide rows restricts early water use and crop growth. Water use is distributed over longer periods. Spacing arrangements serve as a practical means for managing the performance of root systems.

Production strategies to efficiently use stored soil water and limited seasonal precipitation include choice of hybrid, planting date, plant population, and row width.

## Procedures

A dryland experiment was initiated in 1997 at Scandia to determine the effect of planting date (mid-May and mid-June); row spacing (15 and 30 inches); and plant population (30,000, 60,000, and 90,000 plants/a) on grain sorghum yield. In 1997, planting dates were 20 May and 20 June. Plots in both row spacings were planted with a John Deere 71 unit planter. Plots were overplanted and thinned to desired populations. In 1998, the population variable was replaced by a hybrid maturity variable. The experiment consisted of two planting dates; two row spacings (15 and 30 inches); and three hybrids (Pioneer 8699, Pioneer 8500, and Pioneer 8310). Planting dates in 1998 were 21 May and 17 June. Plots were planted at the uniform rate of 60,000 seed/a.

## Results

When averaged over row spacing and plant populations, grain sorghum yields in 1997 were 25 bu/a greater for the May planting than for the June planting (Table 15). Row spacing did not affect grain yield at the May planting date, but at the June planting date, yield in 15-inch rows was 29 bu/a greater than that in 30-inch rows. Temperatures in August were lower than normal, which slowed crop development. An earlier than normal frost also was recorded. Early-season crop growth rate is often greater in narrow rows than in wide rows because of

more efficient light interception and greater soil water use. This early-season growth advantage in the 15-inch rows helped overcome some of the disadvantages of late planting.

The growing season in 1998 was warmer and longer than normal. Growing degree units

in August and September were above normal. Grain sorghum yields were not affected by planting date (Table 16). Row spacing did not affect the yields of Pioneer 8699 or Pioneer 8500, but yield of Pioneer 8310 was reduced in narrow rows at both planting dates. Pioneer 8310 is a tall, late-maturing hybrid and may not be well suited to narrow-row production.

Table 15. Effects of planting date, row spacing, and plant population on grain sorghum yield, Scandia, KS, 1997.

Plant Date	Row Space	Population	Grain Yield
	inches	plants/a	bu/a
May 20	15	30000	115
		60,000	131
		90,000	129
	30	30,000	98
		60,000	135
		90,000	140
June 20	15	30,000	105
		60,000	114
		90,000	120
	30	30,000	76
		60,000	86
		90,000	91
LSD(0.05)			7
Means (average over population)		Yield, bu/a	
May 22	15	125	
	30	124	
June 20	15	113	
	30	84	

Table 16. Effects of planting date, row spacing, and hybrid on grain sorghum yield, Scandia, KS, 1998.

Planting Date	Row Spacing	Hybrid	Yield
			bu/a
May 21	15	Pioneer 8699	136
		Pioneer 8500	134
		Pioneer 8310	127
	30	Pioneer 8699	131
		Pioneer 8500	140
		Pioneer 8310	144
June 17	15	Pioneer 8699	143
		Pioneer 8500	143
		Pioneer 8310	116
	30	Pioneer 8699	141
		Pioneer 8500	138
		Pioneer 8310	137
Means (averaged over hybrid)		Yield, bu/a	
May 21	15		132
	30		138
June 17	15		134
	30		139
			NS*

\*Not significant at the 0.05 level of probability.

# INFLUENCE OF ROW SPACING AND PLANT POPULATION ON CORN PRODUCTION

W. Barney Gordon, Dale L. Fjell, and Scott A. Staggenborg

## Summary

Studies were initiated to investigate the effects of row spacing and plant population on corn grain yield. Two sites (one dryland and one irrigated) were located in Republic County and one irrigated test was located at the Sandyland Experiment Field near St. John. The test consisted of three row spacings (30, 20, and 15 inches) and four plant populations (20,000, 26,000, 32,000, and 36,000 plants/a). Growing season rainfall was over 3 inches below normal at the Belleville site, but July rainfall was ideal. The test averaged 154 bu/acre. Yields were not affected by either row spacing or plant populations. Stands were erratic at the Larson Farm, and the test was abandoned at this site. At the St. John location, yield in the 15- and 20-inch rows was 10 bu/a greater than that in 30-inch rows. Response to plant population was inconsistent.

## Introduction

Early in the century, corn was grown in rows spaced about 40 inches apart to accommodate horse-drawn equipment and later mechanized equipment and post-emergent cultivation practices. The development of effective chemical herbicides and narrow row equipment has given producers the option of reducing row spacing. With the development of corn headers for combines capable of harvesting 15- to 20-inch rows, interest in narrow-row corn spacing (less than 30 inches) is being renewed among producers in many regions. Recently published information on narrow row spacings is limited. Most narrow-row corn research has been conducted in the upper Midwest region and has compared only two row spacings (conventional

30 inch to one other narrower spacing). Information concerning narrow-row spacing effects on corn grain yields is needed under Kansas conditions. This research compares conventional 30-inch rows to 15 two narrower rows at four plant populations.

## Procedures

Experiments were conducted at the North Central Kansas Experiment Field near Belleville, the Richard Larson Farm at Scandia (both sites were located in Republic County), and the Sandyland Experiment Field located at St. John. The soil at Belleville is a Crete silt loam, and the soil at the Larson Farm is a Carr sandy loam. The experiment at St. John was conducted on a Pratt loamy fine sand. The Belleville site was dryland. The Larson and St. John locations were both center- pivot irrigated. The experiment consisted of three row spacings (30-, 20-, and 15-inch rows) and four plant populations (20,000, 26,000, 32,000, and 36,000 plants/a). In addition, the experiments at Belleville and St. John included two corn hybrids (Pioneer 3394 and Pioneer 3325), but only Pioneer 3394 was used at the Larson Farm. A John Deere 71 Unit planter was used at all locations. Plots consisted of four 30-, six 20-, or eight 15-inch rows. All plots were overplanted and thinned to the desired populations.

## Results

Growing season rainfall was below normal at the Belleville location, but July precipitation was above normal. Although yields were very good, there was no response to row spacing or plant population (Table 17). When averaged over the 3

years of the experiment, 30-inch rows yielded slightly better than narrower row spacings.

When averaged over the 2 years of the experiment at the Larson Farm, narrowing row spacing improved yields by 17 bu/a (Table 18). However, this represents less than a 10% increase in yield over the conventional 30-inch rows.

Yields at the Sandyland Expt. Field averaged 158 bu/a (Table 19). Yields in 15-

inch and 20-inch rows were 10 bu/a greater than those in 30-inch rows. Little yield response was seen in populations above 26,000 plants/a.

Although at some locations in some years, yields were improved by planting in row spacings less than 30 inches, the responses have not been consistent or large in magnitude. Generally, yield responses to narrow row spacings have been 10% or less.

Table 17. Effects of row space and plant population on corn grain yield, North Central Kansas Experiment Field, Belleville

Row Spacing	Population	Yield			
		1998	1997	1996	Avg.
	Plants/a			bu/a	
30 inch	20000	147	79	96	107
	26,000	158	79	105	114
	32,000	152	83	115	117
	36,000	151	82	119	117
20 inch	20,000	153	62	91	102
	26,000	156	57	103	105
	32,000	153	57	116	109
	36,000	144	58	123	108
30 inch	20,000	159	52	95	102
	26,000	151	54	104	103
	32,000	155	55	120	103
	36,000	163	55	135	118
<b><u>Row Space Means</u></b>					
30 inch		152	81	109	114
20 inch		152	58	108	106
15 inch		157	54	114	108
LSD (0.05)		NS*	11	NS	
<b><u>Population Means</u></b>					
	20,000	153	64	94	104
	26,000	154	63	104	107
	32,000	153	65	117	112
	36,000	153	65	126	115
		NS	NS	10	

\*Not significant at the 0.05 level of probability.

Table 18. Effects of row spacing and plant population on corn grain yield, Larson Farm, Scandia, KS.

Row Spacing	Population	Yield		
		1997	1998	Avg.
	plants/a		bu/a	
30 inch	20000	134	121	128
	26,000	156	145	151
	32,000	177	163	170
	36,000	180	167	174
20 inch	20,000	163	136	150
	26,000	188	144	166
	32,000	200	164	182
	36,000	204	164	184
15 inch	20,000	167	140	154
	26,000	182	152	167
	32,000	200	163	182
	36,000	206	189	198
<b><u>Row Space Means</u></b>				
30 inch		162	149	156
20 inch		189	152	171
15 inch		189	161	175
LSD(0.05)		8	8	
<b><u>Population Means</u></b>				
	20,000	154	132	143
	26,000	175	147	161
	32,000	192	163	178
	36,000	197	173	185
LSD(0.05)		10	9	

Table 19. Effects of row spacing and plant population on corn grain yield, Sandyland Experiment Field, St. John, KS.

Row Space	Population	Yield		
		1998	1997	Avg.
	plants/a		bu/a	
30 inch	20000	151	217	184
	26,000	147	234	191
	32,000	149	245	197
	36,000	154	246	200
20 inch	20,000	158	225	192
	26,000	166	243	205
	32,000	154	241	198
	36,000	164	244	204
15 inch	20,000	161	232	197
	26,000	172	242	207
	32,000	163	259	211
	36,000	154	253	204
<b><u>Row Space Means</u></b>				
30 inch		150	235	193
20 inch		161	238	200
15 inch		162	247	205
LSD(0.05)		10.1	NS*	
<b><u>Population Means</u></b>				
	20,000	156	225	191
	26,000	161	240	201
	32,000	156	248	202
	36,000	157	248	203
LSD(0.05)		NS	10	

\*Not significant at the 0.05 level of probability.

# EFFECTS OF PLANTING DATE AND SEEDING RATE ON GRAIN YIELDS OF TWO WINTER WHEATS GROWN IN NORTH CENTRAL KANSAS

Scott A. Staggenborg and W. Barney Gordon

## Summary

Individual operations and weather conditions in north central Kansas influence wheat planting dates. Increased double-cropping of wheat after a summer crop has resulted in an increase in the number of acres planted in mid to late October. A study was designed to assess the performance of two wheat varieties from Kansas State University, Jagger and 2137, at several planting rates and planting dates in 1995 and 1996 in north central Kansas. Seeding rates of 30, 60, 90, and 120 lbs of seed/a were used at three planting dates (approximately Sept. 20, Oct. 5, and Oct. 20). As planting was delayed, heads/a and yield decreased as the result of a dry winter. Several warm periods followed by extreme cold in February and March of 1996 damaged Jagger, which broke dormancy during this period. Jagger yields were 20 bu/a lower than those of 2137. Spring tillers accounted for a large portion of Jagger's yield. This resulted in lower test weights than 2137, because the grain from the late tillers developed during hotter temperatures in late June. These results illustrate the importance of planting winter wheat in north central Kansas so that adequate fall growth can be achieved. Such growth aids the plant in winter survival and spring regrowth.

## Introduction

Planting date selection for wheat in north central Kansas often must be balanced between early planting to achieve better stands and fall growth and late planting to reduce the effects of Hessian fly, cheat, and take-all root rot. More intensive cropping systems have resulted in more

acres of double-cropped wheat after a summer row crop. As a result, the number of wheat acres being planted in mid-to-late October also has increased.

Seeding rates for wheat vary less than planting dates. Recommended wheat-seeding rates for northeast Kansas are currently from 60 to 120 lbs/a. As wheat planting is delayed, plant growth and tiller production are reduced as a result of cooler temperatures. It is reasonable to assume that increasing seeding rates as planting is delayed should compensate for reduced full tiller production and increase yields.

The objectives of this study were to evaluate wheat yields at three planting dates and four seeding rates in north central Kansas.

## Procedures

This study was conducted at the North Central Experiment Field at Belleville, KS. Treatments consisted of two varieties (Jagger and 2137); four seeding rates, 30, 60, 90, and 120 lbs/a; and three planting dates (listed in Table 20). A factorial arrangement of treatments in a randomized complete block design with three replications was used. All plots were 300 sq ft in size.

Grain yield, test weight, and moisture were determined in July in 1996 and 1998. Yields were adjusted to 12.5% moisture.

## Results

As expected, all three main effects (planting date, seeding rate, and variety)

affected grain yields (Table 21). Grain yields increased as seeding rates increased from 30 to 120 lbs/a, but yields at 90 and 120 lbs/a were not significantly different (Table 22).

Growing condition differences between the 2 years of the study affected grain yield differently each year as indicated by the significant planting date by year and variety by year interactions (Table 21).

As planting was delayed in 1995, grain yields declined (Table 23). This response was the result of dry conditions during October through December reducing late-season growth. When planting was delayed from late September to early October in 1997, grain yields were not affected (Table 23). However, delaying planting until mid-October reduced yields by 38 bu/a.

A series of warm/cold cycles in February and March 1996 reduced grain yields of Jagger in 1996 (Table 24). In 1998, both varieties produced similar grain yields.

### Conclusions

Seeding rates of 90 and 120 lbs/a produced similar yields across two growing seasons. Delaying planting until mid-October reduced yields over 40% compared to an early October planting date. A late-September planting date produced the maximum yields when October and November received below average rainfall. Performances of Jagger and 2137 were similar under normal conditions.

Table 20. Planting dates for the 1995-96 and 1997-98 wheat growing seasons at Belleville, KS.

1995-96	1997-98
September 25	September 20
October 5	October 2
October 23	October 16

Table 21. Mean squares for wheat yields from two growing seasons at Belleville, KS.

Source	df	Mean Square
Replication	2	2107.9**
Year (Y)	1	12026.8**
Variety (V)	1	2943.1**
Date of Planting (D)	2	14130.2**
Rate of Planting (R)	3	1159.8**
V*Y	1	4471.1**
D*Y	2	1920.0**
R*Y	3	25.9
V*D	2	332.7
V*R	3	36.7
D*R	6	110.5
V*D*Y	2	116.5
V*R*Y	3	194.1
D*R*Y	6	81.5
V*D*R	6	218.2
V*D*R*Y	6	93.7
Error	92	115.2
C.V. (%)	N/A	19.8

\*\*Indicates significant at the 0.01 probability level

Table 23. Wheat yields for three planting dates during two growing seasons at Belleville, KS.

Plant Date	1995-96	1997-98
	bu/a	
Late September	65.6	69.4
Early October	47.1	74.4
Mid October	23.1	46.9
LSD <sub>(0.05)</sub>	6.2 <sup>†</sup>	

<sup>†</sup> LSD for comparing means within a growing season only.

Table 22. Wheat yields for four seeding rates averaged across two varieties, three planting dates, and two growing seasons at Belleville, KS.

Seeding Rate	Grain Yield
lbs/a	bu/a
30	46.6
60	53.9
90	58.0
120	59.2
LSD <sub>(0.05)</sub>	5.0

Table 24. Wheat yields for two varieties during two growing seasons at Belleville, KS.

Variety	1995-96	1997-98
	bu/a	
Jagger	35.2	64.6
2137	55.4	62.5
LSD <sub>(0.05)</sub>	5.0 <sup>†</sup>	

<sup>†</sup> LSD for comparing means within a growing season only.

# KANSAS RIVER VALLEY EXPERIMENT FIELD

## Introduction

The Kansas River Valley Experiment Field was established to study how to manage and use irrigation resources effectively for crop production in the Kansas River Valley. The Paramore Unit consists of 80 acres located 3.5 miles east of Silver Lake on US 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 US 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. The soils are well drained, except for small areas of Kimo and Wabash soils in low areas. 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.

## 1998 Weather Information

The frost-free season was 33 days longer than the 173-day average. The last 32E F frosts in the spring were on April 18 at the Rossville Unit and on April 19 at the Paramore Unit (average, April 21), and the first frost in the fall was on November 11 (average, October 11). Precipitation was above normal in the fall of 1997; below normal from January through May and in August; and above normal in June, July, and September (Table 1). Precipitation totals for October, 1997 through September, 1998 were 7.59 and 7.46 inches below normal for the Paramore and Rossville Units, respectively. Corn and soybean yields were both lower than normal.

Table 1. Precipitation at the Kansas River Valley Experiment Field.

Month	Rossville Unit		Paramore Unit	
	1997-1998	30-Yr. Avg.	1997-1998	30-Yr. Avg.
	Inches		Inches	
Oct.	2.48	0.95	2.22	0.95
Nov.	1.28	0.89	0.80	1.04
Dec.	2.14	2.42	3.06	2.46
Jan.	1.14	3.18	0.87	3.08
Feb.	0.64	4.88	0.75	4.45
Mar.	2.31	5.46	1.34	5.54
Apr.	1.58	3.67	1.08	3.59
May	1.29	3.44	2.60	3.89
June	5.95	4.64	5.01	3.81
July	5.96	2.97	5.10	3.06
Aug.	1.03	1.90	1.21	1.93
Sep.	2.25	1.24	3.73	1.43
Total	28.05	35.64	27.77	35.23

# CORN HERBICIDE PERFORMANCE TESTS

Larry D. Maddux

## Summary

Sixteen herbicides were evaluated in a preemergence test (PRE) and 20 were evaluated in a postemergence test (POST). Slight injury was obtained with several POST treatments but had no effect on yield. All treatments, except one, in both tests gave greater than 80% control of large crabgrass, Palmer amaranth, and common sunflower. Untreated checks yielded only 65 and 85 bu/a in the PRE and POST tests, respectively.

## Introduction

Weed competition can limit crop yields. Chemical weed control and cultivation have been used to control weeds in row crops. Two corn herbicide tests were conducted, a preemergence test (PRE) and a postemergence test (POST). These studies included several of the newer herbicides for use on corn. The major weeds were large crabgrass (Lacg), Palmer amaranth (Paam), and common sunflower (Cosf).

## Procedures

Both tests were conducted on a Sarpy fine sandy loam soil previously cropped to soybeans with a pH of 6.8 and an organic matter content of 1.1%. Pioneer Brand 33R78 and Asgrow 701 IT corn hybrids were planted at 26,200 seeds/a in 30-inch rows on April 23 and May 4 for the PRE and POST tests, respectively. Anhydrous ammonia at 150 lbs N/a was applied preplant, and 10-34-0 fertilizer was banded at planting at 120 lbs/a. Herbicides were applied: preemergent (PRE) - May 4 and early postemergent (EP) - May 27 in the PRE test and preemergent (PRE) - April 24, early postemergent (EP) - May 22, and mid- postemergent (MP) - June 9 in the POST test. Plots were not cultivated. Reported crop injury ratings were made on May 27 for the PRE test and May 30 for the POST test. Ratings reported for weed control were made on June

11 for the PRE test and June 19 for the POST test. The first significant rainfall after PRE herbicide application was on May 11 (0.78 inches). Plots were harvested on September 25 using a modified Gleaner E combine.

## Results

In the PRE test, the greatest corn injury was observed with the Balance + Axiom treatment (Table 2). All treatments gave greater than 80% control of Lacg and Paam. All treatments except Axiom + Balance + Atrazine gave greater than 80% control of Cosf. This treatment had only 1.0 oz/a Balance and 1.11 lb/a Atrazine 90DF. The treatment of Balance + Atrazine, 1.25 oz/a + 1.39 lb/a, resulted in 95% Cosf control. The control plot yielded only 65 bu/a. The Axiom + Balance + Atrazine treatment had a yield of 126 bu/a, which was related to the poor Cosf control. Yields of the other treatments ranged from 142 to 204 bu/a.

Corn injury was observed with several of the POST treatments 7 days after application (Table 3). The two treatments containing Aim had the greatest injury but did not seem to affect yield. Lacg control ranged from 72 - 95%. All treatments did a good job of controlling Paam and Cosf. The untreated check yielded only 85 bu/a. Yields of the treatments were quite variable but ranged from 126 to 181 bu/a. Yields were not correlated well with weed control or injury. The high LSD of 41 bu/a indicates a large variability in yield in this experiment.

Table 2. Effects of preemergent herbicides on corn injury, weed control, and grain yield, Kansas River Valley Experiment Field, Rossville, KS, 1998.

Treatment	Rate	Appl Time	Corn Inj. 23 DAT <sup>1</sup>	Weed Control, 38 DAT <sup>2</sup>			Grain Yield
				Lgcg	Paam	Cosf	
	prod./a		%	%		bu/a	
Untreated check	---		0.0	0	0	0	65
Dual II Magnum <sup>3</sup>	1.0 pt	PRE	3.3	82	82	100	142
Topnotch <sup>3</sup>	2.0 qt	PRE	0.0	87	100	100	188
Frontier <sup>3</sup>	1.25 pt	PRE	0.0	88	95	100	167
Surpass <sup>3</sup>	2.0 pt	PRE	0.0	93	100	100	190
Harness <sup>3</sup>	1.8 pt	PRE	0.0	90	100	100	184
Axiom <sup>3</sup>	13.0 oz	PRE	0.0	90	95	100	184
Bicep II	2.0 qt	PRE	0.0	88	100	82	197
Hornet	2.0 oz	PRE	1.7	83	100	97	201
+ Bicep II	2.0 qt						
Python	1.0 oz	PRE	3.3	83	100	88	182
+ Bicep II	2.0 qt						
Hornet	2.0 oz	PRE	0.0	85	98	92	191
+ Topnotch	2.0 qt						
Axiom	13.0 oz	PRE	0.0	88	100	85	177
+ Atrazine 90DF	1.77 lb						
Axiom	13.0 oz	PRE	0.0	92	88	45	126
+ Balance	1.0 oz						
+ Atrazine 90DF	1.11 lb						
Axiom	13.0 oz	PRE	0.0	98	100	100	204
+ Buctril/Atrazine	2.0 pt	POST					
Bicep II	2.4 qt	PRE	0.0	83	100	93	187
Balance	1.25 oz	PRE	1.7	97	100	95	190
+ Atrazine 90DF	1.39 lb						
Balance	1.25 oz	PRE	8.3	98	100	90	171
+ Axiom	13.0 oz						
LSD(.05)			4.0	13	12	46	38

<sup>1</sup> Crop injury rated - 5/27/98; DAT = days after treatment application.

<sup>2</sup> Lgcg = large crabgrass; Paam = palmer amaranth; Cosf = common sunflower (Rated 6/11/98).

<sup>3</sup> Plus Buctril at 1.0 pt/a, early POST.

Table 3. Effects of postemergent herbicides on corn injury, weed control, and grain yield, Kansas River Valley Experiment Field, Rossville, KS, 1998.

Treatment <sup>1</sup>	Rate	Appl Time <sup>2</sup>	Corn Inj.	Weed Control, 28 DAT <sup>3</sup>			Grain Yield
			7 DAT	Lgcg	Paam	Cosf	
	prod./a		%		%		bu/a
Untreated check	---	---	0.0	0	0	0	85
Bicep II Lite Magnum + Exceed + COC	2.1 qt 1.0 oz 1.0 qt	PRE EP EP	0.0	73	98	100	181
Dual II Magnum + Exceed + COC	1.31 pt 1.0 oz 1.0 qt	PRE EP EP	3.3	83	82	100	166
Dual II Magnum + Exceed + Clarity + COC	1.31 pt 1.0 oz 0.25 pt 1.0 qt	EP EP EP EP	1.7	80	97	100	172
Bicep II Lite Magnum + Spirit + COC	2.1 qt 1.0 oz 1.0 qt	PRE EP EP	0.0	87	100	100	164
Dual II Magnum + Spirit + COC	1.31 pt 1.0 oz 1.0 qt	PRE EP EP	0.0	87	98	100	174
Dual II Magnum + Spirit + Clarity + COC	1.31 pt 1.0 oz 0.25 pt 1.0 qt	PRE EP EP EP	0.0	75	100	100	163
Hornet + Basis Gold + UAN + NIS	2.4 oz 14.0 oz 2.5 + .25%	PRE EP EP	6.7	77	100	100	150
Dual II + Hornet + Atrazine 90DF + UAN + NIS	2.0 pt 1.6 oz 1.0 lb 2.5 + .25%	PRE EP EP EP	3.3	73	88	100	127
Dual II + Hornet + Atrazine 90DF + UAN + NIS	2.0 pt 2.4 oz 1.0 lb 2.5 + .25%	PRE EP EP EP	0.0	82	93	90	147
Dual II + Scorpion III + UAN + NIS	2.0 pt 4.0 oz 2.5 + .25%	PRE EP EP	3.3	83	98	100	170
Scorpion III + Accent + UAN + NIS	4.0 oz 0.66 oz 2.5 + .25%	EP EP EP	1.7	72	87	100	139
Prowl + Atrazine 90DF + COC	3.0 pt 2.0 lb 1.0 qt	EP EP EP	11.7	75	100	100	155

Table 3. Effects of postemergent herbicides on corn injury, weed control, and grain yield, Kansas River Valley Experiment Field, Rossville, KS, 1998.

Treatment <sup>1</sup>	Rate	Appl Time <sup>2</sup>	Corn Inj.	Weed Control, 28 DAT <sup>3</sup>			Grain Yield
			7 DAT	Lgcg	Paam	Cosf	
	prod./a		%		%		bu/a
Prowl + Contour + COC + UAN	3.0 pt 1.3 pt 1 qt + 1 qt	EP EP EP	8.3	88	100	100	150
Atrazine 90DF + Lightning + COC + UAN	1.0 lb 1.28 oz 1 qt + 1 qt	EP EP EP	6.7	95	100	100	179
Basis Gold + COC + UAN	14.0 oz 1 qt + 1qt	EP EP	3.3	87	98	100	128
Harness + Shotgun	1.8 pt 3.0 pt	PRE EP	3.3	95	100	100	159
Shotgun + Basis Gold	3.0 pt 14.0 oz	EP EP	1.7	73	100	100	126
Dual II + Aim + Atrazine 90DF + NIS	2.0 pt 0.33 oz 0.56 lb 0.25%	PRE EP EP EP	16.7	75	100	98	159
Dual II + Aim + Atrazine 90DF + Clarity + NIS	2.0 pt 0.33 oz 0.56 lb 0.25 pt 0.25%	PRE EP EP EP EP	10	87	100	100	140
LSD(.05)			4.6	15	9	6	41

<sup>1</sup> COC = crop oil concentrate; UAN = 28-0-0 fertilizer; NIS = nonionic surfactant.

<sup>2</sup> PRE = preemergence; EP = early postemergence.

