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Abstract
Each Field Day report consists of individual research reports on topics specific to the region, including cultural methods for most of the major crops grown in Kansas, mitigating the effects of weeds, insects, and disease associated with those crops, and irrigation. Research is conducted and reports written by staff of the K-State Research and Extension Southwest Research Extension Center.

Keywords
Report of progress (Kansas State University. Agricultural Experiment Station); 712; Kansas Agricultural Experiment Station contribution; no. 95-12-S; Kansas; Weather; Crops; Tillage systems; Water management; Weeds; Insect biology and control

Southwest Research-Extension Center

FIELD DAY

1994

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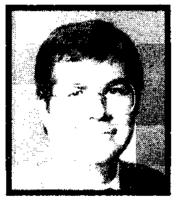
REPORT OF PROGRESS
712

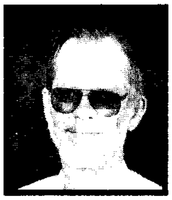
AGRICULTURAL EXPERIMENT STATION
MARC A. JOHNSON, DIRECTOR

KANSAS STATE UNIVERSITY

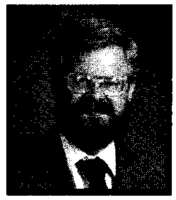
Jim Schaffer - Center Head. Jim received his M.S. and Ph.D. degrees from Kansas State University. He rejoined the staff in 1988. He served as Extension Agronomist from 1980-1983. His research interests include crop production and management techniques.



Paul Hartman - Associate Head and Area Extension Director, Paul received his B.S. and M.S. in Animal Sciences and Industry from Kansas State University. Prior to that, he served as County Extension Agricultural Agent in Stanton and Pratt counties.

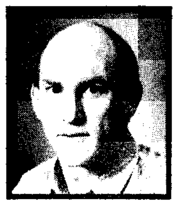


Larry Buschman - Entomologist. Larry Received his M.S. at Emporia State University and his Ph.D. at the University of Florida. He joined the staff in 1981. His research includes studies of the biology, ecology, and management of insect pests, with emphasis on pests of corn - including spider mites.



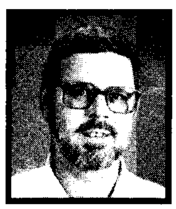
Randall Currie - Weed Scientist. Randall began his agriculture studies at Kansas State University, where he received his B.S. degree. He then went on to receive his M.S. from Oklahoma State University and his Ph.D. from Texas A&M University. His research emphasizes weed control in corn.

Kevin Dhuyvetter - Extension Agricultural Economist. Kevin received his M.S. from Iowa State University. He joined the staff in 1986 and returned in 1990 after spending 10 months with Iowa Farm Bureau. His interests are in crop and livestock production economics and marketing.



Thomas Eck - Ruminant Nutritionist. Tom received his M.S. from Texas Tech University and his Ph.D. from the University of Arizona. He joined the staff in 1992. Research interests include grain processing and poor quality roughage utilization by feedlot cattle.

Jeff Elliott - Research Farm Manager. Jeff received his B.S. from the University of Nebraska. In 1984, Jeff began work as an Animal Caretaker III and was promoted to Research Farm Manager in 1989.



Dave Frickel - Research Associate - Tribune. Dave received his B.S. from the University of Nebraska-Lincoln in 1987. He began his work here as an Agricultural Technician. In 1991, he moved to his current position.

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1994 RESEARCH-EXTENSION CENTER STAFF

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Contribution 95-12-S from the Kansas Agricultural Experiment Station.

Southwest Research-Extension Center

WEATHER INFORMATION FOR GARDEN CITY

by

William Spurgeon and Steven McVey

Precipitation totaled 24.78 inches or 6.87 inches above normal. The wettest months were May and June with 3.24 and 3.23 inches, respectively. Every month received above-average precipitation except November. Snowfall for the year was 33.75 inches, which is equivalent to 4.77 inches of precipitation, or 14.03 inches above normal. All except for 0.50 inches of the snow fell in January, February, and March, with the amounts being 13, 13.75, and 6.5 inches, respectively. Total snowfall in the 1992-1993 winter season reached a record-breaking high amount of 59.75 inches.

Temperatures were slightly lower than normal throughout the entire year. The high precipitation and moderate temperature resulted in record high yields for the wheat crop. Six record breaking low temperatures occurred: (-7° on February 18, -3° on February 19, 36° on September 14, 34° on September 15, 11° on October 30, and 0° on November 25). The lowest temperature for the year was -7°. The temperature reached 0° or below five times. Temperatures on 2 other days tied the record lows (56° on July 28 and 55° on August 6). No record high temperatures were recorded in 1993. The highest temperature for the year was 102° on August 1. Only 3 days had temperatures of 100° or higher.

Average wind speed was 5.3 MPH or 0.80 MPH below normal. Open pan evaporation was 64.94 inches or 13.38 inches below normal. The first freeze in the fall was 32° on October 9, which was only 4 days earlier than normal. The latest freeze in the spring occurred on April 22, making the frost-free period 169 days.

A complete summary of the weather is presented in the accompanying table.

Table 1. Climatic data. Southwest Research-Extension Center, Garden City, KS.

	Precipitation inches		Temperature (°F)						Wind MPH		Evaporation[3] inches	
			Average		Mean		Extreme					
Month	1993	Avg.[1]	Max.	Min.	1993	Avg.[2]	Max.	Min.	1993	Avg.[1]	1993	Avg.[1]
January	1.18	0.33	31.3	12.4	21.8	21.8	49	-5	4.4	5.1		
February	2.34	0.45	35.0	16.1	25.6	33.1	56	-7	4.5	6.0		
March	2.35	1.15	53.0	28.3	40.7	40.0	76	10	5.2	7.4		
April	1.65	1.56	61.8	35.8	48.8	52.5	83	24	6.7	7.7	6.96	8.79
May	3.24	3.11	75.3	47.9	61.6	62.5	92	33	5.9	7.1	9.71	10.96
June	3.23	2.87	84.1	57.7	70.9	73.2	100	47	6.5	7.3	11.97	13.90
July	2.62	2.60	89.4	63.5	76.5	78.4	101	56	5.4	6.2	12.04	14.96
August	2.69	2.16	87.8	61.3	74.6	76.0	102	44	4.3	5.5	10.13	12.78
September	3.01	1.59	77.2	47.9	62.5	67.4	97	34	4.9	5.7	8.44	9.80
October	1.38	0.98	66.2	37.1	51.6	55.0	92	11	4.9	5.3	5.69	7.13
November	0.43	0.76	51.2	21.5	36.4	40.3	71	0	5.1	5.1		
December	0.66	0.35	49.0	19.9	34.5	31.7	69	9	5.1	4.9		
Annual	**24.78**	**17.91**	**66.4**	**37.5**	**50.5**	**53.2**			**5.3**	**6.1**	**64.94**	**78.32**

Average latest freeze in spring	April 25	1993:	April 22
Average earliest freeze in fall	Oct. 13	1993	Oct. 9
Frost-free period	170 days	1993:	169 days

[1] 1961-1990 Average [2] 1951-1980 Average [3] October evaporation, 1962-1982 Average

KSU

Southwest Research-Extension Center

WEATHER INFORMATION FOR TRIBUNE

by
Dale Nolan

Precipitation for 1993 totaled 20.67 in. or 4.76 in. above normal. Precipitation was above normal in 8 months. July was unusually dry with only 0.21 in. of rain, 2.39 in. below normal. The wettest months were May with 4.52 in. and August with 5.27 in. The largest single amount of precipitation was 1.04 in. on May 6. Snowfall for the year totaled 23.0 in., and the greatest single amount of snowfall of 7.0 in. was received on March 2. A total of 60 days of snow cover was recorded in 1993, with 23 days in January.

The air temperature was below normal for the first 11 months of the year and above normal for December. The warmest month was July, with a mean temperature of 74.5° F and an average high temperature of 90.2° F. The coldest month was January, with a mean temperature of 22.2° F with an average high of 31.6° F and an average low of 12.7° F.

Temperature deviation from the normal was greatest in February, when the mean temperature was 8.5° F below normal. The maximum temperature was 103° F on July 31. Temperatures were above 100° F for 5 days. The 30-year average is 10 days above 100° F. Temperatures were 90° F and above for 39 days compared to the 30-year average of 63 days. The lowest temperature for the year was -12° F on February 17. The last freeze (23° F) on April 21 was 10 days earlier than the normal of May 1. The first freeze (27° F) in the fall was October 9, which was 2 day later than normal. The frost-free period was 171 days, which was 12 days more than the normal of 159 days.

Open pan evaporation from April through September totaled 62.64 in., which was 9.03 in. below the normal of 71.67 in. Wind speed for the same period averaged 4.8 mph compared to the normal of 5.7 mph.

Table 1. Climatic data. Southwest Research-Extension Center, Tribune, KS.

	Precipitation inches		Temperature (°F) 1993 Average		Normal		1993 Extreme		Wind MPH		Evaporation inches	
Month	1993	Normal	Max.	Min.	1992	Avg.	Max.	Min.	1993	Normal	1993	Normal
January	1.33	0.36	31.6	12.7	43.3	14.2	50	-5				
February	1.85	0.40	34.7	15.8	48.7	18.7	59	-12				
March	2.12	.99	52.1	26.2	56.6	25.4	78	2				
April	0.87	1.13	60.7	33.0	67.5	35.1	82	21	6.0	6.6	6.31	8.82
May	4.52	2.68	71.4	45.4	76.0	45.3	89	31	5.2	6.1	9.00	10.92
June	2.01	2.68	81.6	53.4	86.9	55.3	102	40	5.4	5.6	13.64	13.71
July	3.80	2.60	87.1	57.3	92.7	61.3	100	49	5.0	4.9	12.53[2]	16.10
August	5.27	1.98	86.0	58.5	89.9	59.2	102	43	4.4	4.8	9.87	13.01
September	0.46	1.54	74.8	44.5	81.3	49.9	95	33	4.8	5.2	7.38	9.55
October	1.28	0.74	65.1	34.6	70.4	37.3	91	6				
November	0.67	.48	48.9	19.5	54.7	25.3	66	-1				
December	0.08	0.33	48.8	17.2	44.9	16.6	70	7				
Annual	**20.67**	**15.91**	**62.2**	**36.4**	**67.7**	**37.0**			**5.2**	**5.5**	**62.64**	**71.67**

Normal latest freeze in spring[1]	May 1	1993:	April 21
Normal earliest freeze in fall	October 7	1993:	October 9
Normal frost-free period	159 days	1993:	171 days

[1]Killing frost in this table is 30°F . Normal is 30-year average (1961-1990) calculated from Station data.

LIMITED IRRIGATION IN A WHEAT-SORGHUM-FALLOW CROPPING SYSTEM

by

Alan Schlegel and David Frickel

SUMMARY

Limited irrigation in a wheat-sorghum-fallow rotation increased grain yields of winter wheat by 19 bu/a and grain sorghum by 38 bu/a. Four in. of irrigation was sufficient to maximize wheat yields but not sorghum yields. Water use efficiency was greater with grain sorghum than wheat. Averaged over the rotation, the least effective strategy for utilizing limited irrigation was to apply all of the irrigation water to wheat. Water use efficiency was similar when irrigating the sorghum only or splitting the irrigation water between sorghum and wheat.

INTRODUCTION

Irrigation well capacity is declining in many areas, requiring changes in irrigation practices. Changing from a full to a limited irrigation system will prolong groundwater supplies and may increase production efficiency. The objective of this study was to determine the most optimal time for applying a limited amount of irrigation water in a wheat-sorghum-fallow rotation.

PROCEDURES

Three irrigation strategies were used to apply a limited amount of irrigation water (8 in. over a 3-year period) in a wheat-sorghum-fallow rotation. The treatments were: 1) apply all irrigation to wheat [4" in early spring and 4" at boot], 2) apply all irrigation to grain sorghum [4" at 10" height and 4" at boot], and 3) split irrigation evenly between wheat and grain sorghum [4" at boot stage of wheat and grain sorghum]. These irrigation treatments were compared to a nonirrigated control.

The center of each plot was machine harvested after physiological maturity and grain yield adjusted to 12.5% moisture. Soil water content was determined gravimetrically at crop emergence and following crop harvest. Earthen berms were constructed around each plot to control surface water movement. Water use was calculated as the sum of soil water depletion, growing season precipitation, and irrigation. Water use efficiency (WUE) was determined by dividing grain yield (lb/a) by water use (in.).

RESULTS AND DISCUSSION

Irrigation of wheat increased yields by 19 bu/a over nonirrigated wheat when averaged over 2 years (Table 1). A single irrigation (4" at boot) produced the same yield (65 bu/a) as two irrigations.

Grain sorghum responded more to irrigation than did wheat. A single irrigation increased grain sorghum yields by 23 bu/a when averaged over 3 years (Table 2). A second irrigation increased yields an additional 15 bu/a. Although grain sorghum yields were restricted severely by freeze damage before maturity in 1992, yields still were increased by about 20 bu/a by irrigation.