<sup>3</sup> Lgcg = large crabgrass; Paam = Palmer amaranth; Cosf = common sunflower.

DAT = days after postemergence treatment application; Injury rated 5/30/98, and weed control rated 6/19/98.

# SOYBEAN HERBICIDE PERFORMANCE TESTS

Larry D. Maddux

## Summary

Herbicides were evaluated in two tests: (1) 12 treatments in a preplant incorporated, preemergence test (PPI/PRE) and (2) 20 treatments in a postemergence test (POST). The PPI and PRE treatments caused very little soybean injury, but most POST treatments caused some injury. The PPI treatments gave better control of large crabgrass and Palmer amaranth (Paam) than PRE treatments. Untreated checks had no grain yield. Paam control was poor with most treatments in the POST test.

## Introduction

Chemical weed control and cultivation have been used commonly to control weeds in row crops. Weeds can seriously depress soybean yields. Two soybean herbicide tests were conducted: the PPI/PRE test included preplant incorporated and preemergence herbicides and the POST test included postemergence herbicides. The major weeds evaluated in these tests were large crabgrass (Lacg), Palmer amaranth (Paam), and common sunflower (Cosf).

## Procedures

Both tests were conducted on a Sarpy fine sandy loam soil with a pH of 7.4 and organic matter content of 1.5% previously cropped to corn. Pioneer Brand 9362 SCN soybeans were planted on May 13 at 144,000 seeds in 30-inch rows. Fertilizer (10-34-0) was banded at 120 lbs/a at planting. The herbicides were applied as follows: PPI & PRE - May 13; early postemergent (EP) - June 10 in the PPI/PRE test and June 7 in the POST test; and late postemergent (LP) - June 13. Significant rainfalls after the PPI and PRE treatments were on May 15 (0.22 inch), May 29 (0.59 inch), and June 8 (1.63 inches). The plots were not cultivated. Ratings reported for crop injury were made on June 9 for the PPI/PRE test and on June 15 and

June 24 for the POST test. Ratings reported for weed control were made on June 30 for the PPI/PRE test and on July 6 for the POST test. Harvest was on October 14 using a modified Gleaner E plot combine, although some plots were not harvested because of high infestations of Paam and Cosf.

## Results

Significant soybean injury was observed with only one treatment, Python + Prowl, PRE + FirstRate, EP, in the PPI/PRE test (Table 4). Lacg and Paam control was much better with the PPI treatments than with the PRE treatments because of the lack of rainfall for activation. Control of Lacg and Paam was lowest with the Command + Authority, PRE treatments, possibly because Authority requires more moisture for activation. Only 0.22 inch rainfall was received during the first 16 days after treatment. Control of Cosf was excellent with all treatments except for the Command + the low rate of Authority. Authority is weak on Cosf. Yields were related closely to weed control, and the untreated check had no yield.

Most postemergence treatments had some injury (Table 5). Treatments containing Cobra, Flexstar, Stellar, Reflex, and Status gave the most injury. Very little injury was observed with Raptor, Expert, and FirstRate. The LP treatment of Select resulted in excellent control of Lacg. All treatments, except Cobra and Stellar alone, gave excellent control of Cosf, which indicates that none were ALS resistant. Paam control was

generally lower than usual, with only six treatments providing greater than 80% control. This could have been related to the lack of rainfall prior to application (plant

stress) and the heavy rainfall the day after application. Grain yields were low, mainly because of the lack of Paam control, and ranged from 9.6 to 31.6 bu/a with no yield for the untreated check.

Table 4. Effects of preemergence and preplant, incorporated herbicides on soybean injury, weed control, and grain yield, Kansas River Valley Experiment Field, Rossville, KS, 1998.

Treatment	Rate	Appl Time	Soybean Inj. 28/7 DAT <sup>1</sup>	Weed Control, 48/28 DAT <sup>1</sup>			Grain Yield
				Lgcg	Paam	Cosf	
	prod./a		%		%		bu/a
Untreated check	---	---	0.0	0	0	0	0.0
Squadron	3.0 pt	PPI	0.0	85	78	100	27.3
Tri-Scept	2.33 pt	PPI	0.0	88	98	100	49.3
Steel	3.0 pt	PPI	0.0	95	87	98	28.0
Broadstrike+Treflan + FirstRate + UAN + NIS	2.0 pt 0.3 oz 2.5+.125%	PPI EP EP	1.7	93	95	98	47.7
FirstRate + Treflan	0.6 oz 2.0 pt	PPI PPI	0.0	90	92	98	35.2
Python + Treflan	1.3 oz 2.0 pt	PPI PPI	0.0	87	95	98	33.9
Python + Prowl + FirstRate + UAN + NIS	1.2 oz 3.0 pt 0.3 oz 2.5+.125%	PRE PRE EP EP	5.0	80	73	100	18.7
FirstRate + Prowl	0.6 oz 3.0 pt	PRE PRE	0.0	78	67	100	15.6
Python + Prowl	1.3 oz 3.0 pt	PRE PRE	0.0	77	75	88	28.3
Prowl + FirstRate + Authority	3.0 pt 0.6 oz 4.0 oz	PRE PRE PRE	1.0	83	83	93	23.6
Command + Authority	1.67 pt 6.8 oz	PRE PRE	0.0	67	63	90	12.8
Command + Authority	1.67 pt 5.33 oz	PRE PRE	1.7	55	72	72	0.0
LSD(.05)			3.1	27	26	28	25.2

<sup>1</sup> DAT = days after treatment application - Preemergence/Postemergence.

Injury rated on 6/9/98; weed control rated on 6/30/98.

Lgcg = large crabgrass; Paam = palmer amaranth; Cosf = common sunflower.

Table 5. Effects of postemergent herbicides on soybean injury, weed control, &amp; grain yield, Rossville, KS, 1998.

Treatment <sup>2</sup>	Rate	Appl Time	Soybean Injury		Weed Control, 28 DAT <sup>1</sup>			Grain Yield
			7DAT	14DAT	Lgcg	Paam	Cosf	
	prod./a		%		%			bu/a
Cobra	8.0 oz	EP	17	3	90	73	98	11.8
+ Pursuit	1.44 oz	EP						
+ COC + UAN	1 pt + 1 qt	EP						
+ Select	8.0 oz	LP						
+ COC + UAN	1 qt + 1 qt	LP						
Cobra	8.0 oz	EP	17	7	88	77	90	22.8
+ Classic	0.5 oz	EP						
+ COC + UAN	1 pt + 1 qt	EP						
+ Select	8.0 oz	LP						
+ COC + UAN	1 qt + 1 qt	LP						
Flexstar	16.0 oz	EP	10	2	90	82	100	18.0
+ Pursuit	1.44 oz	EP						
+ COC + UAN	1 pt + 1 qt	EP						
+ Select	8.0 oz	LP						
+ COC + UAN	1 qt + 1 qt	LP						
Flexstar	16.0 oz	EP	10	0	95	80	100	22.9
+ Classic	0.5 oz	EP						
+ COC + UAN	1 pt + 1 qt	EP						
+ Select	8.0 oz	LP						
+ COC + UAN	1 qt + 1 qt	LP						
Cobra	8.0 oz	EP	15	7	92	72	70	15.5
+ COC + UAN	1 pt + 1 qt	EP						
+ Select	8.0 oz	LP						
+ COC + UAN	1 qt + 1 qt	LP						
Flexstar	16.0 oz	EP	13	3	95	85	98	27.9
+ COC + UAN	1 pt + 1 qt	EP						
+ Select	8.0 oz	LP						
+ COC + UAN	1 qt + 1 qt	LP						
Stellar	7.0 oz	EP	18	3	92	60	72	15.3
+ COC	1 pt	EP						
+ Select	8.0 oz	LP						
+ COC + UAN	1 qt + 1 qt	LP						
Raptor	4.0 oz	EP	0	2	73	58	93	9.6
+ COC + UAN	1 pt + 2 qt	EP						
Stellar	7.0 oz	EP	18	5	48	77	100	11.2
+ Raptor	4.0 oz	EP						
+ COC + UAN	1 pt + 2 qt	EP						
Expert	1.25 oz	EP	2	0	93	57	100	14.6
+ NIS + UAN	0.25% + 2 qt	EP						
+ Select	8.0 oz	LP						
+ COC + UAN	1 qt + 1 qt	LP						

(Continued)

Table 5. Effects of postemergent herbicides on soybean injury, weed control, &amp; grain yield, Rossville, KS, 1998.

Treatment <sup>2</sup>	Rate	Appl Time	Soybean Injury		Weed Control, 28 DAT <sup>1</sup>			Grain Yield
			7DAT	14DAT	Lgcg	Paam	Cosf	
	prod./a		%		%			bu/a
Stellar	7.0 oz	EP	13	3	87	77	95	31.6
Expert	0.94 oz	EP						
+ NIS + UAN	0.25% + 2 qt	EP						
+ Select	8.0 oz	LP						
+ COC + UAN	1 qt + 1 qt	LP						
FirstRate	0.3 oz	EP	3	0	90	72	100	24.4
+ COC	1.0 pt	EP						
+ Select	8.0 oz	LP						
+ COC + UAN	1 qt + 1 qt	LP						
Stellar	7.0 oz	EP	17	5	90	63	100	17.6
FirstRate	0.3 oz	EP						
+ COC	1.0 pt	EP						
+ Select	8.0 oz	LP						
+ COC + UAN	1 qt + 1 qt	LP						
Flexstar	16 oz	EP	12	3	72	73	95	20.6
+ Fusion	10 oz	EP						
+ MSO	1.0%	EP						
Reflex	16 oz	EP	8	2	95	78	92	14.8
+ Fusion	10 oz	EP						
+ MSO	1.0%	EP						
Prowl	2.4 pt	EP	13	3	95	78	100	15.9
+ Pursuit	1.44 oz	EP						
+ Status	10 oz	EP						
+ COC + UAN	1 qt + 1 qt	EP						
Prowl	2.4 pt	PRE	15	2	60	80	100	19.6
+ Raptor	4.0 oz	EP						
+ Status	10 oz	EP						
+ COC + UAN	1 qt + 1 qt	EP						
FirstRate	0.3 oz	EP	2	0	50	72	100	12.5
+ Blazer	1.0 pt	EP						
+ Select	6.0 oz	EP						
+ NIS + UAN	0.125 + 2.5%	EP						
Dual II Magnum	1.34 pt	PRE	8	3	73	90	100	13.3
+ FirstRate	0.3 oz	EP						
+ Flexstar	1.0 pt	EP						
+ NIS + UAN	0.125 + 2.5%	EP						
Dual II Magnum	1.34 pt	PRE	0	0	58	80	100	27.6
+ FirstRate	0.3 oz	EP						
+ NIS + UAN	0.125 + 2.5%	EP						
Untreated Check	0	—	0	0	0	0	0	0.0
LSD(.05)			6	5	22	19	10	11.5

<sup>1</sup> Lgcg = large crabgrass; Paam = palmer amaranth; Cosf = common sunflower.

DAT = days after postemergence treatment application; Injury ratings - 6/15/98 & 6/24/98; weed control rating - 7/6/98.

<sup>2</sup> COC = crop oil concentrate; UAN = 28-0-0 fertilizer; NIS = nonionic surfactant; MSO = methylated sunflower oil.

# WHITE FOOD -CORN PERFORMANCE TEST

Larry D. Maddux

## Summary

The average yield of the 33 hybrids in the test was 172 bu/a, with a range from 143 to 202 bu/a. The LSD(.05) was 23 bu/a (two hybrids must differ in yield by 23 bu/a to be considered significantly different in yielding ability 95% of the time).

## Introduction

This test at the Paramore Unit is one of the 13 locations of a regional fee test coordinated by Dr. L. L. Darrah with USDA-ARS at the University of Missouri. The 1998 test included 30 white hybrids and three yellow hybrid checks submitted by 13 commercial seed producers. Twelve white hybrids were new to the test in 1998.

## Procedures

Anhydrous ammonia at 150 lbs N/a was applied on April 10. Atrazine 4L at 1.5 qt/a

plus Lasso at 2.0 qt/a was incorporated with a field cultivator on April 14. The hybrids were planted on April 17 at 30,000 seeds/a in 30-inch rows on a silt loam soil following a previous crop of soybeans. Fertilizer (10-34-0) at 120 lb/a was banded at planting. The test was cultivated on May 21, furrowed for irrigation on June 1, and harvested on September 8 with a Gleaner E plot combine.

## Results

Yields in this test averaged 172 bu/a, with a range from 143 to 202 bu/a and an LSD(.05) of 23 bu/a (Table 6). Irrigated corn yields were lower than those in previous years. The yellow corn performance test (conducted at the Rossville Unit) had an average yield of 151 bu/a, with a range from 122 to 184 bu/a. The yellow check B73xMo17 yielded 180 bu/a and the other two yellow checks (Pioneer Brand 3245 and 3394) yielded 190 and 180 bu/a, respectively.

Table 6. Grain yield, stand, root and stalk lodging, ear height, moisture content, and days from planting to half-silk of the white food-corn hybrids, Topeka, KS, 1998.

Brand	Hybrid	Yield	Stand	Root Lodged	Stalk Lodged	Half Silk	Moisture
		bu/a	%	%	%	days	%
Asgrow	RX901W	166	87	0	0	71	17.9
DeKalb Genetics	DK665W	170	87	0	0	70	18.4
DeKalb Genetics	EXP868W	143	89	0	0.5	70	15.1
Garst	8419W	156	93	0	0	70	17.0
Garst	8490W	170	85	0	0.5	72	17.8
Garst	N6278W	192	96	0	0	72	16.8
IFSI	90-1	166	93	0	0	71	17.5
IFSI	95-1	165	86	0	0	71	21.9
IFSI	98-1	178	91	0	0	72	18.7
LG Seeds	NB749W	185	93	0	0	74	19.2
NC+	6989W	181	93	0	0.5	74	19.8
NC+	RE652W	192	95	0	0	73	19.5
Novartis	N71-T7	178	90	0	0	72	17.1
Pioneer Brand	3203W	186	86	0	0	73	17.4
Pioneer Brand	32H39	179	92	0	0	70	16.4
Pioneer Brand	32Y65	186	89	0	0	70	17.0
Pioneer Brand	X1167BW	202	91	0	0	71	17.6
Pioneer Brand	X1177PW	193	95	0	0	71	17.5
Tennessee	TN 98-1	180	92	0	0.5	78	20.6
Vineyard	Vx4337	179	93	0	0	71	17.6
Vineyard	Vx4517	171	91	0	0	74	19.5
Vineyard Whisnand	Vx4596	160	87	0	0	70	19.5
Whisnand	50AW	191	97	0	0.4	71	16.3
Wilson	51AW	173	85	0	0	71	17.1
	1780W	168	89	0	0	72	18.1
Wilson	E8051	207	87	0	0	75	19.7
Zimmerman	Z62W	183	87	0	0	76	17.5
Zimmerman	Z64W	199	85	0	0	77	20.1
Zimmerman	Z74W	149	85	0	0	71	17.6
Zimmerman	Z75W	193	91	0	0.5	76	17.5
Yellow check	B73xMo17	180	88	0	1.0	71	14.7
Yellow check	Pioneer 3245	190	98	0	0	71	16.5
Yellow check	Pioneer 3394	180	90	0	0	70	14.7
Mean		179	90	0	0.1	72	17.9
LSD 0.05		23	10	—	NS	3	1.4
CV%		8	7	---	394	3	4.9

# EFFECTS OF APPLICATION METHOD, TIME, AND RATE OF SUPPLEMENTAL NITROGEN ON IRRIGATED SOYBEANS

Larry D. Maddux

## Summary

A study was initiated in 1996 to evaluate effects of nitrogen (N) application time and rate on irrigated soybeans. Soybean yields for the 0 N control plot were 71.8 bu/a in 1996, 65.7 bu/a in 1997, and 61.7 bu/a in 1998. Fertigation at the R3 growth stage resulted in slight yield increases of 2.0 and 3.0 bu/a in 1996 and 1998, but these yield increases were not statistically significant at the 5% probability level. Fertigation at R5 resulted in no significant yield difference. No significant difference in yield was observed in 1997 with any treatment.

## Introduction

Irrigated soybean yields in Kansas commonly exceed 60 bu/a. Nitrogen (N) demand during grain fill is quite high at these yield levels. Some producers have been applying about 30 lbs/a supplemental N to soybean fields through irrigation systems at the R3 stage of growth based on research conducted using broadcast N fertilizer. This research was designed to determine the optimum N rate and time of application to provide maximum economic soybean yields.

## Procedures

A sprinkler irrigated site on a Eudora silt loam soil at the Paramore Unit was used. Nitrogen rates included 0, 30, and 60 lbs N/a.

In 1996 and 1997, UAN was applied as a fertigation treatment at R1, R3 (beginning pod), and R5 (beginning seed). In 1998, the treatments were changed to apply UAN as fertigation treatments at R3, R5, and R3 + R5. However, because of wet weather during the R5 growth stage, the R5 fertigation treatments were not applied. The treatments were arranged in a randomized complete block design with four replications. A minimum of 0.5 inches of water was applied to all plots with each fertigation treatment. Grain yields were determined by machine harvesting.

## Results

No significant differences in soybean yields because of N application time or N rate occurred in any of the 3 years, as shown in Table 7. However, in 1996, we observed a slight trend (2.0 bu/a) to increased yields with fertigation treatments at R1 and R3 growth stages. This same trend was apparent at the 30 lb N/a rate in 1998. No significant differences or trends were seen in the 1997 data. The trends observed in 1996 and 1998 support previous work at Kansas State University, which indicates that irrigated soybeans with high yield potential can benefit from a small amount of N (20 - 40 lbs/a) applied at the R3 growth stage.

Table 7. Effects of nitrogen application times and rates on irrigated soybean yield, Kansas River Valley Experiment Field, Topeka, KS.

N Application Time	N Rate	Yield		
		1996	1997	1998
	lbs/a		bu/a	
None	0	71.8	65.7	61.7
UAN, Fertigation, R1	30	73.9	60.6	
UAN, Fertigation, R1	60	73.5	61.8	
UAN, Fertigation, R3	30	72.4	63.3	64.7
UAN, Fertigation, R3	60	75.1	67.1	62.1
UAN, Fertigation, R5	30	74.0	65.6	
UAN, Fertigation, R5	60	69.3	60.5	
LSD(.05)		NS	NS	NS
<b>N Application Time:</b>				
UAN, Fertigation, R1		73.7	61.2	
UAN, Fertigation, R3		73.8	65.2	64.7
UAN, Fertigation, R5		71.6	63.1	
LSD(.05)		NS	NS	
<b>N Rate:</b>				
	30	72.9	63.1	64.7
	60	71.5	63.6	62.1
LSD(.05)		NS	NS	NS

# MACRONUTRIENT FERTILITY AND THE EFFECT OF STARTER FERTILIZER ON AN IRRIGATED CORN/SOYBEAN ROTATION

Larry D. Maddux

## Summary

A corn-soybean cropping sequence was evaluated from 1983 through 1996 (7 years of corn; 7 years of soybeans) for the effects of N, P, and K fertilization on the corn crop. The 7-year average showed a corn yield increase with increasing N rates up to 160 lbs N/a. Previously applied N at 160 lbs/a also resulted in an average soybean yield increase of 3.1 bu/a. Corn and soybeans both showed yield responses to P, but only soybean had significant 7-year average yield increases (3.3 and 4.5 bu/a for 30 and 60 lbs P<sub>2</sub>O<sub>5</sub>/a). Potassium fertilization increased average corn and soybean yields by 6 and 2.3 bu/a. In 1997, N increased V6 N content and yield of corn. No significant response to residual soil P was obtained, probably because of the almost 41 lbs P<sub>2</sub>O<sub>5</sub>/a applied in the starter to all plots. Plant K content at V6 was increased with K fertilization, but no yield response was obtained. In 1998, soybean had no significant yield responses to previously applied fertilizers.

## Introduction

A study was initiated in 1972 at the Paramore Unit to evaluate the effects of nitrogen (N), phosphorus (P), and potassium (K) on irrigated soybeans. The study was changed to a corn and soybean cropping sequence and planted to corn in 1983. The objectives of the study are to evaluate the effects of applications of N, P, and K made to a corn crop on (a) grain yields of corn and the following soybean crop and (2) soil test values.

## Procedures

The initial soil test in March, 1972 on this silt loam soil showed 47 lbs/a of available P and 312 lbs/a of exchangeable K in the top 6 in. of the soil profile. Rates of P were 50 and 100 lbs P<sub>2</sub>O<sub>5</sub>/a from 1971 - 1975 and 30 and 60 lbs P<sub>2</sub>O<sub>5</sub>/a from 1976 - 1995. In 1997, the broadcast rates of P were dropped, and a starter of 120 lbs/a of 10-34-0 (12 lbs N/a + 41 lbs P<sub>2</sub>O<sub>5</sub>/a) was applied to all plots (1997 & 1998). Rates of K were 100 lbs K<sub>2</sub>O/a from 1971 to 1975, 60 lbs K<sub>2</sub>O/a from 1976 to 1995, and 150 lbs K<sub>2</sub>O/a in 1997. Rates of N included a factorial arrangement of 0, 40, and 160 lbs of preplant N/a (with single treatments of 80 and 240 lbs N/a). The 40 lbs/a N rate was changed to 120 lbs N/a in 1997. N, P, and K treatments were applied every year to soybeans from 1971 to 1982 and every other year (odd years) to corn from 1983 through 1997.

Corn hybrids planted were BoJac 603 - 1983; Pioneer 3377 - 1985, 1987, 1989; Jacques 7820 - 1991 and 1993, Mycogen 7250CB - 1995; and DeKalb 626 - 1997. Soybeans planted were Douglas - 1984; Sherman - 1986, 1988, 1990, 1992, 1996, and 1998; and Edison - 1994. Corn was planted in mid-April, and soybeans were planted in early to mid-May. Herbicides were applied preplant, incorporated each year. The plots were cultivated, furrowed, and furrow irrigated as needed. A Gleaner E plot combine was used for harvesting grain yields.

## Results

Average corn and soybean yields for the 14-year period from 1983 through 1996 (7-year averages) are shown in Table 8. The 7-year average corn yield showed no significant response to P fertilization, although significant responses were obtained in 1985 and 1993. An average increase of 6 bu/a (significant at the 6% level of probability) was obtained over the 7 years for 60 lbs/a of applied  $K_2O$ .

In 1997, corn yields of 194 bu/a were obtained for both the 120 and 160 lbs N/a treatments (Table 9). Corn yield obtained with starter fertilizer only (12 lbs N/a) was only 92 bu/a. No significant yield differences were observed with the previous P treatments, probably because of the almost 41 lbs  $P_2O_5$ /a applied in the starter to all plots. No corn yield response to K fertilization was observed.

However, a P x K interaction occurred. Higher yields generally were obtained when both P and K were applied than when only one was applied. The one exception was the 120-60-0 vs 120-60-150 treatments.

Previously applied N of 160 lbs/a resulted in an average soybean yield increase of 3.1 bu/a (Table 8). Soybeans responded to P fertilization with average yield increases of 3.3 and 4.5 bu/a with 30 and 60 lbs  $P_2O_5$ /a. Potassium fertilization of soybeans resulted in an average yield increase of 2.3 bu/a. However, in 1998, no significant yield responses to previously applied N, P, or K were observed.

These results indicate the importance of soil testing and maintaining a balanced fertility program.

Table 8. Effects of nitrogen, phosphorus, and potassium applications on corn and soybean yields for 7 years in a corn-soybean cropping sequence, Kansas River Valley Experiment Field, Topeka, KS.<sup>1</sup>

Fertilizer Applied			7-Year Average Yield	
N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	Corn	Soybean
	lbs/a		bu/a	bu/a
0	0	0	87	63.9
0	0	60	86	65.6
0	30	0	93	69.0
0	30	60	86	69.8
0	60	0	84	69.6
0	60	60	92	72.3
40	0	0	129	66.3
40	0	60	126	67.7
40	30	0	123	66.7
40	30	60	138	72.8
40	60	0	124	70.9
40	60	60	132	71.4
160	0	0	171	68.8
160	0	60	177	70.0
160	30	0	168	70.5
160	30	60	181	73.8
160	60	0	167	71.3
160	60	60	178	74.2
80	30	60	151	71.5
240	30	60	182	71.7
LSD(.05)			17	5.1
<b>NITROGEN MEANS:</b>				
0			88	68.4
40			129	69.3
160			174	71.5
LSD(.05)			7	2.5
<b>PHOSPHORUS MEANS:</b>				
	0		129	67.1
	30		131	70.4
	60		129	71.6
LSD(.05)			NS	4.5
<b>POTASSIUM MEANS:</b>				
		0	127	68.6
		60	133	70.9
LSD(.05)			NS <sup>2</sup>	2.5

<sup>1</sup> Fertilizer applied to corn in 1983, 1985, 1987, 1989, 1991, 1993, and 1995 and to soybeans for 11 years prior to 1983.

<sup>2</sup> Significant at the 6% level of probability.

Table 9. Effects of nitrogen, phosphorus, and potassium applications on corn and soybean yields in a corn-soybean cropping sequence, 1997 & 1998, Kansas River Valley Experiment Field, Topeka, KS.<sup>1</sup>

Fertilizer Applied			Yield	
N	P <sub>2</sub> O <sub>5</sub> <sup>2</sup>	K <sub>2</sub> O	Corn, 1997	Soybean, 1998
	lbs/a		bu/a	bu/a
0	0	0	93	63.2
0	0	150	95	63.0
0	30	0	101	63.6
0	30	150	87	63.7
0	60	0	86	60.8
0	60	150	89	62.8
120	0	0	200	65.0
120	0	150	181	62.8
120	30	0	189	60.2
120	30	150	208	69.0
120	60	0	195	63.7
120	60	150	190	63.0
160	0	0	203	63.9
160	0	150	177	63.8
160	30	0	184	60.3
160	30	150	205	63.0
160	60	0	191	63.1
160	60	150	204	66.5
80	30	150	187	66.3
240	30	150	206	65.8
LSD(.05)			27	4.8
<b>NITROGEN MEANS:</b>				
0			92	62.9
40			194	64.0
160			194	63.5
LSD(.05)			19	NS
<b>PHOSPHORUS MEANS<sup>2</sup>:</b>				
	0		158	63.6
	30		162	63.3
	60		159	63.3
LSD(.05)			NS	NS
<b>POTASSIUM MEANS:</b>				
		0	160	62.7
		150	159	64.2
LSD(.05)			NS	NS

<sup>1</sup> Fertilizer applied to corn in 1983, 1985, 1987, 1989, 1991, 1993, and 1995 and to soybeans for 11 years prior to 1983. N & K treatments applied to corn in 1997

<sup>2</sup> P treatments not applied in 1997. Starter fertilizer of 10 gal/a of 10-34-0 was applied to all treatments in 1997 & 1998.