Water use by wheat and grain sorghum increased with increased irrigation (Figs. 1 and 2). Therefore, water use efficiency followed a similar pattern as grain yield, with greatest WUE obtained with a single irrigation of wheat and two irrigations of sorghum (Figs. 3 and 4). WUE was about 50% greater with sorghum than wheat. Averaged over both crops, WUE was similar for the sorghum-only and split irrigation treatments. The least effective strategy for utilizing limited irrigation was to apply all of the water to wheat.

Table 1. Wheat response to limited irrigation in a wheat-sorghum-fallow cropping system, 1992-1993, Tribune, KS.

Irrigation	Year	Grain Yield	Grain Moisture	Grain Test Wt.
		bu/a	%	lb/bu
	1992			
Wheat only		53	12.2	57.5
Sorghum only		38	13.5	55.9
Wheat+Sorghum		49	12.5	56.8
None		30	12.9	56.5
$LSD_{.05}$		15	0.8	1.5
P>F		0.020	0.019	0.180
	1993			
Wheat only		76	8.9	57.9
Sorghum only		69	9.3	58.1
Wheat+Sorghum		81	9.6	59.1
None		63	9.2	58.4
$LSD_{.05}$		5	0.2	1.3
P>F		0.001	0.002	0.236
	1992-1993 Averages			
Wheat only		65	11.0	57.7
Sorghum only		54	11.4	57.0
Wheat+Sorghum		65	11.1	58.0
None		46	11.0	57.5
$LSD_{.05}$		7	0.5	1.0
P>F		0.001	0.366	0.222

Figure 1. Water use by wheat, 1992-1993, Tribune, KS.

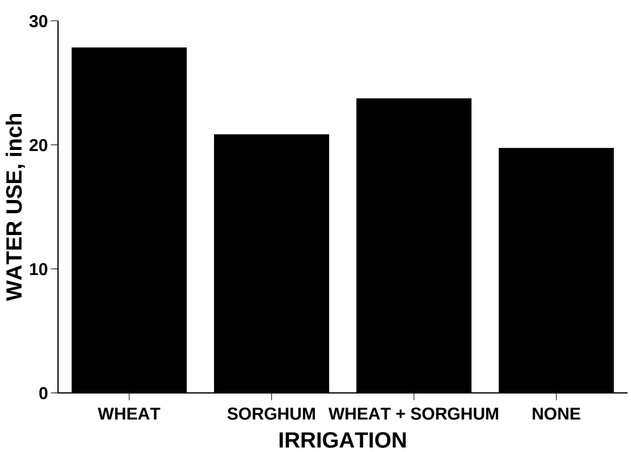


Figure 2. Water use by sorghum, 1991-1993, Tribune, KS.

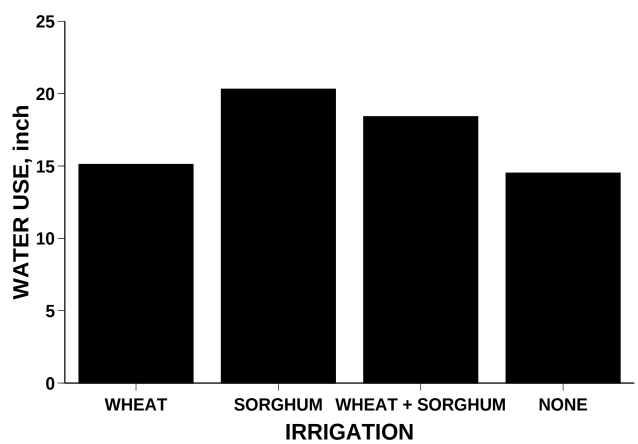


Table 2. Grain sorghum response to limited irrigation in a wheat-sorghum-fallow cropping system, 1991-1993, Tribune, KS.

Irrigation	Year	Grain Yield	Grain Moisture	Grain Test Wt.
		bu/acre	%	lb/bu
	1991			
Wheat only		74	9.4	60.1
Sorghum only		109	9.7	61.0
Wheat+Sorghum		94	9.7	60.6
None		61	9.2	59.9
$LSD_{.05}$		26	0.2	0.7
P>F		0.011	0.003	0.014
	1992			
Wheat only		22	23.2	46.3
Sorghum only		57	20.7	53.0
Wheat+Sorghum		51	21.4	51.3
None		34	22.0	50.3
$LSD_{.05}$		9	1.0	2.0
P>F		0.001	0.003	0.001
	1993			
Wheat only		97	13.7	59.9
Sorghum only		130	13.6	61.0
Wheat+Sorghum		105	13.6	60.3
None		87	13.5	60.1
$LSD_{.05}$		18	0.2	0.4
P>F		0.003	0.355	0.001
	1991-1993 Averages			
Wheat only		64	15.4	55.4
Sorghum only		99	14.6	58.3
Wheat+Sorghum		84	14.9	57.4
None		61	14.9	56.7
$LSD_{.05}$		10	0.6	1.2
P>F		0.001	0.048	0.001

Figure 3. Water use efficiency by wheat, 1992 - 1993, Tribune, KS.

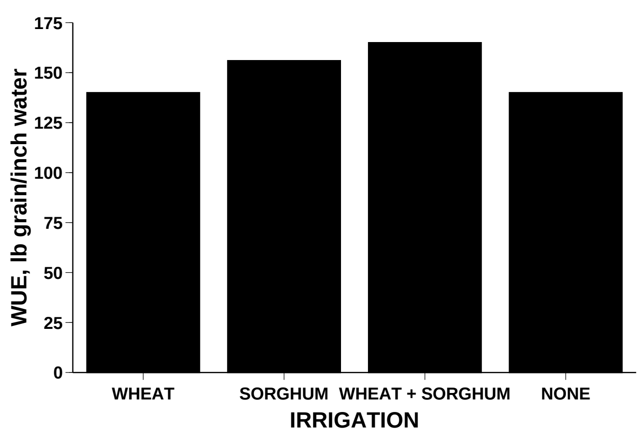
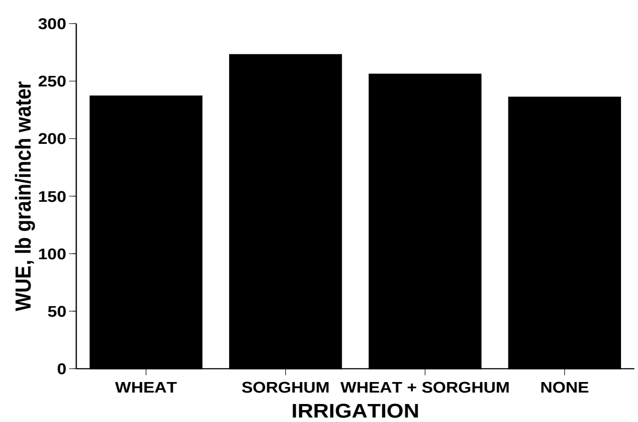


Figure 4. Water use efficiency by sorghum, 1991 - 1993, Tribune, KS.