# **SANDYLAND EXPERIMENT FIELD**

## **Introduction**

The Sandyland Experiment Field was established in 1952 to address the problems of dryland agriculture on the sandy soils of the Great Bend Prairie of SC Kansas. In 1966, an irrigated quarter was added to demonstrate how producers might use water resources more efficiently and determine proper management practices for, and adaptability of, crops under irrigation on sandy soils.

Research at the field has help define adapted varieties/hybrids of wheat, soybeans, alfalfa, grain sorghum, and corn. As irrigated corn, soybean, wheat, and alfalfa production grew in importance, research determined proper management strategies for irrigation, fertilizer, pest control, and related cultural practices. Presently, research focuses on variety/hybrid evaluation; the evaluation of new pesticides for the area; the practicality of dryland crop rotations vs. continuous wheat; corn nitrogen fertilizer requirements; reexamining accepted cultural practices for corn and grain sorghum; and the long-term effects of cropping systems on yield, soil conditions, and residue cover. A long-term study was initiated in 1996 to determine cultural practices to maximize the efficiency of irrigation inputs from both engineering and agronomic standpoints. Also of interest to irrigated corn producers, 1998 was the third year of a study determining the effects of narrower corn rows and plant population on corn yield.

## **Soil Description**

Soil surface horizons range from Pratt, Carwile, and Naron loamy fine sands to Farnum, Naron, and Tabler fine sandy loams. Subsoils are much more varied, ranging from loamy fine sand to clay. These soils are productive under

dryland conditions with intensive management and favorable precipitation patterns. Under irrigation, these soils are extremely productive, and high quality corn, soybean, and alfalfa are important cash crops.

## **1998 Weather Information**

The weather pattern characterizing 1998 differed markedly from 1996 and 1997 and resulted in much below-normal precipitation throughout the growing season, with the exception of July (Table 1).

Wheat yields, overall, were well above average. Dryland sorghum and corn grain yields were below those of the last several years because of a lack of timely moisture and severe heat and moisture stress during critical growth stages. Irrigated corn grain yield was affected negatively by late June heat stress that followed cool conditions in May and early June and delayed anthesis. Then the extremely hot, dry conditions in August resulted in a compressed grain fill period and further hurt yields. Irrigated soybean production was impacted severely by severe heat in late August to September, during peak pod fill.

Soil moisture conditions were poor for establishment of the 1999 wheat crop through September; however, early October rains provided excellent moisture for planting. This rain did result in some replanting and further replanting was necessary when over 6 inches of rain fell at the end of October.

Total precipitation for 1998 was slightly above normal because of the excessively wet period at the end of October (Table 1). Total 1998 precipitation measured 26.7 inches compared to the long-term average of 25.9

inches. Unlike 1996 and 1997, precipitation from May through September was much lower than normal, only 72.5% of the long-term average. If July is not considered, rainfall was only 40% of normal. As of Jan. 1, 1999, topsoil and subsoil moisture contents were adequate to surplus over much of the area.

The low temperature for 1998 occurred in December, temperatures below 0°F on 4 days. Overall, the winter of 1998 was relatively mild with little snowfall; however, a heavy wet snow followed by a severe ice storm occurred in March. The yearly high was

106°F, occurring on September 6. During the period from May 1 to September 30, temperatures were 90°F or higher on 83 days and 100° or higher on 16 days. Temperatures in August were 90°F or higher on 24 days and 100° or higher on 3 days. In September, temperatures were 90°F or higher on 21 days and 100° or higher on 4 days. The storm season was much quieter than normal.

The frost-free season lasted from April 18 until November 10, resulting in a growing season of 206 days, approximately 21 days more than the long-term average.

Table 1. Precipitation at the Sandyland Experiment Field, St. John, KS.

Month	17-Year Average	1997	1998
		inches	
January	0.6	0.0	1.7
February	0.9	2.5	0.5
March	2.1	0.1	4.4
April	2.5	3.0	1.5
May	3.8	1.9	2.5
June	3.9	5.1	1.5
July	2.9	3.7	6.1
August	2.7	5.3	0.3
September	2.1	2.5	0.8
October	2.1	4.0	5.6
November	1.2	0.5	1.7
December	1.1	2.6	0.2
Annual Total	25.9	31.0	26.7

# CORN HERBICIDE EVALUATION

Victor L. Martin and Dallas E. Peterson

## Introduction

Weed control is a major problem in irrigated corn production, especially when postemergence cultivation is eliminated, is. This problem is accentuated on sandy soils low in organic matter. Additionally, there is concern involving the use of atrazine, a common herbicide in SC Kansas and the potential for its movement into groundwater. Atrazine is one of the best, most cost-effective herbicides for season-long broadleaf control on the sandy soils of the Great Bend Prairie. Problems with atrazine do exist, especially when corn is grown continuously, because populations of atrazine-resistant weeds develop. This study was initiated to determine the effectiveness of alternatives to herbicide programs containing preemergence atrazine applications on sandy soils in SC Kansas and to compare newly labeled, not yet labeled, and nonresidual compounds for use in Kansas to more conventional programs.

## Procedures

A loamy fine sand (Pratt and Naron) was used for this study, which was cropped to soybeans in 1997 and corn in 1996. The entire site was tandem disked once and packed in the spring of 1998 prior to planting. Fertilization included 100 lb/a 18-46-0 and 125 lb/a N applied as urea (46-0-0) prior to spring tillage and 100 lb/a N at V-6. A 113-day corn hybrid NC+ 4616, was planted on May 3 at 32,500 seeds/acre at a depth of 1.5 inches. No soil insecticides were used. Plots were 20 ft long and 10 ft (four 30-inch rows) wide with four replications in a randomized complete block.

A total of 17 treatments was used. Preemergence (PRE) treatments were applied on May 6 and postemergence (POST)

treatments on May 29. Treatments were applied using a tractor-mounted compressed-air sprayer at 30 psi and 20 gal/a water. Crop injury and weed pressure were monitored throughout the growing season and examined extensively immediately prior to and 2 weeks after POST treatments. Plots were irrigated as necessary from May 28 until August 30 with a total of 12 inches of water applied in 19 irrigations. Corn was hand-harvested in mid-October and mechanically shelled. Yields were adjusted to 15.5% moisture.

## Results

Treatments are listed in order of descending yield (Table 2). No significant crop injury was noted for any treatment. As in most years, the only grass present was crabgrass. All herbicide combinations provided good to excellent crabgrass control.

The two predominant broadleaf species were puncture vine and pigweed species, predominantly Palmer amaranth, although some lambsquarter, carpet weed, and cocklebur were present. Broadleaf control was fair to excellent, with the weakest treatments being 3 and 10. Number 3 was Dual II only and number 10 was a total POST treatment involving Accent Gold and Banvel. The single weed species that appeared to determine yield was Palmer amaranth. As pressure from this species increased, yields decreased. The yield decrease in treatment number 12 appeared to be due to crop damage caused by the dicamba in the Marksman. The PRE application of Basis (treatment numbers 6 and 15) provided greater crabgrass suppression than expected with an early application.

Of the seven top-yielding treatments, all involved a combination of a PRE herbicide for initial control followed by a POST application. The high rate of Axiom in combination with atrazine injured the crop and appeared to somewhat negatively affect yields. On these light textured, low organic matter soils, the lower 8 oz rate of this product appeared quite effective in controlling crabgrass.

One of the main purposes of this study is to determine the effectiveness of herbicide programs not involving PRE atrazine. As in previous years, treatments involving POST atrazine performed well. Small amounts of atrazine when added to newer products such as Aim, Basis, and Axiom greatly increase their effectiveness, while reducing the risk of

or surface groundwater contamination from atrazine.

Herbicide programs combining PRE and POST applications provide the best most consistent weed control and minimize producer risk.

This study will continue to examine weed control options for corn on sandy soils, however, after 7 years, we can safely state that effective weed control is indeed possible without high use rates of PRE atrazine. The difficulty is comparing cost effectiveness, but with the advent of very low use rate SU compounds and price reductions by manufacturers over the last 18 months, this appears to be less of a problem than in the past.

Table 2. Corn herbicide evaluation study 1998; percent weed control 8 weeks after planting and grain yield at 15.5% moisture, Sandyland Experiment Field, St. John, KS.

Treatment	Rate	Time	Grass	Broadleaf	Yield
	product/a		% soil surface free		bu/a
1 Guardsman	1.5 pt	PRE	94	100	165
Basis Gold	12.6 oz	POST			
Banvel	4 oz	POST			
COC	1% V/V				
AMSULF	3.4 lb				
2 Dual II	1.0 qt	PRE	96	97	164
Aim	1/3 oz	POST			
Banvel	4 oz	POST			
Atrazine	1 pt	POST			
NIS	0.25% v/v				
3 Dual II	1 qt	PRE	96	89	156
Aim	1/3 oz	POST			
Atrazine	1.5 pt	POST			
4 Axiom	8 oz	PRE	98	100	156
Basis Gold	12.6 oz	POST			
Banvel	4 oz	POST			
COC	1% v/v				
Amsulf	3.4 lb				
5 Dual II	1 qt	PRE	99	90	156
Atrazine	1 qt	POST			
6 Basis	1/3 oz	PRE	81	97	154
Basis Gold	12.6 oz	POST			
Banvel	4 oz	POST			
COC	1% v/v				
Amsulf	3.4 lb				
7 Dual II	1 qt	PRE	96	93	153
Atrazine	1.5 qt	POST			
8 Basis Gold	14 oz	POST	84	96	148
Banvel	2 oz	POST			
COC	1% v/v				
Amsulf	3.4 lb/a				

(Continued)

Table 2. Corn herbicide evaluation study 1998; percent weed control 8 weeks after planting and grain yield at 15.5% moisture, Sandyland Experiment Field, St. John, KS.

Treatment	Rate	Time	Grass	Broadleaf	Yield
	product/a		% soil surface free		bu/a
9 Axiom	14 oz	PRE	98	97	146
Basis Gold	14 oz	POST			
Banvel	4 oz	POST			
COC	1%v/v				
Amsulf	3.4 lb/a				
10 Axiom	14 oz	PRE	96	95	142
Atrazine	1.5 lb	PRE			
11 Harness Extra	2.4 qt	PRE	100	100	140
12 Dual II	1 qt	PRE	91	80	132
Marksman	1 qt	POST			
13 Basis	1/3 oz	POST*	88	90	131
Banvel	2 oz	POST			
COC	1%v/v				
Amsulf	3.4 lb/a				
14 Accent Gold	0.375 oz a.i.	0.5 -	81	76	130
Banvel	4 oz	1 in.**			
15 Basis	1/3 oz	PRE	91	92	128
Atrazine	1.5 pt	PRE			
16 Dual II	1 qt	PRE	97	66	124
17 Check			58	5	29
LSD(0.05) <sup>1</sup>			6	7.6	15

<sup>1</sup> Two treatments must differ by more than the LSD to be different.

\* Crabgrass at mouse ear stage

\*\* Crabgrass 0.5 - 1 in. tall

# EFFECTS OF PLANTING DATE, IRRIGATION RATE, AND TILLAGE ON PRODUCTION OF VARIED-MATURITY CORN

Victor L. Martin, Gary A. Clark, Richard L. Vanderlip,  
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## Summary

Planting date has had the most effect on yields, which decreased significantly with later planting, especially for full-season hybrids. No-tillage significantly reduced yields in hot, dry years but not in good years. Decreasing irrigation did not reduce yields in mild, wet years and reduced yields only for the later planting in a hot, dry year.

## Introduction

Corn is the most important cash crop in SC Kansas produced under irrigation, with 13% of the state's crop produced in the nine county area of the Great Bend Prairie. The sandy soils and climate of the region in combination with irrigation result in average yields of 150 to 160 bu/a in most years. Under intensive management with favorable weather, producers expect yields of 190 to 200+ bu/a on their "better" ground. Typically, corn is planted from mid-April to mid-May with populations averaging 24,000 to 30,000 plants/a. Normally, producers plant a full-season hybrid (112 days or greater to black layer), although hybrids of shorter maturity are increasing in popularity.

Though irrigated corn production has been an economic boom to Kansas, it has not been without problems, especially in western Kansas where aquifer depletion is a major concern. Although vast improvements have been and are being made in irrigation technology, many questions remain.

Decreases in water levels of the aquifer in SC Kansas in the region of the Great Bend Prairie have not been as dramatic as those in western Kansas. The structure of the aquifer and the soils of the region have allowed for lesser decreases, and years of high rainfall such as the mid-1970's, 1992, 1993, 1996, and 1997 have resulted in significant recharge of the aquifer in much of the region. Thus, groundwater can be viewed as a sustainable resource, especially with careful management of irrigation and agronomic systems to maximize water use efficiency.

Another factor complicates the view of sustainable irrigation, especially in the Rattlesnake Creek Watershed, where the Quivira National Wildlife Refuge is located and from which it receives its water. Although groundwater is viewed as renewable for irrigators, the lowering of water table levels by irrigation has diminished stream flow into Quivira and resulted in less water than needed to maintain the refuge during periods of below-normal precipitation, especially in the fall during the peak migration period. Strategies are needed not only for managing irrigation to sustain it, but for developing practices to ensure adequate surface waters to maintain the refuge. Although switching hardware on pivots and using irrigation scheduling can help decrease irrigation inputs, the selection of proper agronomic practices (planting date, tillage, hybrid maturity) is potentially as or more important in reducing water usage.

The primary objective of this study is to determine the effects of no-tillage vs. conventional tillage, hybrid maturity, planting

date, level of irrigation inputs, and their interactions on the yield, water usage, and economic return for corn produced on the sandy soils of SC Kansas. This is the third year of a multiyear study. The study involves the departments of Agronomy, Biological and Agricultural Engineering, and Agricultural Economics. Support for this project is provided by the Kansas Corn Commission.

### Procedures

The soil for this study is predominantly loamy fine sand with some fine sandy loam. The site was cropped to grain sorghum in 1994 and 1995 and to wheat in the prior 2 years. Fertilization consisted of 100 lb/a 18-46-0 each year in March. Nitrogen was applied as granular urea (46-0-0) and was split in two 125 lb N/a increments, preplant and V6. Plots at all planting dates received 1 qt/a Dual II + 1 pt/a atrazine preemergence followed by 1 qt/a Marksman postemergence. Plots at the first two planting dates also received 2/3 oz/a Accent to control crabgrass and volunteer grain sorghum in 1996. All plots were planted at 34,000 seeds/a with a John Deere no-till row planter.

Treatments were as follows:

1. Main plots - Planting Date: April 16, May 2, May 15 (1996); April 21, May 5, May 19 (1997); April 24, May 8, May 19 (1998).
2. Split plots - Irrigation Level: 120% (0.92 in./application), 100% (0.78 in. /application), 80% (0.62 in./application).
3. Sub-subplots--Tillage: No-tillage, Chisel-disk
4. Final split plots - Hybrid: Early (Pioneer 3563-103 day), Medium (Dekalb DK 591-109 Day) Late (Pioneer 3162-118 day).

Plots were arranged in a randomized complete block with four replications. Irrigation level differences were achieved by replacing the overhead system with drops, pressure regulators, and three different nozzles that allowed us to apply differential irrigation rates.

Measurements included final plant population, dates of 50% emergence and silking, grain yield, and grain moisture.

### Results

As the data show, part of the site where the medium irrigation rate was applied contained large variations in corn grain yield, most likely related to soil compaction. The differences were larger for 1996 than 1997. This resulted in wide yield variation and lower than expected yields.

Growing season precipitation was much above normal during both 1996 and 1997 and resulted in the need for less irrigation than normal (Figure 1 and Table 3). In 1998, except July, precipitation was much below normal, especially during August. The maximum differences in water applied were 2 inches in 1996, 2.1 inches in 1997, and 4.8 inches in 1998.

Mid-May planting significantly decreased yields overall. Increasing irrigation levels slightly increased yields in 1996, had no effect in 1997, and increased yields for the two later planting dates in 1998 (Figure 2). Extreme heat and low humidity, particularly in late June and August, severely decreased yields for all treatments. No-tillage resulted in lower yields in 1996, had no significant effect in 1997, and significantly decreased yields overall in 1998 (Figure 2). The 108- and 103- day hybrids were competitive with the 118-day hybrid in 1996 and 1997; however, the 118-day hybrid was damaged significantly by growing season conditions in 1998 (Figure 2).

Overall, the two early hybrid yields were less affected by planting date, and yields decreased with increasing maturity and planting date (Figure 3). All three hybrid yields were lower overall with the no-tillage system in 1996, unaffected by tillage in 1997, and lower without tillage in 1998 (Figure 4).

Figures 5, 6, and 7 are presented as an overview of all treatment variables. Three years into the study, several trends are becoming evident.

Planting date has been the single most important variable in determining yields. As planting became later, yields decreased significantly. This was true in spite of the cold conditions. Overall, eliminating tillage did not result in significant yield reductions during good years, but significantly decreased yields in a hot, dry years. Of note, the negative effect of eliminating tillage increased

as planting date was moved later. This is partly contradictory to conventional wisdom. Earlier maturing hybrids were competitive with a full-season hybrid and were less sensitive to planting date. Finally, during the two mild, wet years, decreasing irrigation did not adversely affect yields. Even in a dry, hot year, as in 1998, the low irrigation rate did not adversely affect yields for earlier planting, but did negatively impact yields for later planting.

The fourth and final year of this study is 1999. Then we will conduct an economic analysis of the relative income of each system and determine the cost. We will be able to discuss the agronomic consequences of the planting date, irrigation level, tillage and hybrid maturity interactions and make recommendations.

Table 3. 1996 - 1998 irrigations amounts and numbers in corn study, Sandyland Experiment Field, St. John, KS.

Planting Date	Irrigation Number	Irrigation Rate and Total (inches)		
		80%	100%	120%
April 16, 1996	9	3.7	4.0	4.3
May 2, 1996	11	4.3	4.8	5.3
May 15, 1996	12	4.6	5.2	5.7
April 21, 1997	7	4.3	5.5	6.4
May 5, 1997	7	4.3	5.5	6.4
May 19, 1997	7	4.3	5.5	6.4
April 24, 1998	11	6.2	7.8	9.2
May 8, 1998	11	6.2	7.8	9.2
May 19, 1998	13	7.4	9.4	11.0

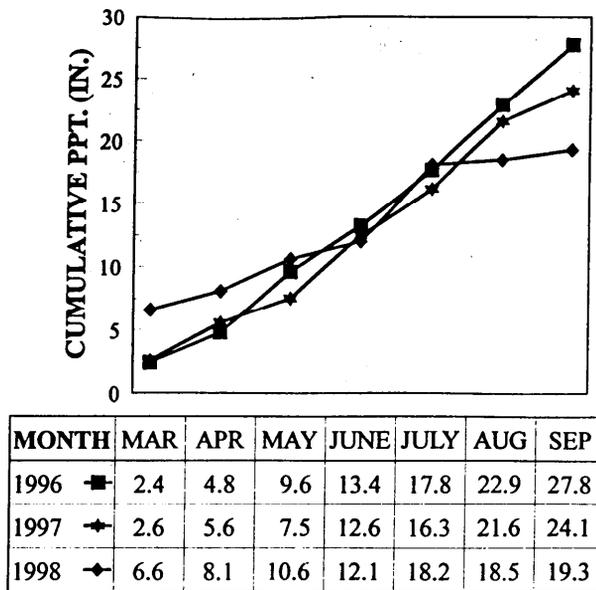


Figure 1. Cumulative precipitation from March through September, Sandyland, 1996-1998.

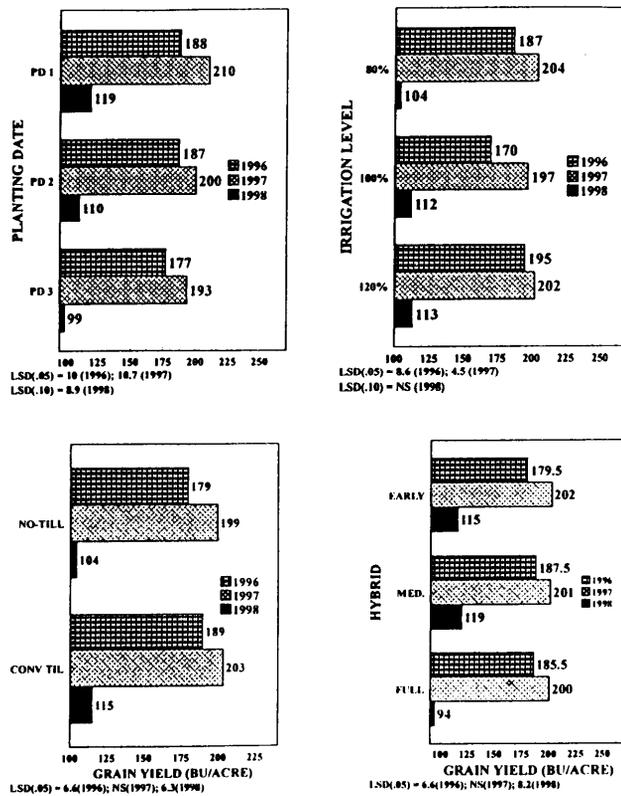


Figure 2. Corn grain yields in planting date X irrigation level X tillage X hybrid maturity study, Sandyland, 1996-1998

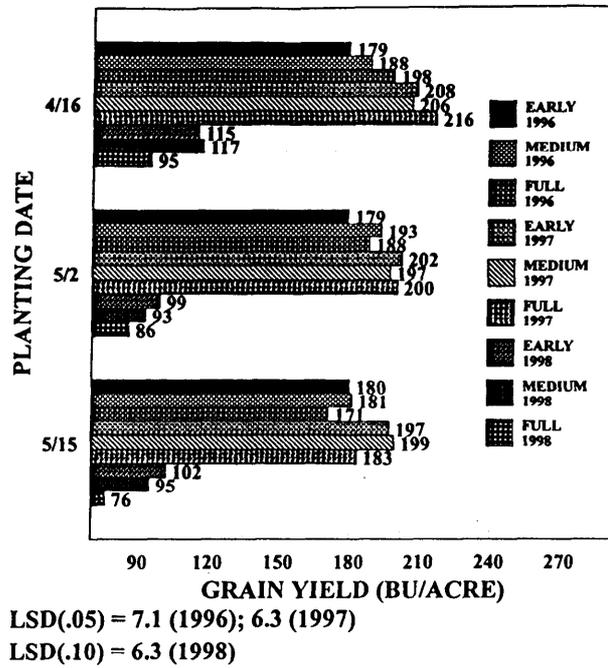


Figure 3. Interaction of hybrid with planting date in irrigated corn study, Sandyland, 1996-1998.

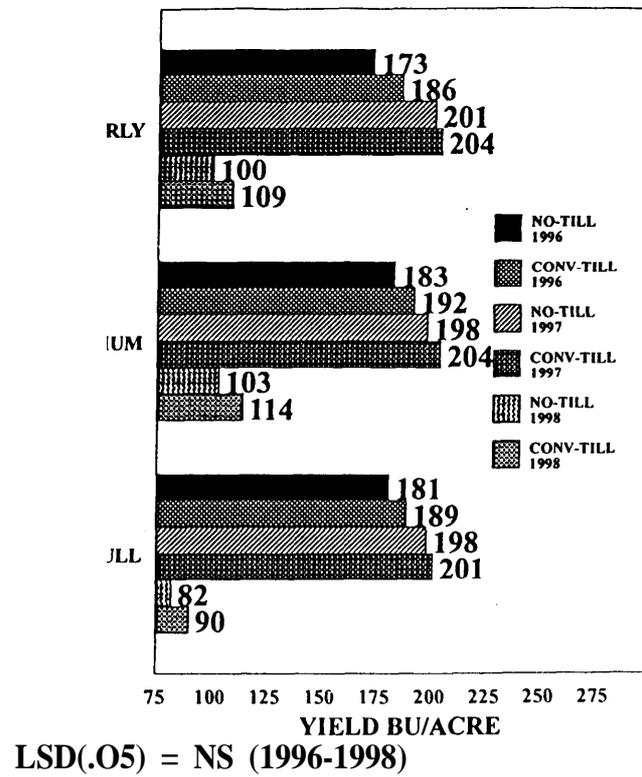


Figure 4. Interaction of hybrid with tillage in irrigated corn study, Sandyland, 1996-1998.

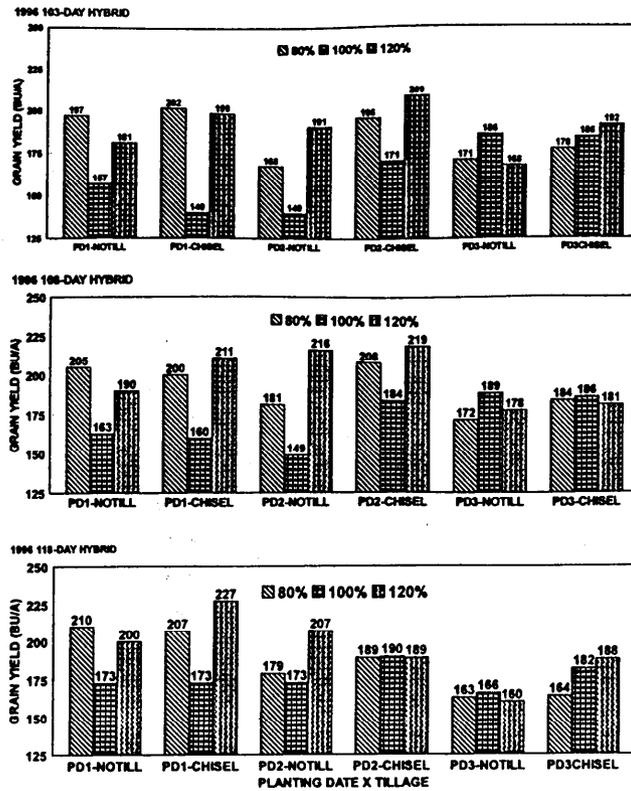


Figure 5. Corn grain yield by hybrid maturity using planting date X irrigation level X tillage interaction, Sandyland, 1996.

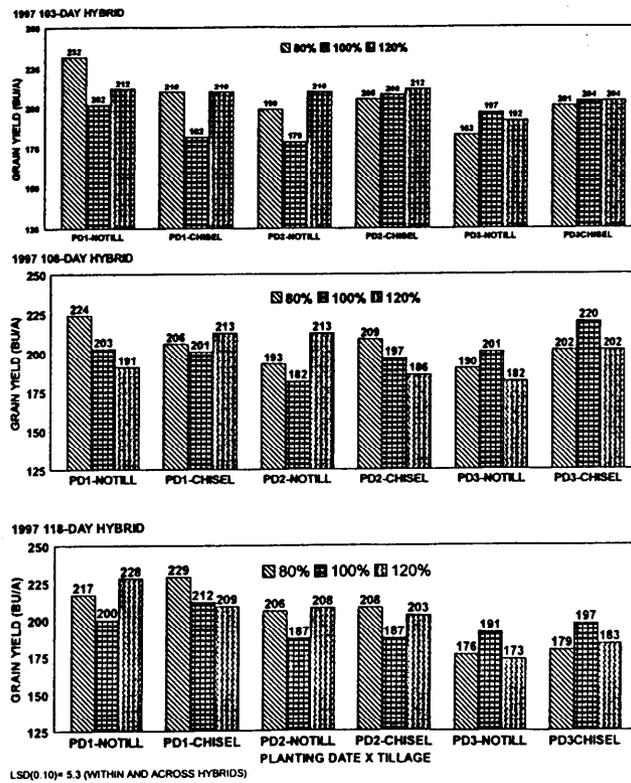
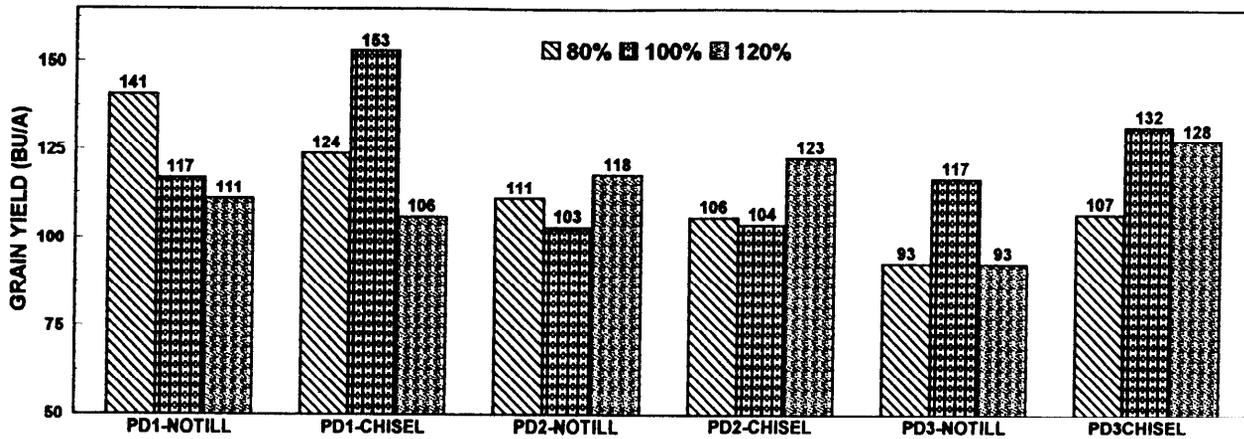
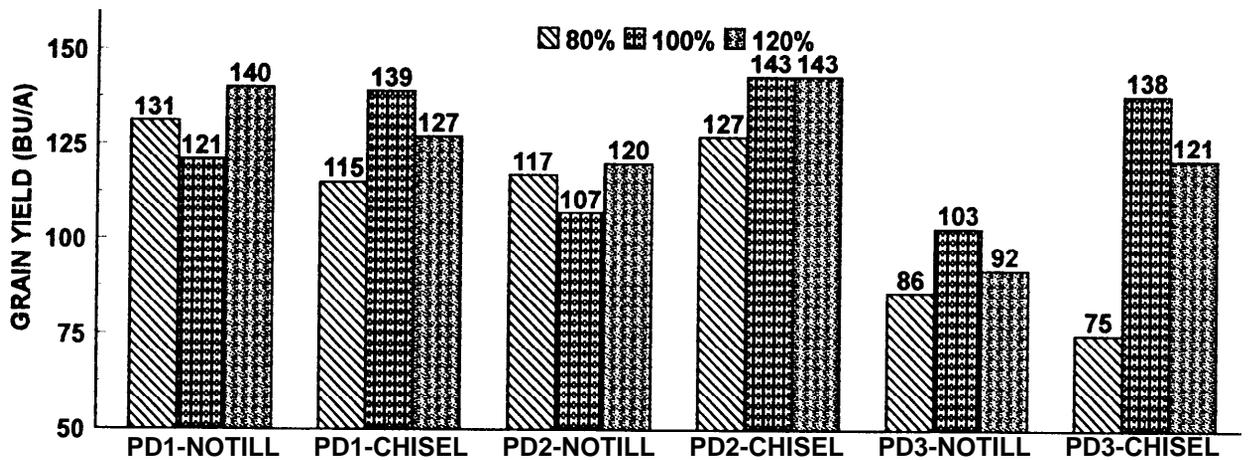


Figure 6. Corn grain yield by hybrid maturity using planting date X irrigation level X tillage interaction, Sandyland, 1997.

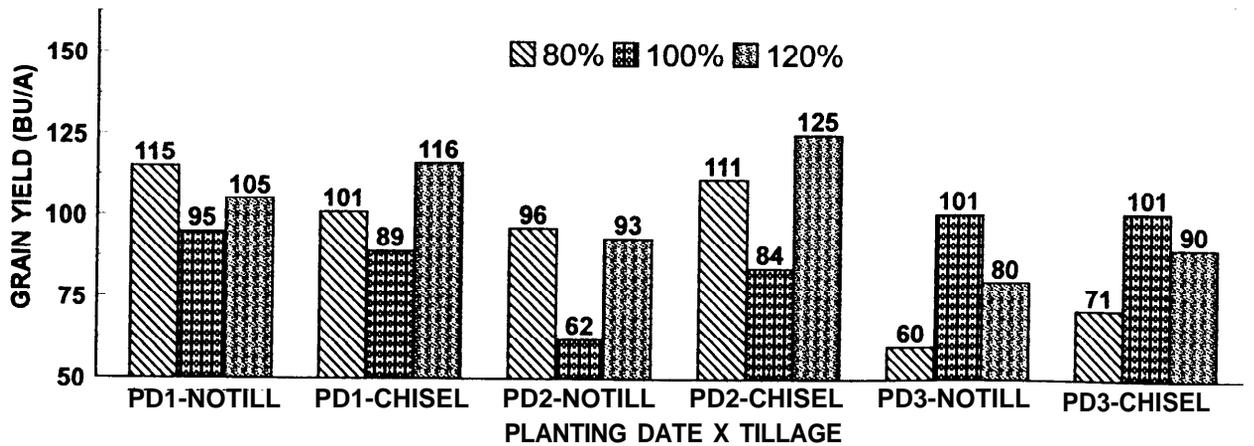
1998 103-DAY HYBRID



1998 108-DAY HYBRID



1998 118-DAY HYBRID



LSD(.10) = NS

Figure 7. Corn grain yield by hybrid maturity using planting date X irrigation level X tillage interaction, Sandyland, 1998.

## **CROP PERFORMANCE TESTING AND NEW PROJECTS**

**Victor L. Martin**

During the 1998 cropping season, performance tests were conducted on dryland wheat and grain sorghum, as well as irrigated wheat, standard and Roundup Ready soybeans, grain sorghum, and both full- and short-season corn hybrids. Great variability rendered the irrigated wheat performance test unusable. The dryland grain sorghum performance test also contained high variability. Information from the crop performance tests is summarized in the respective crop performance test publications available at local county extension offices.

Alfalfa variety trial data will be available in the fall of 1999. A new test was initiated in September 1997 and had excellent emergence and fall growth; however, severe weed pressure rendered the data unusable. For information concerning previous alfalfa variety tests, please contact the Sandyland Experiment Field.

Bt corn studies are continuing, as are several fertilizer studies, both dryland and irrigated. This information can be found in the Kansas Fertilizer Research report (SRP 829) and the Southwest Research-Extension Center Field Day reports (SRP 814).

In 1999, several new studies will be initiated. One study will determine the potential for dryland soybean production on the sandy soils of the area. Roundup Ready soybeans will be used across a range of maturities with tillage and planting date variables. A study furthering work previously done on narrow-row corn will focus on optimum plant populations for 15-inch rows. With the increased drought tolerance and yield potential of grain sorghum hybrids, the effect of population and planting date will be reexamined.

You may contact the Sandyland Experiment Field if your local extension office does not have information concerning existing and new projects.

# UNIFORMITY OF LOW DRIFT NOZZLE IRRIGATION

Gary A. Clark, Danny H. Rogers, Victor L. Martin, Robert Stratton, and Dale L. Fjell

## Summary

Water application patterns from LDN type sprinklers can result in nonuniform water distributions and low coefficients for uniformity for certain spacing and operating pressure arrangements. Increasing the number of deflector plates may help to break up water patterns and improve uniformity. Similarly, increased operating pressure also can improve application uniformity. However, this work measured only a 10-ft sprinkler spacing and a limited number of orifice/pressure combinations. Additional research is being conducted to improve this database and to evaluate these effects on crop yield.

## Introduction

Irrigation systems and nozzle packages should be designed to apply water uniformly to all areas of the irrigated field. Nonuniform applications of water occur when areas of the irrigation system apply more or less water than other areas. These application differences may occur regularly throughout all of the system or just within portions of the system because of nozzle application problems, or they may occur at specific locations within the system as a result of improper nozzle sizing or improper pressure distribution. All irrigation systems will have some nonuniform water applications at levels that are acceptable. Because irrigation events are scheduled to provide “just-in-time” water to the crop, effects of irrigation uniformity on yield can become substantial. This work was conducted to evaluate the uniformity of water applications from low drift type nozzles (LDN).

## Procedures

These studies were conducted at the Sandyland Experiment Field, St. John, Kansas. The irrigation system was a T-L linear with four, 160-ft long spans. Each span had 16 nozzle outlets outfitted with gooseneck pipes, flexible hose drops, and poly weights. On the end of each flexible drop pipe was a pressure regulator and an LDN. The resultant nozzle drops were on a 10-ft spacing.

Three of the spans were arranged with #16 (16/64-in., low rate), #18 (18/64-in., medium rate), or #20 (20/64-in., high rate) nozzle orifices on Senninger, fixed-plate, LDN sprinklers. These were all pressure regulated to 6 psi. The fourth span was arranged with two groups of eight LDN sprinklers. One group had #14 (14/64-in.) orifice nozzles with 15 psi regulators, and the other group had #16 (16/64-in.) orifice nozzles with 10 psi regulators. The resultant water application rates from these two combinations and the #18 orifice at 6 psi sprinkler were similar. This comparison was used to evaluate the effect of operating pressure on water distribution patterns.

Large-diameter catch pans (17-in.-diameter plastic pans) were placed on 4 foot centers parallel to the direction of travel of each span. The system was operated at a speed that would apply approximately 0.80 inches of water to the zones of medium application rate. Collected water was weighed, and data were statistically analyzed and plotted.

## Results

Water application distribution patterns from the #16, #18, and #20 orifice size LDN sprinklers at 6 psi of pressure are shown in Figures 8, 9, and 10, respectively. The Christiansen coefficients of uniformity (CU) for each of these patterns were 71%, 71%, and 79%, respectively.

The #16 and #18 orifice sprinklers had two deflector plates, whereas the #20 sprinkler had three deflector plates. The third plate aided in breaking up the water application pattern, and improving the uniformity. Figure 11 shows the distributions for the medium

water application rate from the LDN sprinklers with the #18 orifice size at 6 psi, the #16 orifice size at 10 psi, and the #14 orifice size at 15 psi. The resultant CU values for these patterns were 78%, 88%, and 93%. These results suggest that for this flow rate and spacing requirement, the higher pressure arrangement resulted in a more uniform water distribution. However, this result may not occur consistently for other spacing and flow arrangements and is being studied currently using laboratory data and computer simulations.

This work was supported in part by the State Water Fund of the Kansas Water Office and the Kansas Corn Commission

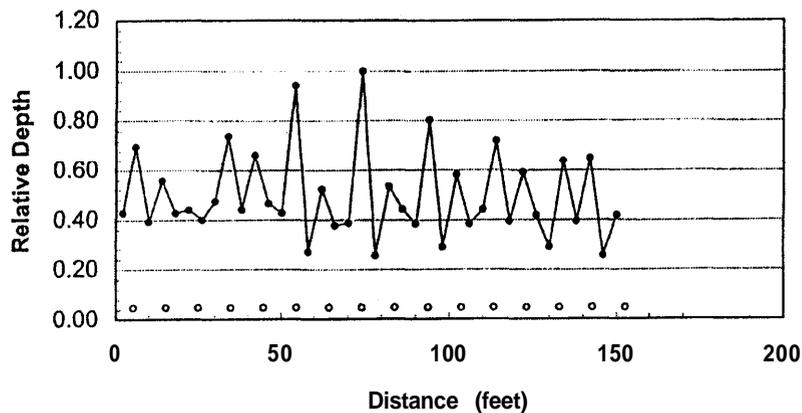


Figure 8. Water application distribution pattern from LDN sprinkler nozzles with a #16 (16/64-in) orifice and two deflector plates operated at 6 psi on a 10-ft spacing and at a height of approximately 7-ft. Sprinkler locations are shown by the open circles. The coefficient of uniformity for this pattern is 71%. Sandyland Experiment Field, St. John, KS.

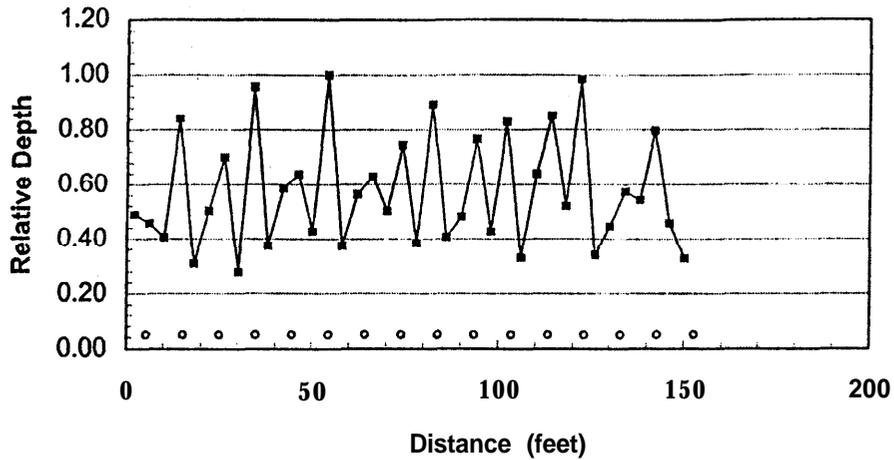


Figure 9. Water application distribution pattern from LDN sprinkler nozzles with a #18 (18/64-in.) orifice and two deflector plates operated at 6 psi on a 10-foot spacing and at a height of approximately 7 feet. Sprinkler locations are shown by the open circles. The coefficient of uniformity for this pattern is 71%. Sandyland Experiment Field, St. John, KS.

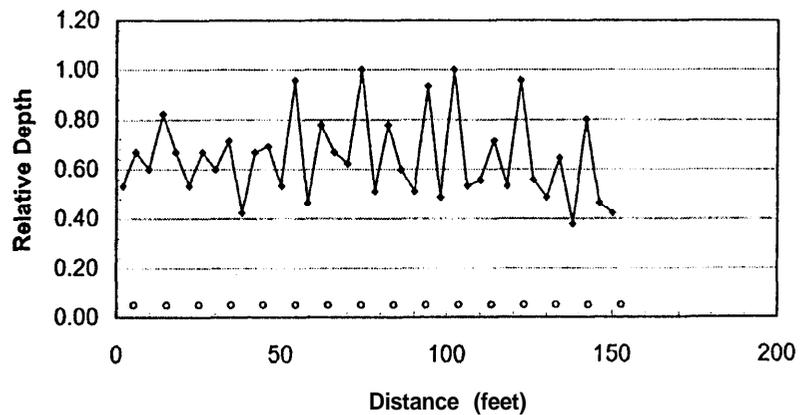


Figure 10. Water application distribution pattern from LDN sprinkler nozzles with a #20 (20/64-in.) orifice and three deflector plates operated at 6 psi on a 10-foot spacing and at a height of approximately 7 feet. Sprinkler locations are shown by the open circles. The coefficient of uniformity for this pattern is 79%. Sandyland Experiment Field, St. John, KS.

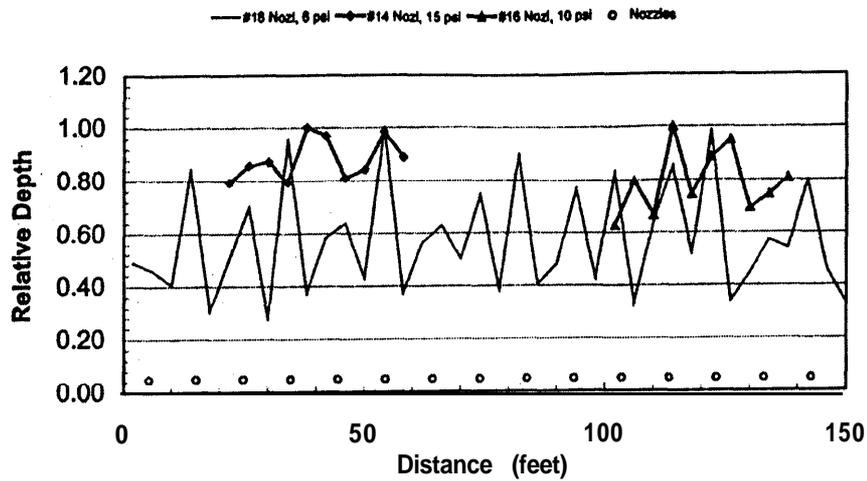


Figure 11. Water application distribution patterns from LDN sprinklers on a 10-ft spacing and a 7-ft height. Three patterns are shown: #18 (18/64-in.) orifice with two deflector plates and operated at 6 psi (solid line); a #16 (16/64-in.) orifice with two deflector plates and operated at 10 psi (bold solid line with triangles); and a #14 (14/64-in.) orifice with a single deflector plate and operated at 15 psi (bold solid line with diamonds). The coefficients of uniformity for these patterns are 78%, 88%, and 93%, respectively. Sandyland Experiment Field, St. John, KS.

# VARIABLE IRRIGATION RATES AND CROP YIELD

Gary A. Clark, Danny H. Rogers, Victor L. Martin, Robert Stratton, and Dale L. Fjell

## Summary

Studies were conducted to evaluate the effects of variable irrigation rates and nonuniform irrigation distributions on crop yield. Corn yield increased with increased applied water and with increased water application uniformity on a loamy sandy site. Soybean yield also increased with increased irrigation on a sandy loam site. Commercial corn yield on one silt loam sites was highest at the lowest irrigation rate of 6.9 inches. Corn yield on the other silt loam site was more variable, and yield from the irrigation rates of 4.9 to 10.7 inches did not vary by more than 12 bu/a.

## Introduction

Irrigation systems are used to provide water to crops when rainfall is not sufficient to meet their evaporative demands. Variable application rates of irrigation water can occur within fields that are irrigated by systems that have nonuniform water distributions. However, improper irrigation scheduling results in water application rates that vary from the optimum by either applying too much water, too little water, or poor timing. This work was conducted to initiate field evaluations of variable water application amounts and the effects on crop yield.

## Procedures

These studies were conducted at the Sandyland Experiment Field, St. John, Kansas and on three commercial farm sites. The Sandyland irrigation system was a T-L linear irrigation machine with four, 160-ft long spans. Each span had 16 nozzle outlets outfitted with gooseneck pipes, flexible hose drops, and poly line weights. On the end of each flexible drop pipe was a pressure regulator and a low drift

nozzle (LDN) type fixed-plate sprinkler. The sprinkler drops were on a 10-ft spacing. Soil at the site was a loamy fine sand.

Three of the spans were each arranged with #16 (16/64-in., low rate), #18 (18/64-in., medium rate), or #20 (20/64-in., high rate) nozzle orifices on Senninger, fixed-plate, LDN sprinklers. These were all pressure regulated to 6 psi. The fourth span was arranged with two groups of eight LDN sprinklers. One group had #14 (14/64-in.) orifice nozzles with 15 psi regulators, and the other group had #16 (16/64-in.) orifice nozzles with 10 psi regulators. The resultant water application rates from these two combinations and the #18 orifice at 6 psi sprinkler were similar. This comparison was used to evaluate the effect of operating pressure on water distribution patterns.

Corn was planted on May 8 in rows that were parallel to the direction of travel and on a 30-in. spacing. The irrigation system was scheduled to apply water in response to crop need. A summary of the sprinkler characteristics and applied water is provided in Table 4. Corn was hand harvested by row on September 15, 1998. Harvest plots included 20 ft of row and 12 rows per water treatment.

Commercial field studies were conducted on three center-pivot-irrigated fields with systems that irrigated 110-130 acres. These fields were designated as Sites 5, 6, and 8. Sites 5 and 6 had silt loam soils, and Site 8 had a sandy loam soil. Sprinklers on each of these center pivot systems were modified to provide three different application depth zones. Each modified zone consisted of five sprinklers that were pressure regulated at 25 psi and had preselected nozzle orifice inserts to provide the desired application

rate. Water from the center sprinkler drop of each zone was measured throughout the season using an in-line, precision flow meter. These modified zones were located on the second and third spans of the center pivot systems. Plots from each of these systems were hand harvested at crop maturity. A summary of the three systems is provided in Table 5.

## Results

Yield results from the Sandyland site are summarized in Figures 12 and 13. Seasonal rainfall (May through August) totaled 10.4 inches. However, 6.1 inches was measured in July, and only 3.6 inches of this was estimated as effective. Therefore, effective seasonal rainfall was estimated to be 7.9 inches.

Figure 12 shows yield and water use efficiency responses to applied irrigation. Yield increased as applied water increased. Water use efficiency (WUE) was calculated as the ratio of yield to total water (irrigation plus rainfall). Higher values of WUE occurred in plots that had higher irrigation coefficient of uniformity (CU)

values. The most uniform plot (#14 orifice at 15 psi) had the lowest yield variation (CV) determined as the ratio of the standard deviation to the mean yield from the 12 rows in a plot.

Yield and water use efficiency data from commercial field sites 5, 6, and 8 are shown in Figures 14, 15, and 16, respectively. Total water (irrigation plus rain) for site 5 ranged from 14.9 to 21.7 inches. Corn yield ranged from 141 to 153 bu/a with the highest WUE of 10.0 bu/inch (Figure 14). Total water for site 6 ranged from 15.2 to 20.6 inches. Corn yield ranged from 150 to 186 bu/a with the highest yield and highest WUE (12.2 bu/in.) occurring at the lowest applied irrigation depth of 6.9 in. (Figure 15). Soybean yield increased with increased irrigation (Figure 16), but the highest WUE of 2.9 bu/in. occurred at the medium irrigation rate of 9.2 inches.

This work was supported in part by the State Water Plan Fund of the Kansas Water Office, and the Kansas Corn Commission.

Table 4. Design and performance characteristics of the linear irrigation system at Sandyland Experiment Field, 1998.

Span	Nozzle Size (1/16-in.)	Operating Pressure (psi)	Flow Rate (gpm)	Measured Coefficient of Uniformity (CU) (%)	Applied Water (in.)
EC	#16	6	4.48	71	6.2
WC	#20	6	6.78	79	9.2
W1	#16	10	5.79	88	8.0
W2	#14	15	5.24	93	7.3

Table 5. Characteristics of the center pivot field sites, St. John, KS, 1998.

System	Crop	Sprinklers	Spacing (ft)	Operating Pressure (psi)	Applied Depth (in.)			
					Low	Medium	High	Rain
Site 5	Corn	Nelson Rotators	17	25	4.9	9.0	10.7	10.0
Site 6	Corn	Nelson Rotators	18	25	6.9	9.4	12.3	8.3
<b>Site 8</b>	Soybean	Nelson Rotators	18	25	<b>7.1</b>	9.2	12.9	7.8

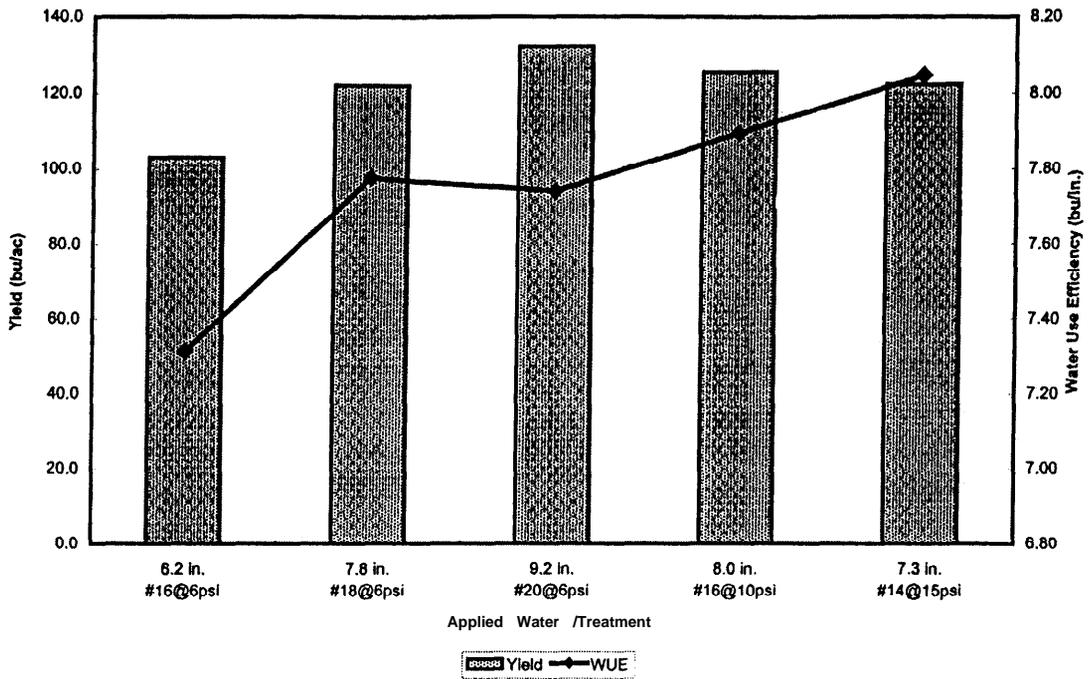


Figure 12. Yield and water use efficiency (WUE), Sandyland Experiment Field, St. John, KS, 1998.