CROPPING SYSTEM AND TILLAGE EFFECTS ON PROFILE WATER DISTRIBUTION AND GRAIN YIELD

by
Charles Norwood

SUMMARY

No tillage resulted in yield increases 17% of the time in WF, 34% of the time for wheat in WSF, and 60% of the time for sorghum in WSF. Water moved deeper in the profile under NT. Compared to CT, twice as much water was stored with NT in the WSF sorghum profile as in the WF and WSF wheat profiles. As much water was stored in the 11-mo fallow period prior to WSFNT sorghum as was stored in the 15- and 19-mo fallow periods of WF and SF. The efficient storage of precipitation in WSF prior to NT sorghum and the resultant increased sorghum yield make the WSFNT system superior to others in this study.

INTRODUCTION

Dryland crop yields are limited by low precipitation and high evaporative potential in the Great Plains. A long-term study is being conducted to determine the effects of cropping system and no tillage (NT) on soil water storage and yield of grain sorghum and winter wheat. This report is a summary of data collected from 1987 through 1992.

PROCEDURES

The research was conducted at the Southwest Research-Extension Center near Garden City, KS, from July 1985 (the beginning of fallow for the 1987 wheat) through October 1992 (1992 sorghum harvest). The soil type was a Richfield silt loam having a pH of 7.7 and an organic matter content of 1.5 %. Cropping systems were wheat-fallow (WF), sorghum-fallow (SF), wheat-sorghum-fallow (WSF), and continuous sorghum (SS). Hard red winter wheat cultivars were 'Larned', planted from 1986 through 1988, and 'TAM 107' planted from 1988 through 1991. Grain sorghum hybrids were 'Dekalb DK 42', planted in 1987 and 1988, and 'Warner 744BR' (bird resistant), planted from 1989 through 1992. The 1988 sorghum was not harvested because of bird damage. Wheat was planted with a John Deere HZ no-till drill in 16-in. rows at a rate of 45 lb/a. Grain sorghum was planted with a Buffalo slot planter in 30-in. rows at a rate of 35000 seeds/a. About 25000 plants/a typically emerged. Ammonium nitrate was broadcast preplant to give 40 lb/a and 60 lb/a N for wheat and grain sorghum, respectively.

Herbicides were used during fallow in the WF and WSF systems to control weeds in NT. Conventional tillage (CT) was used in the SS and SF systems and in the WF and WSF treatments not receiving herbicides. In WFNT, a postharvest application of 1.0 lb/a atrazine plus a spring application of 2.4 lb/a cyanazine was used plus postemergent herbicides as needed for weed control. In WSFNT (prior to wheat), a spring application of 2.4 lb/a cyanazine was followed by postemergent herbicides as needed for weed control. In WSFNT (prior to sorghum) 2.0 lb/a atrazine was applied after wheat harvest, followed by an application of 1.6 lb/a cyanazine about 30 days prior to sorghum planting. Postemergent herbicides were selected according to the weed species present and included glyphosate, paraquat, and 2,4-D. A postplant application of 1.0 lb/a atrazine + 3.0 lb/a propachlor was used for weed control in the sorghum in the WSFCT, SF, and SS plots.

RESULTS AND DISCUSSION

PRECIPITATION

Fallow and growing season precipitation for each of the systems is given in Table 1. Precipitation varied substantially from year to

Table 1. Precipitation at Garden City, KS during study period.

Cropping System	1987	1988	1989	1990	1991	1992	Mean	30-yr Avg
	Year							
Fallow Precipitation				— in —				
WF	23.6	28.3	17.1	25.1	24.2	22.9	23.5	23.5
WSF (wheat)	13.0	21.6	10.8	19.7	17.7	18.1	16.8	16.6
WSF (sorghum)	18.7	11.8	11.9	19.4	13.7	14.4	15.0	15.0
SF	26.1	27.4	18.1	32.6	27.1	25.9	26.2	26.1
SS	12.0	5.4	6.5	12.9	8.9	7.8	8.9	8.2
Growing-Season Precipitation								
Wheat	15.2	6.5	11.3	13.3	10.9	10.1	11.2	11.4
Sorghum	9.9	6.1	13.2	5.3	9.2	13.9	9.6	9.7

year, but average precipitation during fallow periods and growing seasons was very close to the 30-year average. The reason for the traditional long fallow periods is evident from the data in Table 1. On average, precipitation during the WSF fallow periods prior to wheat and sorghum was 71 and 64%, respectively, of that during the WF fallow period. Precipitation during the period between continuous sorghum crops was only 31% of that during the SF fallow period. More precipitation usually occurred during the wheat, rather than the sorghum growing season; however, the reverse was true in 1989 and 1992.

SOIL WATER

Available soil water at wheat planting is shown in Table 2. No-till in WF resulted in significantly greater SWP than CT in 2 years in the first 1-ft increment, in 4 years in the fourth, and in 3 years in the fifth increment. Tillage did not affect SWP in the second and third increments. For wheat in WSF, NT resulted in more SWP in 1 year in the first and second increments, in 2 years in the third and fourth, and in 3 years in the fifth increment. Thus, most of the additional accumulation from NT occurred more than 2 ft below the surface. These differences occurred because tillage resulted in water loss from the CT plots, and crop residue retarded evaporation and runoff from the NT plots, allowing water to move deeper in the profile. Profile water totals were significantly increased for NT in WF in 1989 and 1990 and for WSF in 1989 and 1992. More profile water occurred in both WF treatments than in WSF in 1989 and 1992 and more in WFNT than in WSFNT in 1988. The differences in WF and WSF in 1992 and particularly 1989 occurred because more water was stored in the longer WF fallow periods (Table 1). A significant amount of precipitation in WF occurred between wheat harvest and sorghum harvest. During this time, the sorghum was still using water in the WSF rotation. Greater SWP with NT in WF as opposed to WSF in 1988 also may have been due to the longer fallow period and to the greater efficiency of wheat stubble in preventing evaporation and runoff. Averaged over the 6-year study period, SWP for the NT and CT treatments was 1.22 and 1.30 inches greater, respectively in WF than WSF.