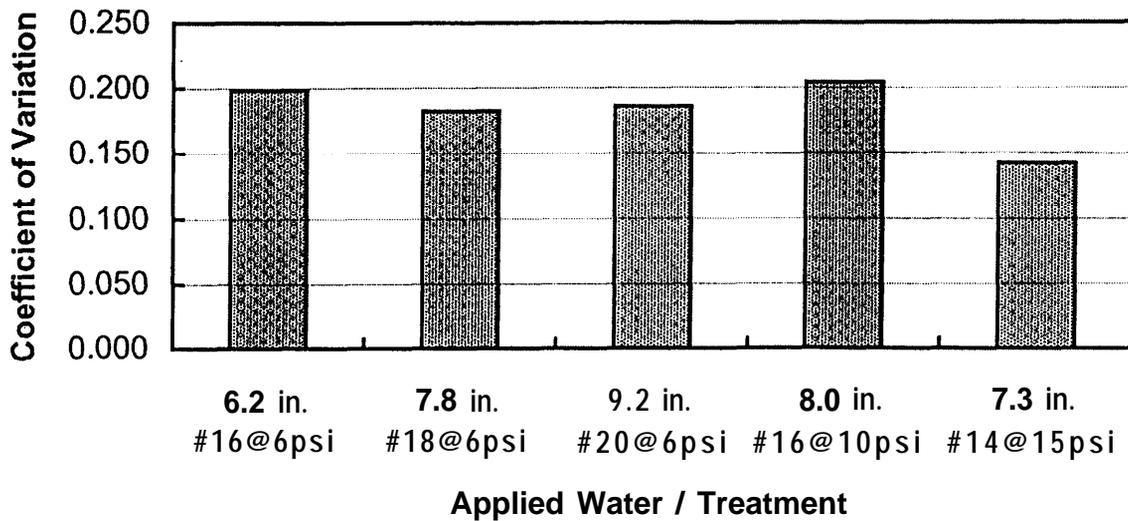


Figure 13. Variation in corn yield from the 12-row plots, Sandyland Experiment Field, St. John, KS, 1998.

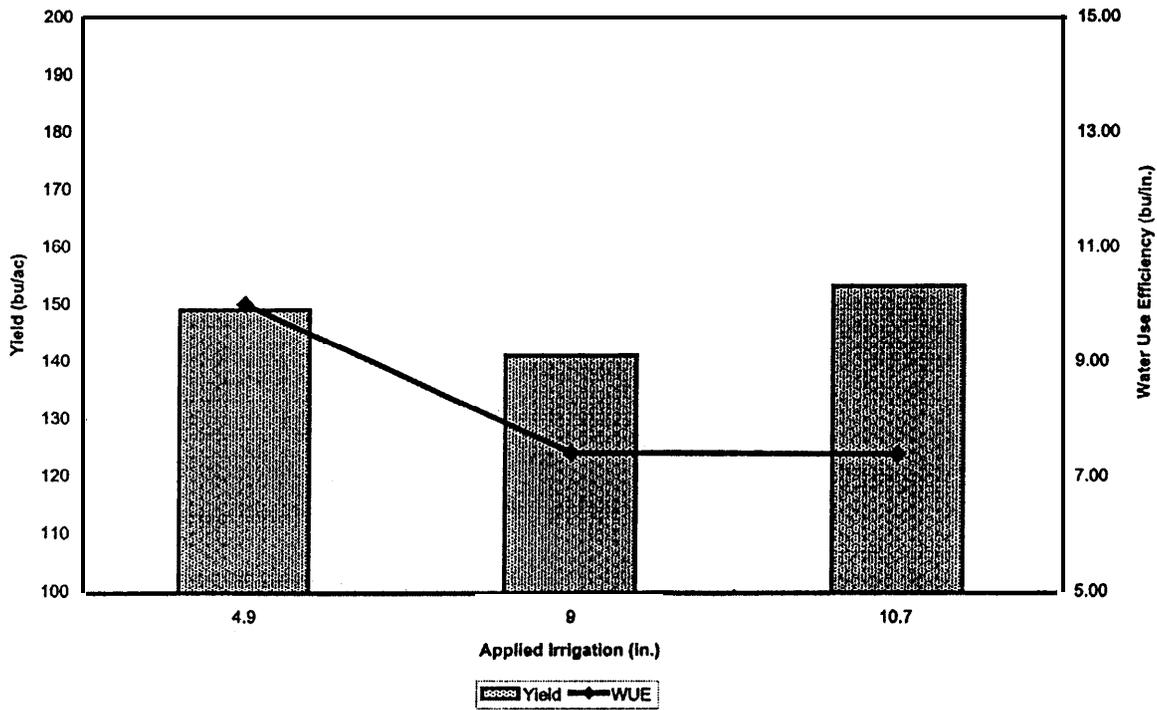


Figure 14. Yield and water use efficiency (WUE) for field site 5 (corn), St. John, KS, 1998.

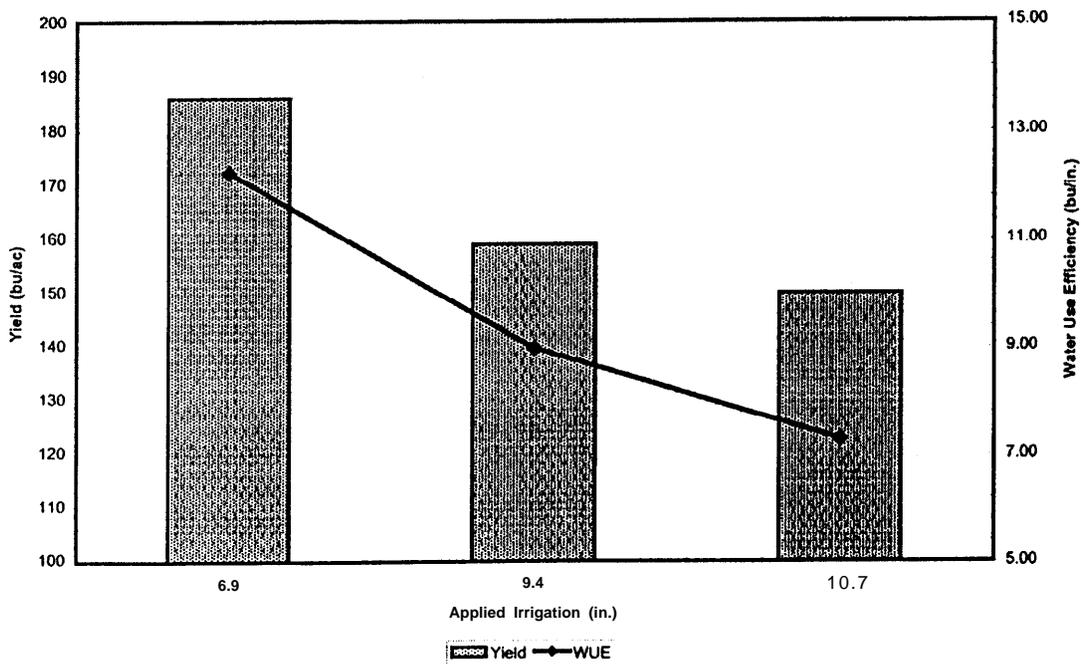


Figure 15. Yield and water use efficiency (WUE) for field site 6 (corn), St. John, KS, 1998.

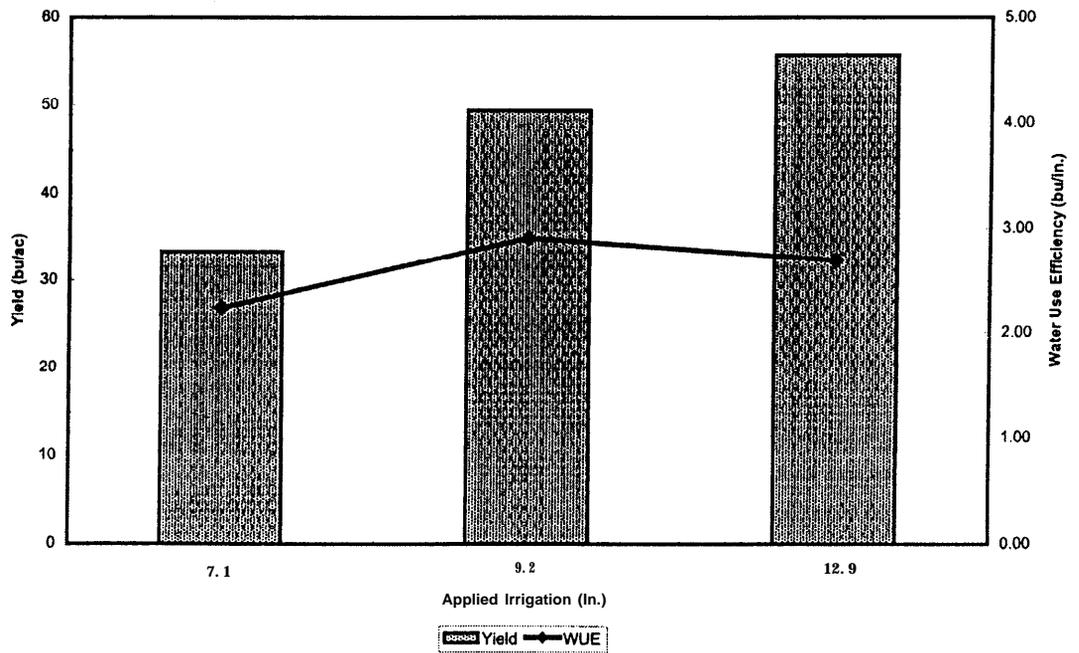


Figure 16. Yield and water use efficiency (WE) for field site 8 (soybean), St. John, KS, 1998.

# EVALUATION OF CORN BORER RESISTANCE AND GRAIN YIELD FOR BT AND NON-BT CORN HYBRIDS AT ST. JOHN, KS

Randall A. Higgins, Larry L. Buschman, Phillip E. Sloderbeck, and Victor L. Martin

## Summary

Twenty-six corn hybrids (15 Bt and 11 non-Bt) were evaluated for corn borer resistance and grain yield. The yield losses to girdling by southwestern corn borers averaged 16.6 bu/a for the unsprayed non-Bt hybrids, 0.7 bu/a for sprayed non-Bt hybrids, and 10.9 bu/a for hybrids with event 176. Hybrids with Bt11, MON810, and CBH351 had virtually no yield loss. Grain yields averaged 127.4 bu/a across all hybrids in the sprayed block and 116.8 bu/a in the unsprayed block.

## Procedures

Corn hybrid plots were machine-planted on 8 May at 26,000 seeds/a at the Sandyland Experiment Field near St. John, KS. Spot replanting was done as necessary. Preemergence herbicides applied on 12 May were 1 qt. Dual and 1 qt. atrazine/a. The soil was a sandy-loam. The field was sprinkler irrigated six times in June, four times in July, and twice in Aug. with totals of 5.4, 4.0 and 1.7 inches of water, respectively. The sprinkler broke down in Aug., so irrigation was inadequate for this critical period. The monthly rainfalls at Pratt for April, May, June, July, and Aug. were 1.1, 2.5, 0.5, 4.8, and 1.8 inches, respectively. The plots were four rows wide (10 ft) by 30 ft long. Two rows (5 ft) of Bt corn were planted between the plots as border rows, and 10-ft alleyways at the end of each plot were left bare. The border rows, and alleyways were included to reduce larval migration between plots. The experimental design was a split-plot with three replications. The main plots were insecticide-protected versus insecticide unprotected, and the subplots were the corn

hybrids. The protected blocks were sprayed on 22 July with Capture (bifenthrin) at 0.08 lb. AI/a. The study included 26 hybrids with relative maturity ratings of 110 to 118 days. An attempt was made to pair each non-Bt hybrid with its Bt sister line or another related hybrid. Pioneer 3162IR was included as the standard commonly used hybrid.

All corn borers were native infestations. First generation corn borer damage was rated on 22 July using the 1 to 9 Guthrie scale. Data for second generation corn borers were taken from five plants chosen at random from the two center rows of each plot. The plants were dissected to record corn borers and tunneling. Kernel damage was recorded as the number of kernels damaged at the tip and at the base or side of the ear (mostly corn earworm damage). Yield was determined by hand harvesting the two middle rows of each plot in late October. Ears from standing plants and those from fallen plants were harvested separately. Grain yield was calculated separately for standing and fallen corn and corrected to 15.5% moisture.

## Results

First generation corn borer leaf feeding damage was light and averaged 1.3 for the non-Bt hybrids and 1.04 for the Bt hybrids on the Guthrie scale (Table 6). Second generation European (ECB) and southwestern corn borer (SWCB) pressures averaged 0.13 and 0.98 larvae per plant, respectively, in the unsprayed non-Bt plots (Table 7). In hybrids with Bt11, MON810, CBH351, and Bt176 and the insecticide treatment, second generation ECB larvae were reduced by 100, 92, 100, 0, and 69%, respectively; second generation SWCB

larvae were reduced by 100, 100, 100, 66, and 95% (Fig. 17); corn borer tunneling was reduced by 100, 99, 100, 58, and 89% (Fig. 18); and yield losses from lodged plants were reduced by 100, 99, 97, 35 and 96%. The yield losses to girdling by SWCB averaged 16.6 bu/a for the unsprayed non-Bt hybrids, 0.7 bu/a for sprayed non-Bt hybrids, and 10.9 bu/a for hybrids with event 176 (Fig.19). Hybrids with Bt11, MON810, and CBH351 had virtually no yield loss.

Across the Bt hybrids (with no corn borer damage), the yield difference between sprayed and unsprayed was 8.1 bu/a. This yield loss could have been due to spider mite damage, but spider mite data were not collected. The plots were treated with Capture, a good miticide.

Corn earworm damage to kernels in the ear tip was moderate, averaging 23.3 kernels damaged per ear in the unsprayed non-Bt corn (Tables 7). Hybrids with Bt11, Mon810, and CBH351 and sprayed non-Bt hybrids averaged 76, 30, 42 and 45% reductions in kernel damage, respectively (Fig 20). Hybrids with Bt176 had little reduction in kernel damage.

Grain yield averaged 127.4 bu/a across all hybrids in the sprayed block, and 116.8 bu/a in the unsprayed block (Tables 7 & 8, Fig. 21). The standard hybrid, Pioneer 3162IR, yielded only 96.0 bu/a in the sprayed blocks and 89.5 bu/a in the unsprayed blocks, which were uncharacteristically low. Although gray leaf spot is sometimes a problem for this hybrid, we observed no unusual levels of disease infection. A number of Bt and non-Bt hybrids were among the top yielders.

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Note: This research was supported by Kansas Corn Commission Check-off Funds through the Kansas Department of Agriculture.

Table 6. Evaluation of corn borer resistance of Bt and non-Bt corn hybrids at St. John, KS, 1998.

Unsprayed Plots			First Gen. Corn Borer Guthrie Ratings
Hybrid	Bt Event	Company	
4494		Novartis Seeds	1.46 a
MAX454	176	Novartis Seeds	1.07 bc
7590Bt	Bt11	Novartis Seeds	1.10 c
7590		Novartis Seeds	1.37 ab
7639Bt	Bt11	Novartis Seeds	1.03 c
H-2530Bt	MON810	Golden Harvest	1.03 c
H-2530		Golden Harvest	1.02 c
3162IR		Pioneer	1.37 ab
31B13	MON810	Pioneer	1.03 c
32J55		Pioneer	1.10 bc
33A14	MON810	Pioneer	1.03 c
8325		Garst	1.30 abc
8325Bt	MON810	Garst	1.03 c
8342Bt	MON810	Garst	1.00 c
7997		Cargill	1.10 bc
7821BT	MON810	Cargill	1.00 c
8021BT	MON810	Cargill	1.00 c
580		DeKalb	1.47 a
580BtY	MON810	DeKalb	1.10 bc
621		DeKalb	1.30 abc
621BtY	MON810	DeKalb	1.00 c
7250		Mycogen	1.43 a
2787	176	Mycogen	1.03 c
2801	176	Mycogen	1.10 ab
8366IT		Garst	1.17 bc
8366Bt/LL	CBH351	Garst	1.00 c

\* Analyzed PROC GLM, PDIFF, P>0.05

Table 7. Evaluation of corn borer resistance of Bt and non-Bt corn hybrids, Unsprayed Block at St. John, KS, 1998.

Unsprayed Plots		2nd Gen. Corn Borer								
Hybrid	Bt Event	Company	ECB Larvae Per Plant	SWCB Larvae Per Plant	% SWCB Girdled Plants*	Cm of Tunneling Per Plant	Ear Tip Damage # of kernels	Yield Standing Plts. Bu/A	Yield Fallen Plts. Bu/A	Total Yield Bu/A
4494		Novartis Seeds	0.13	0.73 ab	26.67 ab	14.9 cd	26.5 abc	82.5 ghi	31.3 a	113.7 a-f
MAX454	176	Novartis Seeds	0.07	0.73 ab	0.00 c	16.7 cd	15.8 c-g	98.9 d-i	10.5 c-g	109.3 b-f
7590Bt	Bt11	Novartis Seeds	0.00	0.00 d	0.00 c	0.0 e	6.3 fg	128.4 a-d	0.0 g	128.4 a-d
7590		Novartis Seeds	0.27	0.73 ab	26.67 ab	12.6 d	17.2 c-g	86.5 f-i	20.0 a-d	106.5 c-f
7639Bt	Bt11	Novartis Seeds	0.00	0.00 d	0.00 c	0.0 e	5.1 g	142.2 ab	0.0 g	142.2 ab
H-2530Bt	MON810	Golden Harvest	0.00	0.00 d	0.00 c	0.0 e	15.8 c-g	116.2 a-f	0.0 g	116.2 a-f
H-2530		Golden Harvest	0.13	0.60 ab	13.33 bc	18.7 bcd	18.7 c-g	100.5 d-i	3.1 fg	103.6 c-f
3162IR		Pioneer	0.20	0.73 ab	20.00 ab	26.4 a	13.8 c-g	70.0 i	19.5 bcd	89.5 ef
31B13	MON810	Pioneer	0.00	0.00 d	0.00 c	0.0 e	22.1 b-f	147.0 a	0.0 g	147.0 a
32J55		Pioneer	0.07	0.87 a	33.33 a	14.5 cd	17.6 c-g	95.6 e-i	24.5 ab	120.1 a-f
33A14	MON810	Pioneer	0.00	0.00 d	0.00 c	0.0 e	14.6 c-g	142.6 ab	0.0 g	142.6 ab
8325		Garst	0.00	0.47 bc	13.33 bc	17.5 cd	18.7 c-g	104.9 c-h	5.7 efg	110.6 b-f
8325Bt	MON810	Garst	0.00	0.00 d	0.00 c	0.0 e	22.7 b-e	135.5 abc	0.0 g	135.5 a-d
8342Bt	MON810	Garst	0.00	0.00 d	0.00 c	0.0 e	25.3 bcd	108.6 c-g	0.4 g	108.9 b-f
7997		Cargill	0.20	0.13 d	13.33 bc	4.0 e	42.5 a	94.4 e-i	7.0 efg	101.5 def
7821BT	MON810	Cargill	0.07	0.00 d	0.00 c	0.0 e	6.7 fg	122.4 a-e	0.0 g	122.4 a-e
8021BT	MON810	Cargill	0.00	0.00 d	0.00 c	0.0 e	6.8 efg	107.4 c-g	0.0 g	107.4 c-f
580		DeKalb	0.07	0.27 cd	20.00 ab	15.5 cd	9.6 d-g	125.6 a-e	10.9 c-g	136.5 abc
580BtY	MON810	DeKalb	0.07	0.00 d	0.00 c	0.4 e	15.2 c-g	119.0 a-e	0.0 g	119.0 a-f
621		DeKalb	0.13	0.87 a	26.67 ab	24.7 ab	35.7 ab	72.7 hi	14.9 b-e	87.7 f
621BtY	MON810	DeKalb	0.00	0.00 d	0.00 c	0.1 e	17.9 c-g	110.6 b-g	0.0 g	110.6 b-f
7250		Mycogen	0.00	0.67 ab	20.00 ab	19.4 bc	19.1 c-g	97.9 d-i	24.6 ab	122.4 a-e
2787	176	Mycogen	0.07	0.13 d	0.00 c	1.6 e	28.7 abc	111.8 b-g	9.2 d-g	121.0 a-f
2801	176	Mycogen	0.27	0.13 d	0.00 c	2.4 e	16.6 c-g	103.1 c-h	13.0 c-f	116.1 a-f
8366IT		Garst	0.20	0.27 cd	13.33 bc	14.5 cd	35.2 ab	93.7 e-i	21.2 abc	114.9 a-f
8366Bt/LL	CBH351	Garst	0.00	0.00 d	0.00 c	0.0 e	13.2 c-g	103.1 c-h	0.6 g	103.6 c-f
LSD value p=0.05			0.21	0.33	17.21	6.7	16.0	32.5	11.4	34.4
F-test Prob.			0.1405	<0.0001	0.0001	<0.0001	0.0018	0.0002	<0.0001	0.0849

\* Based on 5 plants per plot at time of stalk splitting



Table 8. Evaluation of corn borer resistance of Bt and non-Bt corn hybrids, Sprayed Block at St. John, KS, 1998.

Sprayed Plots		2nd Gen. Corn Borer								
Hybrid	Bt Event	Company	ECB Larvae Per Plant	SWCB Larvae Per Plant	% SWCB Girdled Plants*	Cm of Tunneling Per Plant	Ear Tip Damage # of kernels	Yield Standing Plts. Bu/A	Yield Fallen Plts. Bu/A	Total Yield Bu/A
4494		Novartis Seeds	0.00 c	0.00	0.00	0.07	8.3	125.6 b-e	0.0	125.6 b-f
MAX454	176	Novartis Seeds	0.00 c	0.07	1.33	1.53	13.7	137.0 a-d	0.0	137.0 a-d
7590Bt	Bt11	Novartis Seeds	0.00 c	0.00	0.00	0.00	10.5	146.3 ab	0.0	146.3 ab
7590		Novartis Seeds	0.00 c	0.13	0.00	2.4	14.1	132.3 b-e	0.0	132.3 b-e
7639Bt	Bt11	Novartis Seeds	0.00 c	0.00	0.00	0.00	5.7	118.5 b-f	0.0	118.5 b-f
H-2530Bt	MON810	Golden Harvest	0.00 c	0.00	0.00	0.03	25.8	120.1 b-f	0.0	120.1 b-f
H-2530		Golden Harvest	0.00 c	0.20	0.00	3.53	11.3	115.7 b-f	2.3	118.0 b-f
3162IR		Pioneer	0.00 c	0.00	0.00	0.27	12.1	94.5 f	1.4	96.0 f
31B13	MON810	Pioneer	0.00 c	0.00	0.00	0.00	9.7	163.8 a	0.0	163.8 a
32J55		Pioneer	0.00 c	0.00	0.00	0.87	15.4	121.6 b-f	0.0	121.6 b-f
33A14	MON810	Pioneer	0.00 c	0.00	0.00	0.00	11.8	131.4 b-e	0.0	131.4 b-e
8325		Garst	0.07 bc	0.00	0.00	2.20	9.5	126.7 b-e	0.0	126.7 b-f
8325Bt	MON810	Garst	0.00 c	0.00	0.00	0.00	5.5	136.8 a-d	0.0	136.8 a-d
8342Bt	MON810	Garst	0.00 c	0.00	0.00	0.00	18.1	106.5 def	0.0	106.5 def
7997		Cargill	0.00 c	0.00	0.00	1.53	20.8	104.8 ef	0.0	104.8 ef
7821BT	MON810	Cargill	0.00 c	0.00	0.00	0.00	6.7	139.8 ab	0.0	139.8 ab
8021BT	MON810	Cargill	0.00 c	0.00	0.00	0.00	11.1	129.8 b-e	0.0	129.8 b-e
580		DeKalb	0.13 ab	0.07	0.00	1.83	7.8	129.4 b-e	2.9	132.2 b-e
580BtY	MON810	DeKalb	0.00 c	0.00	0.00	0.07	3.9	143.3 ab	0.0	143.3 ab
621		DeKalb	0.00 c	0.07	1.33	2.53	13.3	107.4 c-f	0.0	107.4 c-f
621BtY	MON810	DeKalb	0.00 c	0.00	0.00	0.07	9.2	124.6 b-f	0.0	124.6 b-f
7250		Mycogen	0.07 bc	0.07	0.00	1.00	21.3	138.0 abc	0.9	138.9 ab
2787	176	Mycogen	0.00 c	0.07	0.00	0.47	16.1	128.7 b-e	0.0	128.7 b-e
2801	176	Mycogen	0.00 c	0.00	0.00	0.17	11.4	138.0 abc	0.0	138.0 abc
8366IT		Garst	0.20 a	0.07	0.00	4.20	5.1	124.7 b-f	0.0	124.7 b-f
8366Bt/LL	CBH351	Garst	0.00 c	0.00	0.00	0.07	18.5	119.2 b-f	0.0	119.2 b-f
LSD value p=0.05			0.9	0.12	1.06	2.85	13.1	31.0	2.0	31.1
F-test Prob.			0.0075	0.1350	0.5535	0.1172	0.1507	0.0384	0.2989	0.0445

\* Based on 5 plants per plot at time of stalk splitting.



Fig. 17. Second Generation SWCB Larvae per Plant at St John, KS, 1998.

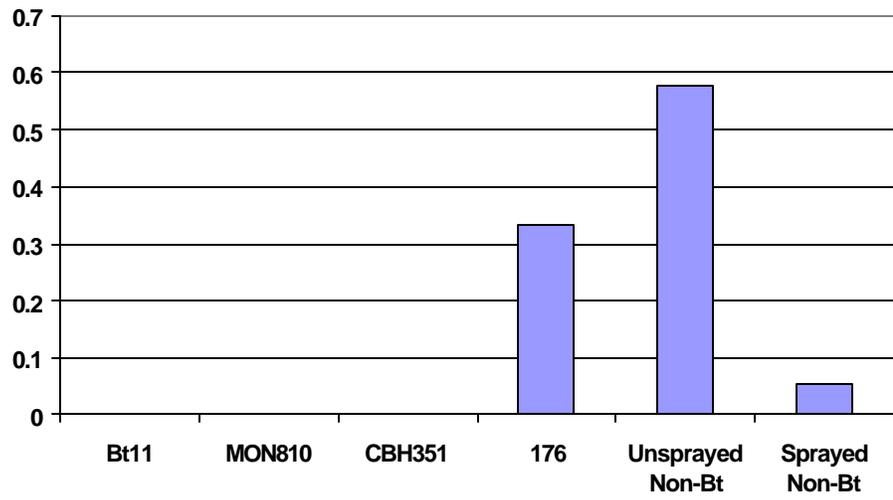


Fig. 18. Second Generation Corn Borer Tunneling in cm per Plant at St John, KS, 1998.

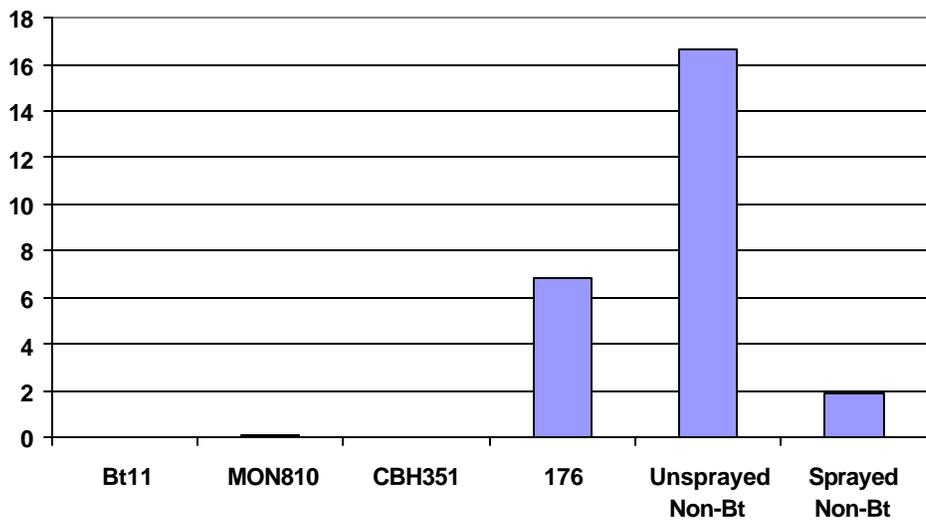


Fig. 19. Fallen Grain Yield in bu/a due to SWCB at St John, KS, 1998.

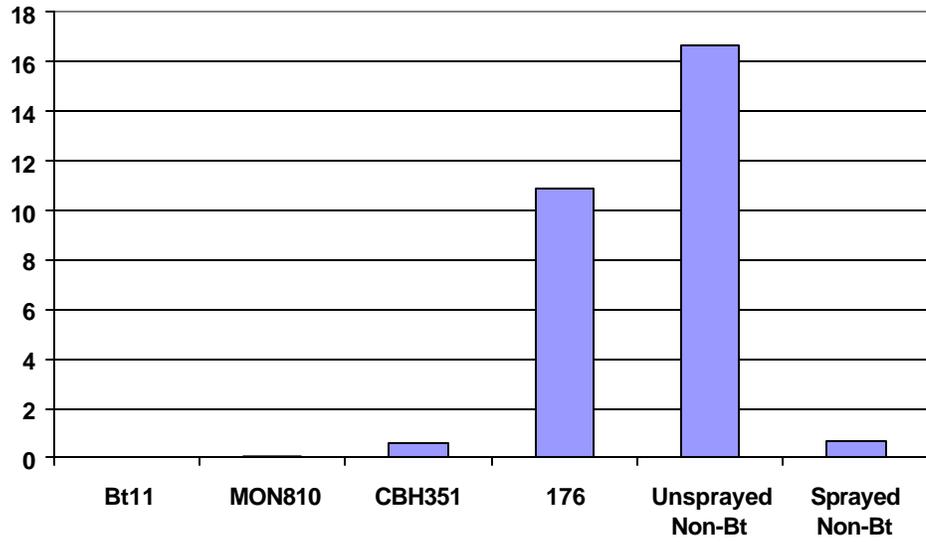


Fig. 20. Number of Kernels Damaged per Plant at St John, KS, 1998.

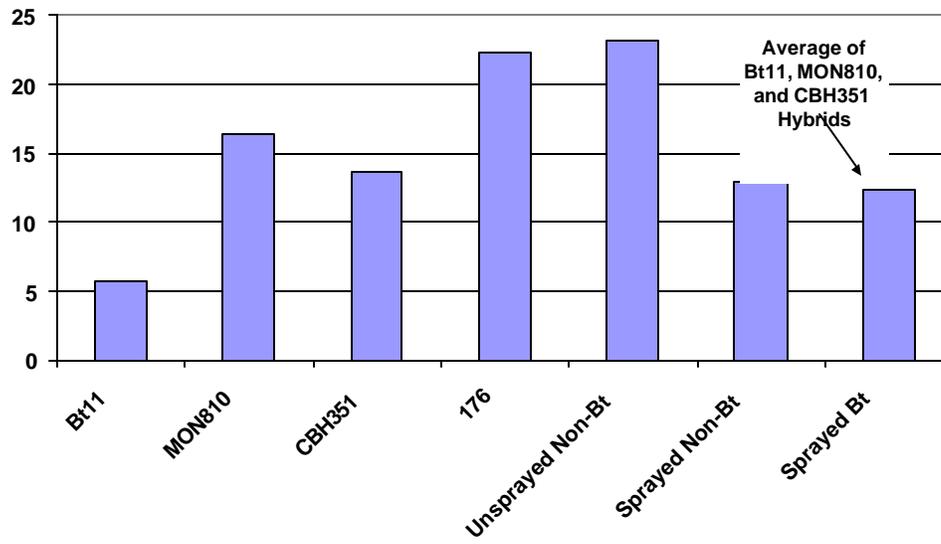
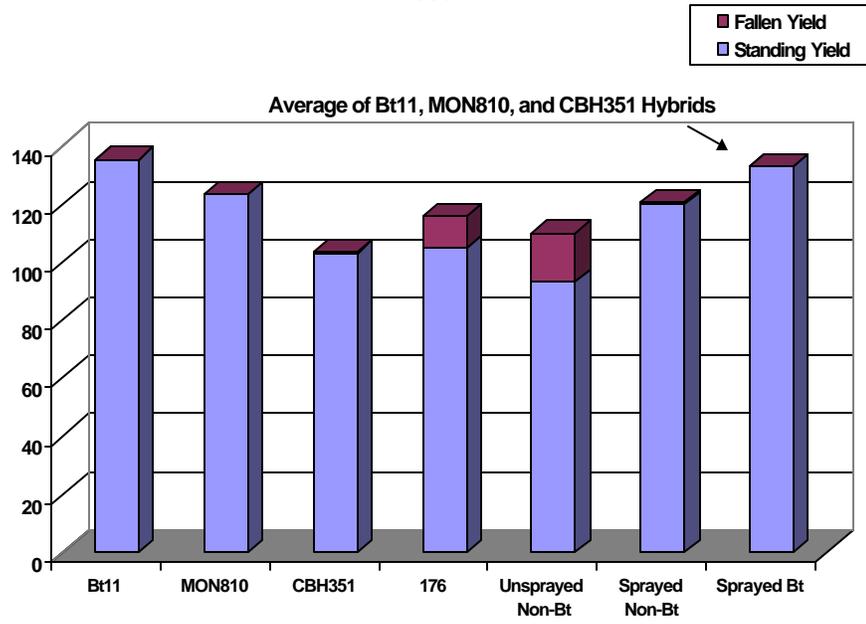


Fig. 21. Standing and Fallen Grain Yield in bu/a at St John, KS, 1998.



# **SOUTH CENTRAL KANSAS EXPERIMENT FIELD**

## **Introduction**

The South Central Kansas Experiment Field was established in 1951 on the US Coast Guard Radio Receiving Station located southwest of Hutchinson. 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, and Hutchinson). The current South Central Field location is approximately 3/4 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 using sound environmental practices. The principal objective is achieved through investigations of fertilizer use, weed and insect control, tillage methods, seeding techniques, cover crop and crop rotation, variety improvement, and selection of hybrids and varieties adapted to the area. Experiments deal with problems related to production of wheat, grain and forage sorghum, oats, alfalfa, corn, soybeans, rapeseed/canola, and sunflower and soil tilth. Breeder and foundation seed of wheat and oat varieties are produced to improve seed stocks available to farmers. A large portion of the research program at the field is dedicated to wheat breeding and germplasm development.

## **Soil Description**

The soil survey for the South Central 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 ca-

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 inches. 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 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 unsuited for cultivated crop production and has been seeded to switchgrass. Small pockets of the Tabler-Natrustolls are found throughout the Field.

## **1997-98 Weather Information**

Precipitation in 1998 totaled 32.04 inches, 2.55 inches above the 30-year average of 29.49 inches (Table 1). As in previous years, precipitation in 1998 was not distributed evenly through the year or within a given month. The highest monthly total was recorded in November (5.29 inches). When the monthly totals were high (March, September, October, and November), most of the precipitation was received in one or two high- rainfall events. However, most of the water received did not run off and was considered beneficial to crop production until the November rains. The soil conditions at planting of the 1998 winter wheat crop (October 1997) were good because of the above-normal rainfall received in August and September of 1997. After planting,

precipitation was considerably below the long-term average for November, but the high soil moisture carried the wheat through until above-normal rainfall occurred through March. These conditions resulted in excellent wheat growth and a considerable number of fall tillers. Even though moisture was below normal during the grain filling period, it was timely and the temperatures were not extreme. These conditions allowed for near-normal to above-normal wheat yields.

considering the precipitation and temperatures during the growing season. August was dry and extremely hot. September precipitation was above normal, but temperatures were again above normal. Soil moisture at wheat seeding time for the 1999 crop was considered excellent. A frost-free growing season of 207 days (April 18 - November 11, 1998) was recorded. This is 24 days more than the average frost-free season of 183 days (April 19 - October 17).

The summer annuals (grain sorghum sunflowers, and soybeans) also yielded well

Table 1. Precipitation at South Central Kansas Experiment Field, Hutchinson.

Month	Rainfall (inches)	30-Yr Avg* (inches)	Month	Rainfall (inches)	30-Yr Avg (inches)
1997			April	1.90	2.92
September	5.74	3.09	May	1.18	4.30
October	2.40	2.48	June	3.59	4.05
November	0.29	1.43	July	4.70	3.07
December	2.46	0.95	August	2.10	3.16
1998			September	3.68	3.14
January	0.41	0.58	October	3.76	2.50
February	1.28	1.00	November	5.29	1.40
March	3.79	2.38	December	0.36	0.99
			1998 Total	32.04	29.49

\* Most recent 30 years.

# OATS FOR GRAIN AND FORAGE

**William F. Heer, Robert L. Bowden, Kraig L. Roozeboom, and James P. Shroyer**

## **Summary**

Grain yields of oats were low in 1998, mainly because of unusual weather conditions. Barley yellow dwarf infection affected both forage and grain yields of some varieties.

## **Introduction**

Oats are utilized not only for grain but also as a forage. Most of the time, oats planted for forage are utilized as a hay crop to feed livestock. The performance test for spring cereals did not report grain yields from oat varieties this year.

## **Procedures**

The oat plots for grain yield were planted on 25 March and the plots for forage yield on 26 March 1998 using the same plot drill and seeding rate. Soil conditions at planting were ideal. The forage oat plots were harvested when the majority of the varieties were in the hard dough stage (15 June 1998) using a Carter Forage harvester. The grain yield plots were harvested on 27 June 1998 with the

Gleaner E plot combine. This harvest date was slightly earlier than usual because of the warmer than normal weather conditions.

## **Results**

Oat varieties need to be evaluated for both grain and forage production, because a variety that has high grain yield potential may not have a high forage yield potential. The 1998 growing season was less than ideal for the production of oat grain. The early months were somewhat wet (Table 1) and cool, followed by hot dry weather in April and May. Precipitation in June was near normal, but the temperatures were higher than normal. Thus, the major factor affecting yields (Table 2) in 1998 was the unusual weather during the entire growing season. Another factor that affected both forage and grain yields was the amount of barley yellow dwarf infection in some of the varieties. Weather conditions did not have as great an influence on the forage results as they did on the grain yields. The data for forage dry matter from 1995, 1996, and 1998 are summarized in Table 3.

Table 2. 1998 Kansas Spring Oat Performance Test - South Central Field - Reno County

Brand	Name	Yield <sup>1</sup>			BYD <sup>2</sup> rating	TW <sup>3</sup> lb/bu	MST <sup>4</sup> %	Head <sup>5</sup> Julian	Lodge %
		1997 bu/a	1998 bu/a	% avg					
Colorado	Rio Grande	82.8	31.5	85.8	8.0	24.8	11.4	150.5	22.5
Illinois	Brawn	82.6	33.0	89.9	5.5	27.0	9.3	148.0	13.8
Wisconsin	Prairie	81.5	36.4	99.3	4.5	27.5	10.2	147.3	21.3
Wisconsin	Bay	81.1	29.4	80.1	5.5	26.5	14.0	151.8	15.0
Illinois	IL891730	79.7	45.9	125.1	4.3	29.8	9.7	144.5	32.5
Minnesota	Milton	71.7	30.8	84.0	6.3	26.5	10.5	150.0	11.3
Wisconsin	Gem	70.6	35.5	96.6	5.0	28.7	15.4	147.5	33.8
So. Dakota	Troy	70.0	29.8	81.1	6.3	27.3	13.7	151.0	25.5
Illinois	Rodeo	69.2	39.1	106.5	4.5	29.4	9.4	146.3	23.8
Illinois	IL862081	68.8	51.3	139.9	3.8	30.2	9.6	142.5	51.3
Wisconsin	Horicon	65.4	35.5	96.7	5.5	28.4	9.7	146.5	35.0
Wisconsin	Belle	65.1	30.0	81.8	6.3	29.8	10.9	149.8	13.8
Ohio	Armor	64.9	39.6	107.9	5.3	29.6	10.4	146.0	33.8
So. Dakota	Settler	64.3	39.7	108.2	6.8	30.6	9.6	145.5	51.3
No. Dakota	Jerry	62.6	28.4	77.3	6.8	30.7	10.5	146.5	10.0
Wisconsin	Dane	61.0	48.0	130.7	5.0	27.6	9.3	140.5	53.8
KS FDN	Ogle	60.1	47.6	129.6	4.5	28.7	9.8	143.8	43.8
Indiana	INO9201	59.6	41.9	114.3	4.3	31.3	9.5	142.0	32.5
KS FDN	Larry	59.4	38.9	105.9	6.0	30.3	9.5	142.5	43.8
Illinois	Hazel	58.8	41.8	114.0	3.8	30.7	9.4	142.3	10.0
Ohio	Chairman	57.6	38.5	104.8	7.0	27.5	9.6	142.5	12.5
KS FDN	Don	56.8	41.3	112.5	6.0	31.6	9.5	142.5	31.3
Canada	Russell	56.7	11.3	30.7	8.8	26.2	10.4	151.3	21.3
Minnesota	Jim	56.3	41.9	114.3	4.8	31.4	9.2	142.3	40.0
KS FDN	Bates	54.1	38.3	104.3	6.0	31.3	8.7	140.5	31.3
Minnesota	Premier	52.6	28.9	78.7	6.5	30.7	10.4	146.0	38.8
Average		65.9	36.7	----	5.6	29.0	10.4	145.8	29.0
CV (%)		8.6	17	17	11.9	3.5	7.2	0.68	50.4
LSD (0.05) <sup>6</sup>		6.7	8.9	24.4	0.9	1.4	0.01	1.4	20.6

1. Bushels per acre (32 pounds per bushel) adjusted to a moisture content of 12.5 percent.

2. Barley yellow dwarf rating (1= no infestation 9= heavy infestation).

3. Grain test weight at harvest.

4. Grain moisture at harvest.

5. Date when 50 percent of plants in a plot were headed (Julian date).

6. Unless two varieties differ by more than the LSD, little confidence can be placed in one being superior to the other.

Table 3. Grain and forage yields of oat, South Central Kansas Experiment Field, Hutchinson, KS

Variety	Dry Matter Yield t/a		
	1998	1996	1995
Armor	2.4	3.2	6.1
Bates	2.4	3.5	6.0
Bay	2.3	1.9	----
Belle	2.1	2.2	----
Brawn	2.1	4.0	5.9
Chairman	2.3	----	----
Dane	2.2	1.2	5.8
Don	2.2	3.8	5.8
Gem	2.3	3.1	----
Hazel	2.4	3.2	6.1
Horicon	2.1	2.6	4.9
IL 862081	2.5	----	----
IL 891730	2.5	----	----
IN 09201	2.1	----	----
Jerry	2.4	----	----
Jim	2.2	----	----
Larry	2.1	2.5	5.2
Milton	2.5	----	----
Ogle	2.4	2.7	6.2
Praire	2.3	3.9	6.2
Premier	2.1	3.3	5.7
RioGrande	2.5	----	----
Rodeo	2.2	----	----
Russell	2.3	----	----
Settler	2.2	----	5.0
Starter	----	1.8	4.7
Troy	2.7	----	----
Mean	2.3	2.9	5.7
LSD <sub>(P=0.05)</sub>	0.3	0.6	0.6
C.V. (%)	8.9	13.4	7.5

Unless two varieties differ by more than the LSD, little confidence can be placed in one being superior to the other.

## **PERFORMANCE TESTS WITH OTHER CROPS**

**William F. Heer and Kraig L. Roozeboom**

### **Introduction**

Performance tests for winter wheat, grain sorghum, alfalfa, canola, and sunflower were conducted at the South Central Kansas Experiment Field. Results of these tests can be found in the following publications.

1998 Kansas Performance Tests with Winter Wheat Varieties. KAES Report of Progress 816.

1998 Great Plains Canola Research. KAES Report of Progress 823.

1998 Kansas Performance Tests with Grain Sorghum Hybrids. KAES Report of Progress 824.

1998 Kansas Performance Tests with Sunflower Hybrids. KAES Report of Progress 827.

1998 Kansas Performance Tests with Alfalfa Varieties. KAES Report of Progress 828.

# EFFECTS OF NITROGEN RATE ON YIELD IN CONTINUOUS WHEAT AND WHEAT IN ALTERNATIVE CROP ROTATIONS IN SOUTH CENTRAL KANSAS

William F. Heer

## Summary

The 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 the above cropping systems. To determine how winter wheat yields are affected by these crops, winter wheat was planted in rotations following them. Yields were compared to those of continuous winter wheat under conventional (CT) and no-till (NT) practices. Initially, the CT continuous wheat yields were greater than those from the other systems. However, over time, wheat yields following soybeans have increased, reflecting the effects of reduced weed and disease pressure and increased soil nitrogen. However, continuous CT winter wheat seems to outyield 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 predominate cropping systems. The 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 29 inch/yr, with 60 to 70% occurring between March and July. Therefore, soil moisture is often not sufficient for optimum wheat growth in the fall. No-tillage (NT) 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 one of several alternative crops would provide improved weed control through additional herbicide options and reduced disease incidence by interrupting disease cycles as well as allow producers several options under the 1995 Farm Bill. However, fertilizer nitrogen (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, evaluation 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 Field. The continuous winter wheat study was established in 1979. The first of the alternative cropping systems where wheat follows short-season corn was established in 1986. The second (established in 1990) has winter wheat following soybeans. Both cropping systems use NT seeding into the previous crop's residue. All three systems have the same N rate treatments.

## Procedures

The research was conducted at the KSU South Central Experiment Field, Hutchinson. Soil was an Ost loam. The sites had been in wheat previous to the starting of the cropping systems. The research was replicated five times using a randomized block design with a split-plot arrangement. The main plot was crop and the

subplots were six N levels (0, 25, 50, 75, 100, and 125 lbs/a). Nitrogen treatments were broadcast applied as  $\text{NH}_4\text{NO}_3$  prior to planting. Phosphate was applied in the row at planting. All crops were produced each year of the study. Crops are 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 1987. The conventional tillage treatments are plowed immediately after harvest then disked as necessary to control weed growth. The fertilizer rates are applied with a Barber metered screw spreader prior to the last tillage on the CT and seeding of the NT plots. The plots are cross-seeded to winter wheat. As a result of an infestation of cheat in the 1993 crop, the plots were planted to oats in the spring of 1994. The fertility rates were maintained, and the oats were harvested in July. Winter wheat has been planted in the plots since the fall of 1994.

### **Wheat after Corn**

In this cropping system, winter wheat is planted after a short-season corn has been 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) prior to planting of winter wheat in mid October. Fertilizer rates are applied with the Barber metered screw spreader in the same manner as for the continuous wheat.

### **Wheat after Soybeans**

Winter wheat planted after a maturity group I soybean has been harvested in early to mid-September in this cropping system. As with the corn, this early harvest again allows the soil profile water to be recharged prior to planting of winter wheat in mid-October. Fertilizer rates are applied with the Barber metered screw spreader in the same manner as for the continuous wheat.

Winter wheat also is planted after canola and sunflowers to evaluate the effects of these two crops on yield. Uniform N is used; therefore, the data are not presented.

## **Results**

### **Continuous wheat**

Grain yield data for continuous winter wheat are summarized by tillage and N rate in Table 4. Wheat yields in the CT and NT treatments were comparable for the first 4 years. In the fifth year (1992), cheat started to become a serious yield-limiting factor in the NT treatments. By 1993, it had almost completely taken over the NT treatments. As a result of the cheat problem, the plots were planted to oats in the spring of 1994. This resulted in a significant reduction in cheat. The results for 1995 were not affected by cheat but more by the climatic conditions of the year. The cool wet winter with lush growth was followed by a warm period. This then was followed by cold wet weather during seed setting and grain filling. The yield data reflect these conditions. The yield increases that occurred with increasing N rate did not materialize that year. These weather conditions contributed to the NT treatments having greater yield reductions than the CT treatments. Conditions in 1996 and 1997 proved to be excellent for winter wheat production in spite of the dry fall of 1995 and the late spring freezes in both years. Yields in 1998 generally were higher than those in 1996 and 1997 and increased with higher N rates up to 75 lb/a.

### **Wheat after Corn**

Wheat yield increases with increasing N rates were observed in wheat following corn in 1988 and 1990 (Table 5). The extremely dry conditions from planting through early May of 1989 caused the complete loss of the wheat crop in the rotation for this year. In

1988, 1990, 1991, 1992, and 1993, when timely precipitation occurred in both germination and spring regrowth periods, wheat yields following corn were comparable to those of continuous wheat. Though not as apparent with sorghum, the effect of reduction in soil N in the 0 N plots also can be seen in the yields. Wheat yields in 1994 showed the benefits of the cool wet April and early June. Had it not been for these conditions occurring at the right time of the plants' development, yields would have been considerably less. Weather conditions were quite different for the 1995 wheat crop in the rotation. These conditions caused considerable variability and reductions in yields compared to 1994. However, the yields in the rotation were higher than those of continuous wheat. Also, the test weights for the wheat in the rotation averaged 60 lb/bu, whereas the average for the continuous wheat was only 53 lb/bu. This points out the necessity of using some type of rotation in the farming operation to produce high quality crops. In 1996, the corn prior to wheat was dropped, and cover crops were added to this cropping system.

### **Wheat after Soybeans**

Wheat yields after soybeans also reflect the differences in N rate. However, a comparison of the wheat yields from this cropping system with those of wheat following corn shows the effects of residual N from soybean production in the previous year. This is especially true for the 0 to 75 lb N rates in 1993 and the 0 to 125 lb rate in 1994 (Table 6). Yields in 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. Yields for 1997 and 1998 both show the leveling off after the first four increments of N. In comparison to yields in the continuous wheat, yields of rotational wheat are starting to reflect the presence of the third crop (grain sorghum) in the rotation. As the rotation continues to cycle, the differences at each N rate will probably stabilize after four to five cycles, with a potential to reduce fertilizer N applications by 25 to 50 lbs/a where wheat follows soybeans.

### **Other Observations**

Nitrogen application significantly increased grain N contents 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 is limited. This loss has not occurred in continuous winter wheat regardless of tillage or in the wheat after soybeans. Corn will have the potential to produce grain in favorable years (cool and moist) and silage in nonfavorable (hot and dry) years. In extremely dry summers, extremely low grain sorghum yields can occur. The major weed control problem in the wheat after corn system is with the grasses. This was expected, and work is being done to determine the best herbicides and time of application to control grasses.

Table 4. Wheat yields by tillage and nitrogen rate in a continuous wheat cropping system, South Central Kansas Experiment Field, Hutchinson, KS.

N Rate <sup>4</sup>	Yield bu/a																					
	1998		1989 <sup>1</sup>		1990		1991		1992		1993 <sup>2</sup>		1994 <sup>3</sup>		1995		1996		1997		1998	
	CT <sup>5</sup>	NT	CT	NT	CT	NT	CT	NT	CT	NT	CT	NT	CT	NT	CT	NT	CT	NT	CT	NT	CT	NT
0	39	32	35	12	58	50	53	53	40	26	28	2	34	25	26	16	46	23	47	27	52	19
25	44	41	38	28	60	57	72	70	42	40	31	3	55	52	28	12	49	27	56	45	61	37
50	40	39	35	27	57	57	74	60	45	38	28	3	59	63	30	9	49	29	53	49	61	46
75	48	46	37	27	60	58	66	62	45	51	31	11	72	73	30	16	49	29	50	46	64	53
100	46	50	37	31	58	61	65	56	45	42	27	10	66	76	23	15	46	28	51	44	55	52
125	41	48	36	30	55	59	67	57	44	44	26	4	64	76	23	12	45	25	48	42	56	50
LSD* (0.01)	NS	10	NS	11	NS	NS	9	9	NS	13	NS	5	17	17	NS	6	NS	NS	8	8	5	5

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

<sup>1</sup> ANOVA for three replications.