Available soil water at sorghum planting is presented in Table 3. No-till in WSF resulted in significantly more SWP in 2 years in the first 1-ft increment, in 3 years in the second, in 2 years in the third, and in 4 and 5 years in the fourth and fifth increments, respectively. As in the wheat systems, most of the additional accumulation in the sorghum plots was deeper in the profile, rather than near the surface. Profile SWP was higher with NT in WSF as compared to WSFCT in 4 of 6 years. Less SWP occurred in SS than in all other treatments in 2 years, and SS had less SWP than WSFNT and SF in 1 additional year. Soil water at planting was greater in SF than WSFCT in 4 of 6 years, but was never significantly

Table 2. Available soil water at wheat planting as affected by cropping system and tillage, 1987-1992.								
		Year						
Cropping System	Depth (ft)	1987	1988	1989	1990	1991	1992	Avg
		— in —						
WFCT	0-1	1.54a[1]	1.38a	1.65a	1.73b	1.50a	1.61b	1.57a
WFNT		1.50a	1.34a	1.61a	1.93a	1.34b	1.77a	1.57a
WSFCT		1.57a	1.38a	1.30b	1.93a	1.61a	1.42b	1.54a
WSFNT		1.46a	1.38a	1.54a	2.01a	1.34b	1.38b	1.54a
	1-2							
WFCT		1.42ab	1.22a	1.46a	1.57a	1.22a	1.57ab	1.42ab
WFNT		1.54a	1.26	1.61	1.65a	1.38a	1.61a	1.50a
WSFCT		1.14b	1.26a	0.24c	1.73a	1.22a	1.30b	1.14b
WSFNT		1.34ab	1.38a	0.94b	1.57a	1.38a	1.57ab	1.34ab
	2-3							
WFCT		1.46a	1.22ab	1.14a	1.50a	1.30a	1.57ab	1.38ab
WFNT		1.30ab	1.46a	1.42a	1.81a	1.18a	1.73a	1.50a
WSFCT		1.10b	1.06b	0.04c	1.54a	1.10a	0.98c	0.98c
WSFNT		1.14b	1.18ab	0.39b	1.69a	1.10a	1.34b	1.14bc
	3-4							
WFCT		1.57a	1.34b	1.22b	1.50b	1.61ab	1.42b	1.46ab
WFNT		1.42a	1.73a	1.81a	2.05a	1.69a	1.81a	1.73a
WSFCT		1.38a	1.10b	0.35d	1.89a	1.42ab	0.75c	1.14b
WSFNT		1.42a	1.02b	0.79c	2.17a	1.26b	1.22b	1.30b
	4-5							
WFCT		1.89a	1.81ab	1.61b	1.89b	2.09a	1.81b	1.85ab
WFNT		1.81ab	1.97a	2.09a	2.17a	2.01a	2.17a	2.05a
WSFCT		1.61b	1.54c	1.26c	1.89b	1.77b	1.18c	1.54c
WSFNT		1.69ab	1.61bc	1.61b	2.24a	1.97ab	1.69b	1.81b
	0-5							
WFCT		7.91a	7.01ab	7.13b	8.19b	7.72a	7.99ab	7.64ab
WFNT		7.52a	7.76a	8.54a	9.57a	7.56a	9.09a	8.35a
WSFCT		6.81a	6.30b	2.05d	8.98ab	7.17a	5.67c	6.34c
WSFNT		7.09a	6.57b	5.28c	9.69a	7.05a	7.20b	7.13bc

[1]Means within a column at the same depth followed by a different letter differ ($P<0.05$).

greater than in WSFNT. Thus, in terms of water storage for sorghum, the shorter fallow period of WSF can be compensated for by using NT, so the longer fallow period of SF has no advantage for water storage. As in the wheat systems, NT and crop residue lowered evaporation, reduced runoff, and allowed movement of water to deeper depth. A comparison of WF and WSF indicates that the amount of additional water stored by NT in the WSF profile was twice as much at sorghum planting than at wheat planting. Averages of 0.71, 0.79 and 1.49 in. more water were stored by NT in WF, WSF wheat, and WSF sorghum, respectively, compared to CT. Of the 1.49 in. stored by NT in WSF sorghum, 0.94 in. was found below 3 ft. Available water with NT averaged 8.35, 7.13, and 8.46 in. for WF, WSF wheat, and WSF sorghum, respectively. Available water in the 5-ft profile with CT averaged 7.64, 6.34, and 6.97 in. for those three systems and 8.39 in. for SF. Further comparisons of the data in Tables 2 and 3 indicate that SWP for sorghum in WSFNT exceeded that in WFNT by 1.2 in. or more in 2 years, whereas SWP for WFNT exceeded that for WSFNT sorghum by only 0.6 in. or less in 4 years. The potential for increased SWP with NT was greater for sorghum in WSF than for wheat in either system, and maximum soil water accumulation occurred for WSFNT sorghum, with no advantage to the longer fallow periods of either WF or SF.

Although SWP in WSFNT sorghum, WFNT, and SF was similar, precipitation during fallow for WSF was only 64% of that in WF and 58% of that in SF (Table 1), indicating that a higher percentage of the precipitation was stored in the WSF system than in the WF and SF systems. Actual fallow efficiencies (the percentage of precipitation stored in the soil) are available only for 1991 and 1992. Average fallow efficiencies for these 2 years were 20 and 23% for WFCT and WFNT, 29 and 32% for WSFCT and WSFNT prior to wheat, and 40 and 46% for WSFCT and WSFNT prior to sorghum, respectively. Fallow efficiencies for SF and SS were 25% and 75%, respectively. Thus, there was a trend toward higher fallow efficiences with no-till, fallow efficiencies were higher prior to sorghum than wheat, and shorter fallow periods were more efficient than longer fallow periods. The higher fallow efficiencies prior to sorghum, particularly prior to SS, occurred because most of the precipitation during these fallow periods came in the winter and spring, periods of low evaporative demand.

Table 3. Available soil water at sorghum planting as affected by cropping system and tillage, 1987-1992.