<sup>2</sup> Severe cheat infestation in NT treatments.

<sup>3</sup> Yields for oat crop.

<sup>4</sup> Nitrogen rate in lb/a

<sup>5</sup> CT conventional, NT no-tillage

Table 5. Wheat yields after corn by nitrogen rate, South Central Kansas Experiment Field, Hutchinson, KS.

N Rate	Yield						
	1988	1990	1991	1992	1993	1994	1995
lb/a				bu/a			
0	9	21	44	34	18	13	17
25	13	31	71	47	24	27	26
50	17	43	76	49	34	40	24
75	19	53	61	47	37	48	36
100	17	54	62	47	47	48	41
125	19	55	62	44	49	42	37
LSD* <sub>(0.01)</sub>	5	4	7	5	9	4	4
CV (%)	27	8	10	8	15	10	18

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

Table 6. Wheat yields after soybeans by nitrogen rate, South Central Kansas Experiment Field, Hutchinson, KS.

N Rate	Yield							
	1991	1992	1993	1994	1995	1996 <sup>1</sup>	1997	1998
lb/a				bu/a				
0	51	31	24	23	19	35	13	21
25	55	36	34	37	26	36	29	34
50	55	37	41	47	34	36	40	46
75	52	37	46	49	37	36	44	54
100	51	35	45	50	39	36	45	55
125	54	36	46	52	37	36	47	57
LSD <sub>(0.01)</sub>	NS	4	6	2	1	1	4	3
CV (%)	7	6	9	5	7	2	9	4

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

<sup>1</sup> Spring wheat yields.

# EFFECTS OF SEED TREATMENTS ON WINTER WHEAT STANDS AND YIELDS, 1998

Robert L. Bowden and William F. Heer

## Summary

The RTU Vitavax-thiram treatment significantly increased stand count, and the LS082 + LS004 treatment appeared to decrease test weight. No significant differences in yield occurred among treatments.

## Introduction

Several new seed treatments are being tested for their effects on winter wheat in the Great Plains region. This study evaluated effects of 12 seed treatments (3 controls and 9 chemical applications) on wheat emergence (fall stand), fall and spring growth, and grain yield.

## Procedures

The experiment was done in 1997-98 at the Hutchinson Experiment Field. The site was in the second year of continuous wheat in Clark-Ost clay loam soil. Cultivar 2137 foundation seed was used. It has moderate resistance to most foliar diseases. Each company applied treatments in water. Rates are listed in Table 11. The design was a randomized complete block with 10 replications and 12 treatments, including untreated controls from each company. Seed was planted at 60 lb/a on Oct. 3, 1997 with a six-row cone seeder set to a depth of 1.5 in. Plots were 5 ft by 20 ft and then trimmed to 13 ft long for final yield. Stand counts were taken from a 1-m section of an inner row in each plot on Oct. 17, 1997 at the zero- to one-tiller stage of development. Harvest with a small plot combine was done on June 23, 1998. Seed yields were adjusted to 13.5% moisture and 60 lb/bu.

## Results

The three controls were similar, so they were combined for analysis. Each treatment was compared to the combined control with SAS GLM/ least squares means with the Dunnett's test, which is designed to optimize comparisons with a control. Experiment-wise error rate was set at  $\alpha=0.05$ . Results of the data analysis are presented in Table 7.

Planting was about 1 week before the recommended time. Soil moisture was good at planting. No significant root diseases, insect pressure, or barley yellow dwarf were noted. Some leaf rust developed late, but no obvious differences were noted among treatments. Plots matured early because of heat and dry conditions.

Although the overall F-test for stand count was not significant, the Dunnett's test indicated that the RTU Vitavax-thiram treatment significantly increased the stand count ( $P \leq 0.01$ ) over the untreated control. The F-test for test weight was significant. The LS082+LS004 treatment appeared to significantly decrease test weight. However, it had no significant effects on stand or yield, so this may not be a real effect. The F-test for yield differences was not significant. The Dunnett's minimum significant difference for yield was 3.2 bushels per acre. The LSD, which does not control experiment-wise error rates, was 2.8. In either case, no significant yield differences occurred among treatments.

Table 7. Winter wheat fall stand, test weight, and yield as affected by seed treatment, South Central Kansas Experiment Field, Hutchinson, KS, 1998.

Company	Treatment (Chemical and Rate)	Fall Stand	Test Weight	Yield
		plts/ft	lb/bu	bu/a
AGSCO	DB Green 3 fl.oz./bu	12.8	55.9	50.4
AGSCO	ST GOLD 6 fl.oz./bu	12.4	56.3	50.9
Gustafson	Gaucho 480 1 fl.oz./cwt + LS082 15 ppm + LS004 20 ppm	12.9	57.0	52.7
Gustafson	Gaucho 480 2 fl.oz./cwt + LS082 15 ppm + LS004 20 ppm	12.2	56.3	53.1
Gustafson	LS082 15 ppm + LS004 20 ppm	11.9	55.6 *	50.6
Gustafson	LS098 0.35 fl.oz./cwt	12.9	55.9	50.4
Gustafson	RTU Vitavax-thiram 6 fl.oz./cwt	14.8 **	56.7	52.8
Novartis	Dividend XL 0.5 fl.oz./cwt	12.9	56.2	50.8
Novartis	Dividend XL 0.5 fl.oz./cwt + Maxim 1.25 g ai/100kg	12.3	56.4	52.3
F-test <i>p</i> -value for hypothesis of no treatment differences		0.103	0.010	0.289
Dunnett's Minimum Significant Difference From Control (α=0.05)		2.2	0.9	3.2
C.V. %		17.3	1.5	6.1

\* Significantly different from control at P=0.05 according to Dunnett's test.

\*\* Significantly different from control at P=0.01 according to Dunnett's test.

NOTE: The study of tillage and nitrogen fertilization for alfalfa was terminated after 1997. No new data were collected in 1998 on the study of Austrian winter pea as a cover crop with grain sorghum.

# MULTIPLE-SITE EXPERIMENTS

## PERFORMANCE OF HIGH-OIL CORN HYBRIDS

Scott A. Staggenborg, Larry D. Maddux, and W. Barney Gordon

### Summary

A study was conducted to assess the effects of 11 high-oil corn hybrids and their grain parents under dryland and irrigated conditions. Grain yields ranged from 104 to 149 bu/a for the high-oil hybrids under dryland, and oil contents ranged from 6.4 to 7.6%. These hybrids also produced higher levels of lysine, protein, and energy. The grain parent yields ranged from 108 to 181 bu/a under the same conditions. Under irrigation, grain yields ranged from 163 to 131 bu/a for the high oil hybrids, and oil contents ranged from 5.8 to 7.7%. The grain parent yields ranged from 107 to 131 bu/a under the same conditions. On average, the high-oil corn hybrids produced grain yields within 8% of the conventional hybrids under dryland conditions and 24% greater yields under irrigation.

### Introduction

Interest in performance of high-oil corn has increased in northeast Kansas. Dupont Optimum Quality Grains estimated that approximately 1 million acres of high-oil corn was produced in the U.S. in 1997, with approximately 70% being used as livestock feed and the remainder for cash sales. Because of isolation requirements and small market areas, these hybrids are not entered routinely into university performance trials. The objective of this study was to evaluate the performance of several high-oil corn hybrids and compare them to their non-high-oil counterparts.

### Procedures

Eleven high-oil corn hybrids were evaluated in 1998 under irrigation at the Rossville Unit of the Kansas River Valley Experiment Field and under dryland at the Paramore Unit of the Kansas River Valley Experiment Field and the North Central Experiment Field. All hybrids utilized ATop Cross® pollinators to achieve elevated oil levels. For each high-oil hybrid used, its normal yellow corn counterpart also was included. Appropriate isolation was utilized between the grain parent hybrid block and each high-oil hybrid group of the same pollinator. All plots at Rossville and Paramore Units were planted on April 24, 1998, and all plots at the North Central Field were planted on May 6, 1998. Irrigation amounts of approximately 1.5 acre/inch were applied on July 20 and August 21.

Statistical analyses of these hybrids pose a unique problem in that isolation groups have a set of unique treatments. Variances were compared between each high-oil hybrid group. Because variances were different, the high-oil corn hybrids were analyzed within each company only. The normal corn hybrids also were analyzed as a complete group as a randomized block design.

### Results

Grain yields were average to below average for both dryland and irrigated conditions. Yields of dryland high-oil corn yields ranged from 104 to 149 bu/a (Tables 1 and 3). Grain yields for the grain parent followed a similar pattern, ranging from 108 to 181 bu/a (Tables 1 and 3).

Previous research with high-oil corn at other universities and at Kansas State indicated an 8 to 15% yield decline compared to conventional yellow corn. These results indicate differences of approximately 12 bu/a or 8%.

Under irrigation at the Rossville Unit, the high-oil hybrids produced grain yields that averaged over 23 bu/a higher than those of the grain parents: 131 to 163 bu/a versus 107 to 130 bu/a. This large difference is difficult to explain. Possibly, soil conditions were not uniform across the plot area. However, because of the blocking of the high-oil hybrids and grain parents for isolation, we could not determine if that was the case. Such a difference between high-oil and grain parent corn hybrids has never been reported previously.

These results also indicated differences among the high-oil hybrids as well as between the high-oil and conventional hybrids in many of the grain quality components measured. In the high-oil hybrids, oil contents ranged from 5.8 to 7.7%, which were approximately 2.9 percentage points higher than oil contents of the conventional hybrids. Lysine levels in the high-oil hybrids ranged from 0.29 to 0.32%, which were 0.029 percentage points higher than lysine levels of the conventional corn hybrids. The high-oil hybrids were 0.159 percentage points higher in protein and 662 Mcal/a higher in energy than their conventional counterparts. Price premiums averaged \$0.19/bu for the high-oil corn hybrids.

Table 1. Yield, oil content, lysine, energy, protein, and test weight for high-oil corn hybrids at North Central Experiment Field, Belleville, KS, 1998.

Hybrid	Yield (bu/a)	Oil (%)	Lysine (%)	Energy (Mcal/a)	Protein (%)	Oil Premium (\$/bu)
Pfister 2652-H	125.3	7.0	0.313	12992	9.2	0.20
Pfister 2680-H	104.0	7.4	0.318	10800	8.8	0.24
Pfister 3409-H	115.6	6.9	0.308	11938	9.1	0.19
Pfister 3977-H	125.6	7.6	0.306	13077	8.6	0.26
LSD <sub>(0.05)</sub>	11.9	0.5	NS	1275	NS	0.05
NK N6423TC	127.1	6.6	0.307	13099	9.1	0.16
NK N66U6	123.8	7.0	0.319	12807	9.6	0.20
NK N62K8	110.7	6.9	0.314	11430	9.5	0.19
NK N7376	130.7	6.9	0.318	13502	9.7	0.19
NK N7577	133.2	6.8	0.311	13749	9.2	0.18
LSD <sub>(0.05)</sub>	13.7	NS	NS	1454	NS	NS
Dekalb DK 595TC	124.6	6.6	0.320	12833	10.0	0.16
Pioneer 32R90	116.1	7.0	0.327	12009	10.4	0.20

Table 2. Yield for non-high-oil corn hybrids and the yield difference between each hybrid and its high-oil counterpart, North Central Experiment Field, Belleville, KS, 1998.

Hybrid	Yield (bu/a)	Yield Difference (bu/a)	Oil (%)	Lysine (%)	Energy (Mcal/a)	Protein (%)
Dekalb DK 595	118.8	5.8	3.9	0.291	11747	9.8
NK N6423	107.5	19.6	3.9	0.288	10638	9.5
NK N7333	132.4	-1.7	3.8	0.288	13100	9.5
NK N7590	141.5	-8.4	4.1	0.288	14061	9.5
Pfister 2652	129.4	-3.8	3.8	0.279	12775	9.0
Pfister 2680	112.3	-8.3	4.0	0.284	11142	9.2
Pfister 3049	121.2	-5.6	4.1	0.277	12039	8.6
Pfister 3977	134.5	-8.9	4.1	0.282	13358	8.9
Pioneer 3245	133.3	-17.3	3.9	0.286	13197	9.4
LSD <sub>(0.05)</sub>	14.4	---	NS	0.007	1431	0.5

Table 3. Yield, oil content, lysine, energy, protein, and test weight for high-oil corn hybrids at Paramore Unit, Kansas River Valley Experiment Field, Topeka, KS, 1998.

Hybrid	Yield (bu/a)	Oil (%)	Lysine (%)	Energy (Mcal/a)	Protein (%)	Oil Premium (\$/bu)
Pfister 2652-H	146.7	7.6	0.301	15273	8.5	0.26
Pfister 2680-H	137.9	6.7	0.290	14209	8.4	0.17
Pfister 3409-H	136.4	7.2	0.299	14153	8.6	0.22
Pfister 3977-H	148.9	7.3	0.291	15451	8.0	0.23
LSD <sub>(0.05)</sub>	NS	0.6	0.009	NS	0.5	0.06
NK N6423TC	138.3	6.7	0.298	14257	8.9	0.17
NK N66U6	111.8	7.3	0.312	11600	9.6	0.23
NK N62K8	117.1	6.7	0.298	12072	8.9	0.18
NK N7577	125.3	7.2	0.308	13003	9.3	0.22
LSD <sub>(0.05)</sub>	19.2	NS	0.005	2006	0.2	NS
Dekalb DK 595TC	145.5	6.4	0.294	14939	8.8	0.14
Pioneer 32R90	152.6	6.8	0.310	15756	9.8	0.18

Table 4. Yield for non-high-oil corn hybrids and the yield difference between each hybrid and its high-oil counterpart, Paramore Unit, Kansas River Valley Experiment Field, Topeka, KS, 1998.

Hybrid	Yield (bu/a)	Yield		Oil (%)	Lysine (%)	Energy (Mcal/a)	Protein (%)
			Difference (bu/a)				
Dekalb DK 595	138.0		7.5	4.0	0.267	13677	8.5
NK N6423	144.7		-6.4	4.3	0.271	14411	8.6
NK N7590	169.6		-44.3	4.5	0.273	16961	8.6
Pfister 2652	153.6		-6.9	4.3	0.262	15312	7.8
Pfister 2680	157.5		-19.6	4.4	0.255	15715	7.4
Pfister 3049	141.0		-4.6	4.4	0.259	14072	7.7
Pfister 3977	165.1		-16.2	4.6	0.268	16537	8.2
Pioneer 3245	181.3		-28.6	4.2	0.280	18026	9.3
LSD <sub>(0.05)</sub>	20.1		---	0.5	0.007	2155	0.6

Table 5. Yield, oil content, lysine, energy, protein and test weight for high-oil corn hybrids at Rossville, KS, 1998.

Hybrid	Yield (bu/a)	Oil (%)	Lysine (%)	Energy (Mcal/a)	Protein (%)	Oil Premium (\$/bu)
Pfister 2652-H	149.9	7.2	0.293	15534	8.1	0.22
Pfister 2680-H	134.3	7.7	0.297	13977	8.1	0.26
Pfister 3409-H	148.1	7.5	0.299	15389	8.3	0.25
Pfister 3977-H	150.0	7.2	0.293	15542	8.0	0.22
LSD <sub>(0.05)</sub>	NS	NS	NS	NS	NS	NS
NK N6423TC	163.2	6.8	0.281	16850	7.5	0.18
NK N66U6	140.6	6.9	0.299	14572	8.7	0.22
NK N62K8	131.7	7.2	0.294	13596	8.4	0.19
NK N7577	160.4	7.4	0.301	16658	8.6	0.24
LSD <sub>(0.05)</sub>	6.2	NS	0.008	753	0.5	NS
Dekalb DK 595TC	145.5	6.4	0.294	14268	8.8	0.15
Pioneer 32R90	152.6	5.8	0.310	10382	9.8	0.04

Table 6. Yield for non-high-oil corn hybrid and the yield difference between each hybrid and its oil counterpart at Kansas River Valley Experiment Field, Rossville, KS, 1998.

Hybrid	Yield (bu/a)	Yield		Oil (%)	Lysine (%)	Energy (Mcal/a)	Protein (%)
			Difference (bu/a)				
Dekalb DK 595	129.9		8.7	3.9	0.267	12844	8.6
NK N6423	112.4		50.8	3.9	0.268	11107	8.7
NK N7590	133.4		27.0	4.1	0.268	13250	8.5
Pfister 2652	123.1		26.8	4.1	0.264	12234	8.2
Pfister 2680	109.1		25.2	4.0	0.265	10837	8.3
Pfister 3049	111.0		37.1	4.1	0.267	11000	8.4
Pfister 3977	106.8		43.2	4.5	0.270	10677	8.4
Pioneer 3245	108.7		-7.1	4.1	0.278	10809	9.3
LSD <sub>(0.05)</sub>	NS		---	NS	0.009	NS	0.7

# COTTON VARIETY PERFORMANCE – 1998

Scott A. Staggenborg and Stewart R. Duncan

## Summary

Thirteen upland cotton varieties were grown at four locations in South Central Kansas. yield and fiber quality varied among locations and varieties.

## Introduction

Cotton production has grown steadily in Kansas during the past several years. In 1991 Kansas Agricultural Statistics reported 2,000 acres of cotton in Kansas. By 1998, cotton acres had increased to approximately 10 times that amount. Interest in cotton continues to increase in the South Central part of the state, largely because of the crop's ability to withstand drought and relatively low grain prices.

All cotton varieties that are currently available to producers in Kansas were adapted for growing regions to the south. Although many of the upland cotton varieties currently used on the High Plains of Texas and Oklahoma may be suitable, extensive variety testing has not been done. The objective of this study was to evaluate several upland cotton varieties for lint yield and quality in South Central Kansas.

## Procedures

Four locations were selected to represent the cotton-growing region of Kansas. They were distributed from north to south from Hillsboro, KS (Marion County) to Wellington (Sumner County), with two sites near Burton in Harvey County. Cotton varieties included in the study were: Deltapine DP2156, DP2379, and DP5111; Paymaster PM183, PM2183B,

PM2183BG, PM2145RR, and PM2200RR; Stoneville ST 239, STX016, and STH 186; and KSU Narrow Low and Narrow High. All seed were treated with Gaucho (Gustafuson) for early season thrip and aphid control.

Plots were planted on May 12, 1998 in Sumner County; on May 14, 1998 in Harvey County; and on May 26, 1998 in Marion County. All plots were 10-ft wide by 30-ft in length and were planted with a Hege plot drill (Hege Corp, Caldwell, KS).

The Harvey County irrigated and the Sumner County dryland plots were harvested on September 25, 1998. The Marion County site was harvested on November 18, 1998. The Harvey County dryland plot was not harvested for yields, because an error was made during harvest that rendered the data unusable. At that site, all plants and open bolls in 20-row ft. were counted. A subsample of 100 consecutive bolls then was removed to determine boll weight and fiber quality, and lint yields were calculated. All open bolls were harvested in 20 row-ft at the Sumner County site and in 30 row-ft at the Marion County site.

## Results

The 1998 growing season had above-average temperatures and below-average precipitation. Precipitation was timely, with the majority of it occurring in July and early August. Early-season temperature stress resulted in late fruit development, but the heat in August and September quickly moved the crop to maturity before a freeze occurred.

At the Harvey County irrigated site, lint yields averaged 996 lb/a for the entire plot (Table 7). Lint yields at the Marion County site averaged 278 lb/a (Table 8). At the Sumner County site, lint yields averaged 514 lb/a (Table 9). Hail on June 22, 1998 set the crop back at this site.

Lint quality was influenced primarily by location and somewhat by variety (Tables 10-12). Overall, the above-average temperatures during the growing season resulted in average to above-average levels of fiber maturity, length, and strength. Location differences were apparent in average fiber length and

strength as well as color grade between the Marion County site and the other two sites. The average length and strength were lower at Marion County, however, the average micronaire was higher. The Marion County site also had lower color grades, averaging a 61. These can be attributed to the later planting date and the fact that several inches of rain fell from October 31 to November 12.

Table 7. Cotton performance in Harvey County, KS in 1998 – Irrigated study.

Company	Variety	Yield (lbs/a)	Bolls/plant	Lint/ Boll (g)	Turnout (%)
Paymaster	PM183	1048 a	4.0 b	1.54 cd	0.225 cd
Deltapine	DP2156	1044 a	4.9 b	1.66 bc	0.234 bc
Paymaster	PM2183BG	1039 a	4.0 b	1.56 cd	0.226 cd
Stoneville	ST239	1028 a	5.0 b	1.85 a	0.244 ab
Stoneville	STX016	1025 a	7.1 a	1.64 bc	0.246 a
Stoneville	STH186	1012 a	3.9 b	1.75 ab	0.229 cd
Paymaster	PM2145RR	949 ab	4.7 b	1.45 d	0.225 cd
Paymaster	PM2200RR	825 b	3.3 b	1.61 bc	0.222 d
Average		996	4.6	1.63	0.231
C.V. (%)		12.9	26.9	6.7	3.4

Table 8. Cotton performance in Marion County (Hillsboro), KS in 1998 – Dryland study.

Company	Variety	Yield (lbs/a)	Bolls/Plant	Lint/ Boll (g)	Turnout (%)
Deltapine	DP2156	415 a	4.7 a	1.67 a	0.268 a
Paymaster	PM2183BG	290 ab	2.8 b	1.12 b	0.189 b
Paymaster	PM183	284 ab	3.5 b	0.87 b	0.157 b
KSU	Narrow Low	267 ab	3.2 b	1.22 b	0.214 ab
KSU	Narrow High	235 b	1.6 c	1.03 b	0.189 b
Paymaster	PM2200RR	207 b	2.9 b	0.97 b	0.176 b
Paymaster	PM2145RR	199 b	3.0 b	1.02 b	0.179 b
Average		278	3.2	1.15	0.199
C.V. (%)		40.8	21.9	25.2	19.5

Table 9. Cotton performance in Sumner County (Wellington), KS in 1998 – Dryland study.

Company	Variety	Yield (lbs/a)	Bolls/ Plant	Lint/ Boll (g)	Turnout (%)
Deltapine	DP5111	650 a	7.9 ab	1.43 a	0.233 a
Paymaster	PM2183B	579 a	6.4 bc	1.31 ab	0.206 ab
Deltapine	DP2156	558 a	6.1 bc	1.34 a	0.211 ab
Deltapine	DP2379	539 a	5.5 c	1.31 ab	0.219 a
Paymaster	PM2145RR	529 a	8.6 a	1.25 ab	0.205 ab
Paymaster	PM2200RR	397 b	6.4 abc	1.03 bc	0.176 b
Paymaster	PM183	344 b	6.5 abc	0.81 c	0.137 c
Average		514	6.8	1.21	0.198
C.V. (%)		16.8	22.5	17.2	13.5

Table 10. Cotton fiber quality in Harvey County, KS in 1998 – Irrigated study

Company	Variety	Micronaire	Length (in)	Strength	Color Grade
Paymaster	PM183	4.0 a	1.01 d	26.7 d	42-1
Deltapine	DP2156	3.5 b	1.08 c	30.0 c	41-4
Paymaster	PM2183BG	3.4 bc	1.08 c	30.1 c	42-4
Stoneville	ST239	3.4 bc	1.15 ab	32.9 b	42-2
Stoneville	STX016	3.3 bc	1.12 b	32.8 b	41-2
Stoneville	STH186	3.3 bc	1.16 a	34.2 ab	41-3
Paymaster	PM2145RR	3.2 bc	1.08 c	32.8 b	51-3
Paymaster	PM2200RR	3.1 c	1.17 a	36.1 a	41-3
Average		3.4	1.11	31.9	42-2
C.V. (%)		7.8	2.3	4.1	37.7

Table 11. Cotton fiber quality in Marion County (Hillsboro), KS in 1998 – Dryland study.

Company	Variety	Micronaire	Length (in)	Strength	Color Grade
Deltapine	DP2156	4.4 a	0.94 ab	23.9 ab	61-1
Paymaster	PM2183BG	4.4 a	0.91 c	23.5 ab	52-4
Paymaster	PM183	4.0 a	0.92 bc	22.6 b	62-1
KSU	Narrow Low	4.0 a	0.95 ab	24.8 ab	61-1
KSU	Narrow High	3.9 a	0.96 a	25.3 a	61-3
Paymaster	PM2200RR	3.7 a	0.95 ab	24.0 ab	52-1
Paymaster	PM2145RR	4.2 a	0.94 ab	23.9 ab	61-1
Average		4.1	0.94	24.0	61-1
C.V. (%)		11.0	2.7	7.0	2.7

Table 12. Cotton fiber quality in Sumner County (Wellington), KS in 1998 – Dryland study.

Company	Variety	Micronaire	Length		
			(in)	Strength	Color Grade
Deltapine	DP5111	4.0 a	1.07 a	29.7 abc	52-4
Paymaster	PM2183B	3.3 bc	1.02 b	28.8 bcd	51-2
Deltapine	DP2156	3.5 b	1.02 b	28.1 cd	51-2
Deltapine	DP2379	3.7 ab	1.06 a	30.6 ab	51-4
Paymaster	PM2145RR	3.4 b	1.02 b	28.7 bcd	51-3
Paymaster	PM2200RR	3.1 c	1.08 a	31.4 a	41-3
Paymaster	PM183	3.5 b	0.98 c	26.7 d	42-1
Average		3.5	1.04	29.1	51-1
C.V. (%)		7.1	1.6	5.0	2.4

# EFFECTS OF PLANTING DATE, HYBRID MATURITY, AND HEAD MOTH CONTROL ON SUNFLOWER YIELDS IN THE CENTRAL KANSAS CORRIDOR.

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## Summary

Two years of results have demonstrated the difficulty of establishing small plot sunflower research. Though mid-April-planted plots yielded similarly to those planted in mid-May, stands were much less uniform. Head clipper weevils are not usually a problem in large fields, but raised havoc in the mid-May-planted plots in 1997, which artificially lowered the 2-yr average yield. The lack of head moth larva influence on yields, even in untreated plots where numbers were well above treatment levels, is difficult to explain.

Harvest of sunflowers planted in mid-April or mid-May still left time for conventional or no-till planting of wheat. Mid-June and mid-July-planted sunflowers were not harvested until late in the season, leaving little time for planting a successful wheat crop. This study indicates that planting sunflowers in mid-April or (preferably) mid-May will result in seed and oil yield increases vs. mid-June and mid-July planting. The corresponding increase in gross returns more than offsets the costs for control of head moth larvae, which will occur with earlier plantings.

## Introduction

Kansas is the third highest sunflower producing state in the nation. The central corridor of Kansas produces roughly a of the state's sunflowers. The 1995 Farm Bill has played a major role in the increase in sunflower acreage in central Kansas. Production questions have grown along with producer numbers. Past experience has led many central Kansas growers

to plant sunflowers in mid-June to mid-July, either to avoid complications brought on by sunflower head moth larvae or as a double-crop option after wheat harvest.

This was the final year of a 3 year experiment to evaluate the yield response of two different maturity hybrids over four planting dates (modified from five planting dates in 1996) at intervals of approximately 28 days. The effects of head moth control on yields also were evaluated.

## Procedures

Locations in 1998 included the South Central Experiment Field near Hutchinson (Clark silt loam complex), the North Central Kansas Experiment Field near Scandia (Crete silt loam), and the Harvey County Experiment Field near Hesston (Ladysmith silty clay loam). All sites were dryland. Sunflowers were planted on four different dates from mid-April to mid-July at approximately 28-day intervals. Treflan® at 2 pints/a was preplant incorporated at the Hutchinson and Hesston sites. Prowl® at 2 pints/a was applied preplant incorporated at Scandia. Extremely wet soil conditions prevented the first two plantings at Scandia, resulting in abandonment of that site. At Hutchinson, pheasants, skunks, and head clipper weevils destroyed the mid April, mid May, and mid June plantings, respectively, so this site was abandoned, too. Four-row plots of 'Mycogen Comet' (medium early maturity, 90d) and 'Mycogen Cavalry' (medium maturity, 99d) hybrid sunflowers were planted at 24,000

seeds/a at all sites and thinned to a final stand of 21,000 plants/a, if necessary. Plants were monitored for sunflower head moth beginning at ray petal appearance. At 10 and 100% bloom, head moth control plots were sprayed with Warrior® or Asana® at 0.03 or 0.05 pounds ai/a, respectively, in 20 gallons of water. Larvae counts were taken at 3 weeks after 100% bloom. The center two rows of each four-row plot were harvested for yield as they reached “combine” maturity. Harvest dates at Hesston were 15 Sept. (mid- April planting), 17 Sept. (mid-May planting) and 16 Nov. (mid-June and mid-July plantings). Yields were adjusted to 10% moisture.

## Results

Sunflower head moth numbers were high for the April, May, and June plantings, but control was good with either treatment (Table 13). Unexpectedly, however, seed yield was not affected. Larval infestation levels experienced in these tests certainly would be expected to cause significant economic loss in producers’ fields if left untreated.

Seed yields were greatest from the mid-May planting and least from the mid-June and mid-July plantings, with mid-April yields being intermediate but acceptable (Table 14). As expected, the 2-year yield averages show a seed yield advantage to mid-April and mid-May planting vs traditional and double-cropped planting dates. However, mid-April stand establishment was not nearly as consistent as that from mid-May-planted sunflowers in either year. Mid-June sunflowers were seeded into a dry seedbed and experienced above-normal temperatures and less than adequate rainfall for uniform establishment. When precipitation did occur, the intensity of the rainfall packed the soil surface and kept stands erratic.

Only in the mid-May planting did Cavalry, the fuller season hybrid, produce higher yields than those of Comet (Table 14). Yields of Comet sunflowers were significantly higher only in the mid-April seeding, though the shorter season hybrid showed a trend to yield better in mid-June and mid-July plantings, too. Over 2 years, the fuller season hybrid tended to yield higher when planted in mid-May, and the early season hybrid produced higher seed yields when planted later in the season.

Other research has shown that oil percentage also tends to decline with delayed sunflower planting. A premium of 2% of market price is paid or penalty is assessed for every percentage point above or below 40% oil content, respectively, of the sunflowers. Oil yields for both hybrids were of premium levels for all but the mid-June planting (Table 14). For the mid-July planting, oil yields were enhanced by excellent growing conditions and a longer than normal fill period in September (>200 GDD above normal). Oil percentages for the mid-June planting reflected the stresses of untimely rainfall and extreme heat during flower and fill.

Within planting dates, Cavalry tended to produce seed with higher oil content than Comet, though the only significant difference occurred in the mid-May planting. Comet’s oil level was greater than that of Cavalry in the mid-April-planted plots. Mid-July planting may produce a higher-oil seed (2 yr avg.) than mid-June planting, but mid-June yields are more likely to provide a greater gross return because of the advantage of a longer growing season.

Table 13. Effects of planting date and head moth control on sunflower yields, Hesston, KS, 1998.

Planted	Sprayed	1998		2-Year Average	
		Yield	Larvae	Yield	Larvae
		lb/a	no./head	lb/a	no./head
April	Yes	1394	1.5	1677	3.2
	No	1422	15	1616	32
May	Yes	2325	4	1757	3.9
	No	2460	36	1663	54
June	Yes	821	3	1190	5.6
	No	659	8	1114	44
July	Yes	602	1	708	1.8
	No	608	0.5	705	1.9

LSD<sub>(0.05)</sub> 234

† Seed yields (adjusted to 10% moisture) must differ by more than the LSD to be considered significantly different.

Table 17. Effects of planting date and hybrid maturity on sunflower seed yields and percent oil in a study at Hesston, KS, 1998.

Planted	1998				2-Year Average			
	Seed Yield†		Oil		Seed Yield		Oil	
	Comet‡	Cavalry	Comet	Cavalry	Comet	Cavalry	Comet	Cavalry
	lb/a		%		lb/a		%	
April	1582	1234	46.0	41.3	1689	1605	46.4	45.4
May	2044	2741	43.8	47.8	1510	1910	43.0	45.7
June	854	626	35.0	37.3	1172	1132	37.7	40.0
July	710	500	43.4	44.2	891	522	41.3	42.0

LSD<sub>(0.05)</sub> 234 2.4

† Seed yields (adjusted to 10% moisture) must differ by more than the LSD to be considered significantly different.

‡ Comet and Cavalry average 90 and 99 days to maturity, respectively.

# **EFFECTS OF PLANTING DATE, HYBRID MATURITY AND ROW SPACING ON GRAIN SORGHUM YIELDS IN EXTREME SOUTH CENTRAL KANSAS.**

**Stewart R. Duncan, Scott A. Staggenborg, Ed LeValley, and Glenn Newdigger**

## **Summary**

Grain sorghum hybrids responded differently to planting date, depending on location, and obviously were influenced by timely rainfall. May-planted plots were harvested 34 and 61 days earlier than June-planted plots at Wellington and Isabel, respectively. Earlier harvest allows for potentially easier double-cropped wheat planting or fall tillage operations. No-tillage improved crop yields compared to conventional tillage, most likely as a result of water conservation and utilization. For the second year in a row, row width did not influence yield in this study. Two years of results from Wellington with two different types of growing season suggest that yields tend to be more consistent when grain sorghum is planted in May vs June, regardless of hybrid maturity or row width. This was the final year of this study.

## **Introduction**

The 1995 Farm Bill has played a major role in the stabilization and increase of grain sorghum acres in central Kansas. Grain sorghum in the south central area of Kansas is planted traditionally in early June or as a double crop after wheat harvest. Research results from the 1990's at the Harvey County Experiment Field near Hesston and the Sandyland Experiment Field near St. John have shown a consistent yield increase attributed to planting sorghum 3 to 4 weeks earlier than traditional planting dates for the area. In years when crop yields from traditional planting dates were greater, the earlier-planted crop yields were still very acceptable. In addition, harvest dates are

generally 3 to 4 weeks earlier with earlier plantings.

This experiment, funded in part by the Kansas Grain Sorghum Commission, evaluates the yield response of two different maturity hybrids planted in two different row spacings at two planting dates (early to mid May and early to mid June) at intervals of approximately 28 days. This is the second, and final, year of the study.

## **Procedures**

Locations were on the Farmers COOP Equity farm at Isabel, in Barber County (Farnum loam) and on the Wellington Area Test Farm near Wellington, in Sumner County (Bethany silt loam). Grain sorghum was seeded on May 19 and June 25 at Wellington and May 22 and June 10 at Isabel in 10-in. and 30-in. rows. Early (Pioneer 87G57) and medium early (Pioneer 8500) hybrids were planted at rates to achieve final stands of 32,000 plants/a. Appropriate grass and weed control herbicides and 100 lb N/a were broadcast applied preemergence. The Isabel field had a conventional vs no-tillage treatment, and Wellington plots were no-till. At harvest maturity, the center two rows (30-in. rows) or the center 5 feet (10-in. rows) of each plot were combine harvested. Harvest dates at Wellington were September 10 for the May 19 planting and October 14 for the June 25 planting. Harvest dates at Isabel were September 10 for May 22 planting and November 10 for June 10 planting. Yields were adjusted to 12.5% moisture.

## Results

Untimely rains in early May delayed planting of both sites by 10-14 days. Rainfall at Wellington also delayed the June planting to 10 days later than desired, but still coincided with potential double-cropped planting dates. All plots received adequate rainfall until June. Monthly rainfall totals and 30-year average precipitation are shown in Table 15. The Wellington plots received average precipitation amounts in the month of July, but very little timely precipitation in August and September, during critical growth stages for June-planted sorghum. The sparse rainfall received at Willowdale, the nearest weather station to Isabel, was evidently timely. Above-normal rainfall during July was reflected in final yields.

Results from previous studies in north central and northeastern Kansas have shown a trend towards higher grain yields in narrower rows when growing season precipitation is average to above normal. Row width did not affect grain yields at either site (Table 16). At Wellington, in spite of being no-tilled, a high intensity rain the night after planting prevented desirable emergence and stand establishment in the 10-in. row plots, which were not harvested for yield. Sorghum planted in 30-in. rows emerged and established stands in spite of the crusted soil surface, demonstrating an advantage of wider rows under adverse conditions.

Experiment field research has consistently shown a yield advantage to fuller maturity hybrids with earlier planting dates. As planting date is pushed back into June, this advantage gradually will disappear, and often reverse, with the yield advantage going to the earlier maturing hybrid. At Wellington, no yield difference existed between hybrids, regardless of planting date, though yields were reduced greatly in the June-planted plots (Table 17). The 2-year averages

from Wellington show that differences did exist in 1997, a year with favorable conditions throughout the growing season (Table 17). The 2-year average also indicates the stability of yields from one year to the next when sorghum is planted in early to mid-May vs mid to late June. Planting in June vs May did not significantly reduce the yield of Pioneer 87G57 at Isabel, but Pioneer 8500 planted in June suffered significant yield reductions when compared to the May plantings (Table 17). Apparently, high temperatures, possibly in combination with moisture stress, coincided with the onset of bloom for June-planted Pioneer 8500 and resulted in reduced seed set and seed yields. The top ½ to ¾ of many heads was affected. This condition was most apparent in the conventionally tilled plots, where the grain yield of Pioneer 8500 plots was reduced nearly 40% compared to May-planted plots, even though no significant differences in yield were recorded in either hybrid (Table 18). If the conventional till plots were analyzed separately, the yields of June-planted Pioneer 8500 plots were significantly lower than those of any other conventional-till plantings at Isabel.

Tillage practices significantly affected yields in the Isabel plots. No-till sorghum yields were 20% higher than those of conventionally tilled sorghum (Table 18). Though the tillage x hybrid interaction was not significant, conventional tilled, June (6/10)-planted sorghum did poorly, especially the fuller maturity hybrid.

Table 15. Growing season precipitation amounts for 1998 and the 30-year averages for Willowdale and Wellington, KS.

Month	Willowdale		Wellington	
	1998	30 yr avg	1998	30 yr avg
monthly precipitation, inches				
June	0.39	4.00	2.47	4.60
July	6.53	2.56	3.78	3.26
August	1.32	3.29	1.07	3.47
September	0.66	2.59	1.32	3.47
Total	8.90	12.44	8.64	14.80

Table 16. Effects of row width on grain sorghum yields near Wellington and Isabel, KS, 1998.

Planting date	Row spacing	Wellington		Isabel
		1998	2 yr. avg.	1998
	inches		bu/a	
May	10	0	78 <sup>†</sup>	111
	30	76	78	107
June	10	27	53	93
	30	28	57	92
LSD <sub>(0.10)</sub>		NS		NS

<sup>†</sup> May, 1998, 10-in. row plots with never were established because of a hard rain and are not included in the 2-year average at Wellington. The reported 2-year average yield for 10-in. rows planted in May is actually only from the 1997 study. Based on this and other research, however, no significant yield difference would be expected between 10- and 30-in. row plantings in May or June.

Table 17. Effects of planting date and hybrid maturity on grain sorghum yield near Wellington and Isabel, KS, 1998.

Hybrid	Planting Date	Wellington		Isabel
		1998	2 yr. Avg.	1998
				bu/a
Pioneer 87G57	May†	78‡	70	105
	June	26	83	98
Pioneer 8500	May†	75	87	114
	June	29	82	87
LSD <sub>(0.10)</sub>		8.8		12.6

† May, 1998, 10-in. row plots with never were established because of a hard rain, and are not included in the 2 year average at Wellington. The reported 2-year average yield for 10-in. rows planted in May is actually only from the 1997 study. Based on this and other research, however, no significant yield difference would be expected between 10- and 30-in. row plantings in May or June.

‡ Yields at a location must differ by more than the LSD to be considered significantly different.

Table 18. Effects of tillage system on grain sorghum yields at Isabel, KS, 1998.

Tillage system	Planting Date	Hybrid	Yield
			bu/a
Conventional till	May	Pioneer 87G57	95†
		Pioneer 8500	108
	June	Pioneer 87G57	89
		Pioneer 8500	68
No-till	May	Pioneer 87G57	114
		Pioneer 8500	119
	June	Pioneer 87G57	106
		Pioneer 8500	106
LSD <sub>(0.10)</sub>			NS
Conventional till			90
No-till			112
LSD <sub>(0.10)</sub>			8.9

† Yields must differ by more than the LSD to be considered significantly different.

# EFFECTS OF PLANTING DATE, MATURITY GROUP, AND ROW SPACING ON SOYBEAN YIELDS IN EXTREME SOUTH CENTRAL KANSAS.

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## Summary

The MGIII and MGIV cultivars performed better than MGII soybeans when planted in May. When planted in June, however, no difference existed between cultivars. At only one of seven locations did a yield difference occur as the result of row width, and the 10-in. row yields were better than those from 30-in. rows. Under these low-yielding conditions, row spacing did not have an effect. Weeds must be controlled, especially in a dry year such as 1998, to allow crops to survive and potentially produce profitable seed yields. The MgIII and MgIV cultivars were harvested a minimum of 20 days earlier when planted in May than when planted in June. May planting would allow for potentially easier and more timely double-cropped wheat planting or fall tillage. The MGII soybeans generally did not yield well or reach harvest maturity before November. For May plantings, no differences were evident between tillage systems, but in a dry year, the only harvestable stands planted in June were no-till. Because funding was discontinued, this will be the last year of this study.

## Introduction

The 1995 Farm Bill and the release of Roundup® Ready Soybeans have played a major role in the dramatic increase of soybean acres in central Kansas. Acreage has increased by 500% and over 300% since 1995 in the South Central (SC) and Central Crop Reporting Districts, respectively. Traditionally, in the SC district, very few acres were planted to soybeans

as a full-season crop unless the field was irrigated. Most of the dryland soybean acreage was planted as an opportunity double crop after wheat harvest. The dryland acres usually were seeded in the first 2 weeks of June. Research results from the 1990's at the Harvey County Experiment Field near Hesston showed consistently decreasing yields as soybean planting was delayed from the first week of May to mid-June. That work also showed that maturity group IV (MGIV) soybeans outyielded maturity group III (MGIII) and maturity group II (MGII) when planted in the first 2 weeks of May. After mid-May, the MGIII soybeans significantly outyielded cultivars in the other two maturity groups. Maturity group II soybeans were always the lowest yielding. In a rotational study at the South Central Experiment Field near Hutchinson, MGII soybeans planted in late April have yielded erratically (0-40+ bu/a) but have averaged 25 bu/a for 7 years. In addition, a delay in planting from early May to mid-June will delay physiological maturity approximately 1 day for every 3 days delayed. Consequently, harvest dates are generally up to 2 weeks earlier with earlier plantings.

This experiment, funded in part by the Kansas Soybean Commission, evaluated the yield response of three different maturity groups of soybeans planted in two different row spacings at two planting dates (early to mid May and early to mid June) at intervals of approximately 28 days. This was the first, and final, year of the study.

## Procedures

Locations were on the Farmers COOP Equity farm at Isabel in Barber County (Farnum loam), on the Jim Coady farm near Freeport in Harper County (Pond Creek silt loam), on the John Cox farm near Freeport in Harper County (Pond Creek silt loam), on the Wellington Area Test Farm near Wellington in Sumner County (Bethany silt loam), and on the Marvin Duncan farm near Arkansas City in Cowley County (Vanoss silt loam). Soybeans were seeded in 10-in. and 30-in. rows at rates to achieve final stands of 165,000 plants/a. Weed control was attained with the application of appropriate herbicides and hand weeding if necessary. The Isabel and Duncan fields also had a conventional vs no-tillage treatment. The Coady and Cox farms were minimum tilled and planted to Roundup® Ready soybeans and the Wellington plots were planted no-till. At harvest maturity, the center two rows (30-in. rows) or the center 5 feet (10-in. rows) of each plot were hand harvested. Planting and harvest dates are summarized in Table 19. Yields were adjusted to 13% moisture.

## Results

Untimely rains delayed the May planting at the Wellington and Isabel sites by 10-14 days. Rainfall at Wellington also delayed the June planting to 10 days later than desired, but it still coincided with potential double-cropped planting dates.

The only June-planted soybeans to attain adequate stands and produce seed yields were conventionally tilled at the Duncan farm, Wellington plots, and the no-tilled plots at Isabel. All plots except the Duncan farm received adequate rainfall until June. The Wellington plots received adequate rainfall until June, and average precipitation amounts in the month of July, but very little timely precipitation in August and

September. The sparse rainfall recorded near Isabel allowed for good yields in June no-till-planted soybeans, but the conventional seedbed was too dry to facilitate adequate emergence and stand establishment. The Duncan farm plots received less than 6 in. of precipitation throughout the growing season.

The effect of row spacing on soybean yields was not what would be expected based on studies from other regions of the state. Results from previous studies in central and northeastern Kansas have shown a trend towards higher grain yields from soybeans planted in narrow rows (7.5-10 in.) vs traditional-width (30 in.) rows when grown in high-yielding environments (>50 bu/a). Conversely, in lower-yielding environments (<30 bu/a), soybean yields generally were favored in 30-in. rows. In this study, with low-to medium-yielding sites, row width affected grain yields only in the conventionally tilled soybeans at Isabel (Table 20), where the 10-in. rows outyielded traditional 30-in. rows.

Limited experiment field research has shown a yield advantage to MGIV vs MGIII cultivars when planted in late April or early May. As planting date is pushed back into late May and June, the yield advantage has reversed in favor of the early maturing soybeans. Maturity group V soybeans are popular and yield well in southeastern Kansas, at the same latitudes as the plots in this study, but they had not been included in any previous studies. Differences in yield were noted between maturity groups at each location, whether only May (Table 21) or May and June (Table 22) plantings produced yields.

The lack of weed control was the major contributing factor in the loss of the no-till planted MGIV soybeans on the Duncan farm (Table 21). This was also the only site where the MGIV soybeans outyielded MGIII soybeans in May plantings. The severe moisture stress throughout the growing season

(weedy and 4.75 in. rainfall) may have led to earlier infestations of charcoal rot in the MGIII plots, which could have resulted in lower seed yields. At the Coady, Cox, and conventional-tilled Isabel sites (Table 21), MGIII soybeans significantly outyielded MGIV soybeans, similar to results from Hesston when both groups were planted in mid May and later. May-planted MGIV soybeans yielded the lowest at these four sites. The MGIV plants were green and functioning all summer, but extreme heat and drought resulted in very low pod set and seed fill.

May-planted soybeans tended to have higher yields than those planted in June (Table 22). No difference existed in yields of conventionally tilled, May-planted MGIV and MGIII soybeans at the Duncan farm, but the MGIV soybeans produced greater yields than the May-planted MGIV soybeans and all June-planted plots. However, May-planted MGIII soybeans did not significantly outyield plots of MGIII or MGIV soybeans planted in June. Conventional-tilled MGIV soybean yields were not affected by planting date and were very low, but not significantly lower than those of June-planted MGIII and MGIV soybeans. All MGIV and June MGIII and MGIV plantings on the Duncan farm were heat and/or drought stressed during the critical reproductive stages from bloom through pod fill, which lowered yields. At Wellington, May-planted MGIII and MGIV soybeans outyielded all other treatments (Table 22). Yields did not vary between May- and June-planted MGIV plots, reflecting the same conditions as those at the Duncan farm. No differences in yield between maturity groups were detected in June-planted plots. Less than 60% of the normal precipitation fell at Wellington from June through September, and when coupled with extremely high temperatures, resulted in very low soybean yields. May plantings were favored. Timely and above-normal July precipitation resulted in acceptable no-till soybean yields at Isabel,

regardless of planting date or maturity group (Table 22). May- and June-planted MGIV yields were similar and no greater than yields of May-planted MGIII soybeans. Yields of June-planted MGIII soybeans were less than those of May-planted MGIV plots and no greater than those of MGIV plots planted in June. As was the case at the Duncan farm and Wellington, MGIV soybeans were the lowest yielding at the site; however, no yield differences existed in the June planting dates among maturity groups. The improved performance of the MGIV soybeans with June planting and adequate rainfall is similar to results from southeast Kansas where MGIV cultivars are planted frequently in June and into early July in double-cropped systems after wheat.

Conventional vs no-till systems were compared at the Duncan farm and at Isabel, but only for the May planting dates (Table 23). The difference in tillage significantly affected yields on the Duncan farm, but not at Isabel. Yields of no-till soybeans at the Duncan farm were only ½ and ⅓ of yields of conventionally tilled soybeans when MGIV yields were included and excluded, respectively, from the analysis. No-till MGIV plots had no harvestable yield at the Duncan farm. Weed control was not achieved in the no-till plots at planting, and season-long weed pressure took a heavy toll on soybean plants, especially on the MGIV soybeans, which was reflected in the yield. Conversely, conventional-tilled plots were weed free at planting, and a light shower within 24 hours of planting activated the preemergent herbicides, which resulted in good weed control throughout the season. The lack of significant precipitation and surface moisture throughout the growing season did not favor later germination and establishment of weeds. At Isabel, yields of no-till and conventional-tilled plots were similar within maturity groups and between MGIII and MGIV (Table 23). However, MGIV soybean yields were the lowest in the study.

Table 19. Planting and harvest dates for a soybean study in South Central KS, 1998.

Location	Planting Date		Harvest Date(s)					
			DOP† 1			DOP 2		
	1	2	MGIII	MGIV	MGV	MGIII	MGIV	MGV
Duncan, conv. till	5/7	6/9	9/8	9/8	11/23	10/17	10/17	11/23
Duncan, no-till	5/7	6/9	9/8	9/8	11/23	no harvestable stands		
Isabel, conv. till	5/22	6/10	9/18	9/18	11/12	no harvestable stands		
Isabel, no-till	5/22	6/10	9/18	9/18	11/12	11/12	11/12	11/12
Wellington	5/19	6/25	9/25	9/25	11/23	10/15	10/15	11/23
Cox farm	5/14	6/9	9/11	9/11	11/24	no harvestable stands		
Coady farm	5/14	6/9	9/14	9/14	10/15	no harvestable stands		

† Date of planting

Table 20. Effects of row width effects on soybean yields in South Central KS, 1998.

Row	Duncan Farm		Cox Farm	Coady Farm	Wellington	Isabel	
	Conv. Till	No-Till				Conv. Till	No-Till
inches				bu/a†			
10	21	15	13	19	10	31	28
30	22	14	14	18	10	26	30
LSD <sub>(0.10)</sub>	NS	NS	NS	NS	NS	3.8	NS

† Yields at a location must differ by more than the LSD to be considered significantly different.

Table 21. Yields of May-planted soybean as affected by cultivar maturity group in a study near Arkansas City, Freeport, and Isabel, KS, 1998.

Planting Date	Maturity Group	Duncan Farm,	Coady Farm	Cox Farm	Isabel,
		No-Till			Conv. Till
bu/a					
May	III	10	34	18	38
	IV	14	29	14	33
	V	0	18	8	14
LSD <sub>(0,10)</sub>		2.5	4.2	2.1	4.5

† Yields at a location must differ by more than the LSD to be considered significantly different.

Table 22. Effect of cultivar maturity group on soybean yields near Arkansas City, Wellington, and Isabel, KS, 1998.

Planting Date	Maturity Group	Duncan Farm,	Wellington	Isabel,
		Conv. Till		No-Till
bu/a				
May	III	18	14	33
	IV	22	15	37
	V	8	10	18
June	III	12	7	29
	IV	14	6	31
	V	8	8	24
LSD <sub>(0,10)</sub>		6.5	2.2	7.5

† Yields at a location must differ by more than the LSD to be considered significantly different.

Table 23. Effects of tillage system on May-planted soybean yields near Arkansas City and Isabel, KS, 1998.

Tillage System	Maturity Group	Duncan Farm	Isabel
		bu/a	
Conventional till	III	18†	38
	IV	22	33
	V	8	14
No-till	III	10	33
	IV	14	37
	V	0	18
LSD <sub>(0,10)</sub>		6.1	7.5

† Yields at a location must differ by more than the LSD to be considered significantly different.

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