Cropping System	Depth (ft)	Year 1987	1988	1989	1990	1991	1992	Avg
		— in —						
WSFCT	0-1	1.65b[1]	1.85a	1.77b	1.85a	1.93a	2.01b	1.85ab
WSFNT		1.65b	1.93a	1.97a	1.73a	2.01a	2.20a	1.93a
SF		1.65b	1.65b	1.81ab	1.81a	1.73b	1.93bc	1.77ab
SS		1.85a	1.46c	1.57c	1.85a	1.65b	1.81c	1.69b
	1-2							
WSFCT		1.22b	1.34b	1.57b	1.42b	1.50bc	1.69ab	1.46b
WSFNT		1.46a	1.65a	1.57b	1.65a	1.65ab	1.73ab	1.61a
SF		1.61a	1.57a	1.77a	1.77a	1.81a	1.81a	1.73a
SS		1.61a	1.06c	1.73a	1.61a	1.38c	1.61b	1.50b
	2-3							
WSFCT		0.47b	0.87c	1.22b	1.30a	1.54ab	1.26a	1.10b
WSFNT		1.22a	1.65a	1.30ab	1.57a	1.57ab	1.38a	1.46ab
SF		1.18a	1.30b	1.65a	1.54a	1.65a	1.50a	1.50a
SS		1.42a	0.31d	1.65a	1.42a	1.18b	1.42a	1.22ab
	3-4							
WSFCT		0.43b	1.10b	0.91b	1.38bc	1.54b	1.14a	1.06b
WSFNT		1.14a	1.97a	1.34a	1.85a	1.85ab	1.38a	1.57a
SF		1.57a	1.18b	1.69a	1.65ab	2.13a	1.34a	1.61a
SS		1.42a	0.55c	1.50a	0.94c	1.02c	1.42a	1.14b
	4-5							
WSFCT		1.42b	1.54bc	1.06c	1.73bc	1.50c	1.50b	1.46b
WSFNT		1.65ab	1.97a	1.97a	2.17a	1.73b	1.93a	1.89a
SF		1.85a	1.57b	1.81ab	1.97ab	2.24a	1.50b	1.81a
SS		1.50b	1.26c	1.61b	1.54c	1.34c	1.54b	1.46b
	0-5							
WSFCT		5.28b	6.65b	6.54b	7.64b	7.95b	7.60a	6.97b
WSFNT		7.17a	9.17a	8.19a	8.94a	8.82ab	8.62a	8.46a
SF		7.91a	7.24b	8.78a	8.74a	9.61a	8.07a	8.39a
SS		7.80a	4.65c	8.07a	7.40b	6.61c	7.83a	7.05b

[1]Means within a column at the same depth followed by a different letter differ (P<0.05).

Table 4. Yields of winter wheat and grain sorghum as affected by cropping system and tillage, 1987-1992.							
	Year						
Cropping System	1987	1988	1989	1990	1991	1992	Mean
	— bu/a —						
Wheat							
WFCT	23.6a[1]	19.3a	36.7a	49.1ab	41.8b	26.3a	32.7a
WFNT	26.6a	19.2a	42.8a	50.2ab	51.6a	29.9a	36.7a
WSFCT	24.1a	25.4a	12.0c	56.8a	41.3b	23.9a	30.6a
WSFNT	23.0a	19.3a	22.7b	46.1b	50.2a	29.1a	31.8a
Grain Sorghum							
WSFCT	49.2c	--[2]	90.2a	51.9a	43.5b	96.8b	66.3b
WSFNT	69.1a	--	98.6a	58.0a	70.6a	110.0a	81.4a
SF	64.2ab	--	70.6b	53.0a	70.7a	97.5ab	71.2ab
SS	56.1bc	--	55.3c	38.1b	33.3b	71.4c	50.8c

[1]Means within a column followed by a different letter differ ($P<0.05$).
[2]Not harvested because of bird damage.

YIELD

Wheat yield differences among years were a function of SWP, precipitation, and temperature (Table 4). Lodging, caused by a combination of rainfall and high winds after heading, reduced wheat yields in 1987, whereas dry growing seasons (Table 1) reduced yields in 1988 and 1992. Wheat yields in WSF were reduced in 1989 because less SWP (Table 2) resulted from a dry fallow period (Table 1). Although low SWP also occurred in WSF in 1992, timely rainfall and cool conditions during grain fill resulted in similar yields from WF and WSF. Little difference between WF and WSF yields was observed in the other years. Favorable climatic conditions in 1990 and 1991 resulted in yields often exceeding 50 bu/a.

No-till WF increased yield only in 1991, whereas with WSF, NT resulted in yield increases in 1989 and 1991. Although the yield increase in 1989 for WSFNT apparently was due at least partly to more SWP (Table 2), the increase for WFNT in 1991 occurred in the absence of more SWP. Conversely, in 1990, more SWP in WFNT than WFCT did not result in a yield increase. Timely spring rains may have eliminated the advantage of more SWP in NT in 1990, but the reason for the yield increase in 1991 in the absence of more SWP in NT is unknown. A yield decrease because of cold temperatures occurred for WSFNT in 1990. Temperatures as low as -17° F occurred in mid-December of 1989 before the wheat entered dormancy. Wheat was planted shallower in WSFNT than in WSFCT because of typically firmer soil and was less protected from the cold. The WFNT wheat was not affected because of protection by the stubble remaining from the preceding wheat crop.

Sorghum yields ranged from 33 bu/a for SS in 1991 to 110 bu/a for WSFNT in 1992, the coolest and wettest year. In WSF, yield was significantly increased by NT in 3 of 5 years, compared to CT. The higher yield apparently was caused partly by increases in SWP with NT (Table 3), although those increases were not always statistically significant. Wheat stubble probably contributed to the yield increase by causing a reduction in evaporation from the soil surface during the growing season. The yield of SF was significantly higher than that of WSFCT in 2 years but did not differ from that of WSFNT in 4 years. The lower yield of SF compared with WSF in 1989 was caused by delayed maturity, resulting in lack of grain fill before frost. The 1989 growing season was cooler and wetter than average, and sorghum was planted about 2 weeks later than planned. The reason that sorghum in SF, but not WSF, was affected is unknown. Continuous sorghum produced less grain than WSFNT in all years and less than WSFCT and SF in 3 and 4 years, respectively. However, the SS system produced a crop every year.

ALTERNATIVE CROPS FOR THE ROTATION OF TWO CROPS IN 3 YEARS

by
Charles Norwood

SUMMARY

Dryland corn in the rotation of two crops in 3 years yielded less than grain sorghum in 1991, a dry year. In 1992, a very wet year, corn yielded more than grain sorghum. Yields of the two crops were similar in 1993. Dryland soybean and sunflower yielded well in 1992 and 1993, but rainfall was above average. Dryland soybean and sunflower may not produce enough residue to comply with crop residue requirements. Dryland sunflower reduced yields of the following wheat crop in 1 of 2 years.

INTRODUCTION

The wheat-sorghum-fallow system (two crops in 3 years) is superior to the wheat-fallow system (one crop in 2 years) in terms of yield and profitability, particularly when combined with reduced or no tillage. There is interest in incorporating other crops into the rotation. A long-term study was begun in 1991 to evaluate dryland corn, sunflower, and soybean in the rotation of two crops in 3 years. Grain sorghum is included as a control. This report is a summary of the first 3 years of the study.

PROCEDURES

The wheat-corn-fallow, wheat-sorghum-fallow, wheat-sunflower-fallow, and wheat-soybean-fallow cropping systems were compared from 1991 through 1993 (soybean and sunflower were destroyed by predators in 1991). All systems contained conventional (CT), reduced (RT), and no-tillage (NT) treatments. A postharvest treatment of 2.0 lbs/a atrazine was applied to the stubble remaining from the previous wheat crop for the RT treatment in corn and sorghum and was followed by tillage as necessary for weed control. An early preplant application of 1.6 lbs Bladex + 0.5 lbs atrazine followed the atrazine in the NT treatment in corn and sorghum. Alachlor or propachlor can be substituted for the Bladex, as can other suitable herbicides. The RT and NT soybean and sunflower treatments thus far have utilized only postemergence herbicides such as Landmaster and Roundup for weed control during fallow. Conventional till, RT, and NT treatments are also included for the wheat crop. The RT and NT treatments thus far have been 2.4 lbs Bladex for RT followed by postemergent herbicides (two or three applications) as necessary for weed control in NT. Herbicides for all crops are subject to change as newer herbicides become available. No-till wheat has not proven to be profitable in other studies, but is included in case more economical herbicides become available. An economic analysis of the results will be conducted once sufficient data are collected and will include a CT wheat, followed by an NT row-crop treatment.

Hybrids and varieties planted were Warner 744 BR grain sorghum, Garst 8714 corn (105 day maturity), Cargill SF100 sunflower, and Ohlde 3431 soybean. The crops were planted at rates to result in 25000, 15000, and 17000 plants/a for sorghum, corn, and sunflower, respectively. Sixty lbs/a soybean and 40 lbs/a wheat seeds were planted. The soil type is a Ulysses silt loam with a pH of 7.8 and an organic matter content of 1.5%.

RESULTS AND DISCUSSION

Row crop yields are presented in Table 1. Dry conditions reduced yields, particulary of corn, in 1991. The other years had precipitation

Table 1. Yields of corn, sorghum, soybean, and sunflower in a dryland wheat-row crop-fallow rotation.

Previous Crop	1991	1992	1993	Avg
	Year			
		— bu/a —		
Corn				
CT[1]	17.6a[2]	145.6a	86.0b	83.1
RT	27.4ab	111.6b	94.1ab	77.7
NT	44.2a	150.1a	99.8a	98.0
Grain Sorghum				
CT	43.8b	99.0a	95.5a	79.4
RT	50.4b	87.3a	88.3b	75.3
NT	61.9a	101.1a	91.1ab	84.7
Soybean				
CT	--[3]	36.1a	27.3a	31.7
RT	--	29.2b	29.6a	29.4
NT	--	38.2a	26.8a	32.5
Sunflower		— lbs/a —		
CT	--	1575b	3155b	2365
RT	--	1696ab	3102b	2399
NT	--	1872a	3300a	2586

[1]CT = Conventional tillage, RT = Reduced tillage, NT = No tillage.
[2]Yields for the same crop within a column followed by the same letter do not differ at the 0.10 level of probability.
[3]No yield because of predator damage.

well above normal, resulting in above average yields. In 1991, corn yields were 40%, 54%, and 71% of the respective CT, RT, and NT sorghum yields. The data indicate that grain sorghum yielded substantially more than corn in the dry year, but that the yield difference narrowed as tillage was reduced (the result of more soil water at planting, data not shown). The year 1992 was one of the wettest on record, so corn yields were much greater than sorghum yields; corn yields of this magnitude will rarely, if ever, occur again. Corn and sorghum yields were roughly equivalent in 1993, and rainfall was again above normal. Both corn and sorghum responded to a reduction in tillage in 1991. The only other yield increase occurred for corn in 1993.

The soybean and sunflower crops were destroyed by rabbits and birds in 1991. Soybean yielded well in 1992 and 1993, because of above normal rainfall. A yield of at least 20 bu/a is probably necessary for soybean to have any chance as a dryland crop. The price in relation to that of sorghum and corn and other factors such as conservation compliance (little crop residue) will make soybean a difficult crop to incorporate in dryland systems. Sunflower also produces low amounts of residue, but will probably produce a more consistent yield than soybean. The yield of sunflower was rather low in 1992, considering the rainfall, but was excellent in 1993. Soybean did not respond to a reduction in tillage in either year, but NT sunflower yielded more than CT sunflower in both years.

Tillage had no effect on wheat yields (Table 2). Soybean was not planted prior to the 1991 wheat crop, and as mentioned above, predator damage eliminated the sunflower and soybean crops in 1991 (prior to the 1993 wheat). The lack of an effect of tillage on wheat yields was due primarily to favorable distribution of growing-season rainfall. Previous studies have shown NT to result in yield increases more often for grain sorghum than wheat. This will probably occur with the other row crops as well.

The effects of the previous crops on wheat yields are presented in Table 3. Wheat yields following sunflower were significantly lower than yields following the other row crops in 1992. This will be investigated further in 1994 and future years.

Table 2. Wheat yield as affected by tillage in a wheat-row crop-fallow rotation.

Previous Crop	1991	1992	1993	Avg
	Year			
	— bu/a —			
Corn				
CT[1]	39.8a[2]	46.8a	40.3a	42.3
RT	34.8a	46.0a	44.7a	41.8
NT	31.1a	42.3a	42.4a	38.6
Grain Sorghum				
CT	39.5a	48.2a	42.8a	43.5
RT	29.8a	48.3a	41.0a	39.7
NT	36.5a	42.6a	39.0a	39.4
Soybean				
CT	--[3]	44.8a	--	--
RT	--	43.4a	--	--
NT	--	41.7a	--	--
Sunflower				
CT	34.8a	36.1a	--	35.4
RT	35.7a	36.3a	--	36.0
NT	33.8a	32.3a	--	33.0

[1]CT = Conventional tillage, RT = Reduced tillage, NT = No tillage.
[2]Yields for the same crop within a column followed by the same letter do not differ at the 0.10 level of probability.
[3]No yield because of predator damage.

Table 3. Wheat yield as affected by previous crop in a wheat-row crop-fallow rotation.

Previous Crop	1991	1992	1993	Avg
	Year			
	— bu/a —			
Corn	35.2a[1]	45.0a	42.5a	40.9
Grain sorghum	35.3a[2]	46.4a	40.9a	40.9
Soybean	--[3]	43.3a	--	--
Sunflower	34.8a	34.9b	--	--

[1]CT = Conventional tillage, RT = Reduced tillage, NT = No tillage.
[2]Yields within a column followed by the same letter do not differ at the 0.10 level of probability.
[3]No previous crop because of predator damage or crop not planted.

YIELD OF DRYLAND CORN AS AFFECTED BY TILLAGE, PLANTING DATE, AND PLANT POPULATION

by
Charles Norwood

SUMMARY

Dryland corn yields were increased by early planting and no tillage. Yields decreased at a population of 20000, compared to populations of 10000 and 15000, in 1991, a dry year. Yields increased with higher populations in 1992 and 1993, which had growing-season rainfall well above average. More research under drier conditions is needed.

INTRODUCTION

Dryland corn is not grown commonly in southwest Kansas, because of lack of drought tolerance. However, with adequate rainfall, corn will produce more grain than will sorghum. Also, the price of corn is usually higher than that of sorghum. Farmers growing irrigated corn who are forced to reduce their irrigated acres may want to consider dryland corn. Little is known about date of planting and planting rates for dryland corn. Therefore, a study of date by rate of planting was begun in 1991. Data are presented for the 1991-1993 period.

PROCEDURES

Dryland corn (Garst 8714, maturity 105 days) was planted on three dates, May 1, May 15, and June 1, and thinned to populations of 10000, 15000, and 20000 plants per/a in a wheat-corn-fallow system. Conventional and no-till treatments were included. The study was superimposed on the CT and NT treatments discussed for corn in the preceding section.

RESULTS AND DISCUSSION

Results are presented in Table 1. Yields were low in 1991 because of low subsoil water and a dry growing season. Yields usually were not affected much by planting date, but the May 15 date produced the lowest yields. There was a tendency for lower yields with the 20000 plant population, but yields were not reduced as much as expected. Yields from all dates and populations were increased by NT because of more soil water at planting (data not shown) in 1991.

Yields from the first two planting dates were similar in both 1992 and 1993, whereas the June 1 date produced lower yields. Dates earlier than May 1 were not included because of lack of space, but corn from earlier dates probably would not yield more than that from the May 1-15 dates. Precipitation in 1992 and 1993, particularly 1992, was above average, and no extended periods occurred when the temperature exceeded the mid 90's. Therefore, corn yield in these 2 years benefited from higher populations, peaking at about 175 bu/a in 1992 (in a normal year, I would be estatic with 75 bu/a). Yields like these are not likely to occur again. There was a tendency for NT corn to yield more than CT corn, particulary in 1993. A larger percentage increase usually will result from NT in drier years, as was the case in 1991.

Table 1. Effects of tillage, planting date, and plant population on dryland corn yield, Garden City, KS.

Planting date and Population	1991 CT	1991 NT	1992 CT	1992 NT	1993 CT	1993 NT	Avg CT	Avg NT
	— bu/a —							
May 1								
10000	25.2	47.0	126.1	112.3	81.8	77.4	77.7	78.9
15000	17.6	44.2	145.6	150.1	86.0	99.8	83.1	98.0
20000	19.5	35.0	165.8	173.8	101.1	113.0	95.5	107.3
Avg	20.8	42.0	145.8	145.4	89.6	96.8	85.4	94.7
May 15								
10000	17.6	36.6	129.0	117.6	79.4	94.0	75.3	82.7
15000	10.3	36.8	139.1	147.6	94.5	104.8	81.3	96.4
20000	10.1	33.9	156.5	175.9	101.9	109.0	89.5	106.3
Avg	12.6	35.8	141.5	147.0	91.9	102.6	82.0	95.1
June 1								
10000	28.4	45.9	92.6	103.1	71.0	69.0	64.0	72.7
15000	28.3	39.6	128.2	118.5	93.7	97.8	83.4	85.3
20000	19.0	39.6	122.8	136.8	80.6	101.7	74.1	92.7
Avg	25.2	41.7	114.5	119.5	81.8	89.5	73.8	83.6

LSD (0.10)

	1991	1992	1993
Tillage	11.3	9.5	10.5
Date	4.5	5.9	6.5
Population	5.1	8.4	9.0

NITROGEN MANAGEMENT OF IRRIGATED WINTER WHEAT

by
Alan Schlegel and James Schaffer

SUMMARY

Grain yields of irrigated winter wheat were increased from 33 bu/a without N to over 80 bu/a with N averaged over 3 years. A N rate of 120 lb N/a was sufficient for maximizing grain yield. The best method was a single application of N in the early spring. Grain yields were less with all of the N applied in the fall and not increased by split N applications. Grain protein was increased linearly by increasing N rates. Applying 1/3 of the N late in the growing season (3-way split) was generally not effective in increasing grain protein.

INTRODUCTION

Nitrogen management of irrigated winter wheat was evaluated over a 3-year period near Garden City. The objectives were to determine the optimal rate and time of N application to irrigated wheat and whether split N applications were beneficial in increasing grain yield and grain protein content.

PROCEDURES

Nitrogen fertilizer has been applied annually since 1990 to irrigated continuous wheat grown on a Mantor fine sandy loam near Garden City. Four rates of N (40, 80, 120, and 160 lb N/a) were broadcast at four application timings; all fall, all spring (Feeke's growth stage 3 [GS3]), a 2-way split of 1/3 fall + 2/3 GS3, and a 3-way split of 1/3 fall + 1/3 GS3 + 1/3 GS8 (early boot). Plant tiller population and plant height were measured at physiological maturity. The center of each plot was machine harvested, and grain yields were adjusted to 12.5% moisture. Grain samples collected at harvest were analyzed for protein content.

RESULTS AND DISCUSSION

Nitrogen fertilizer increased wheat yields up to 50 bu/a averaged over 3 years (Table 1). Yields increased with increasing N rates up to 120 lb N/a, with no further increase with 160 lb N/a. Spring application of N produced greater yields than applying all of the N in the fall. However, split N applications were no better than a single application in the early spring (GS3).

Grain protein increased linearly with increasing N rates. Protein content was about 10% with 0 and 40 lb N/a and increased about 1% for each 40 lb of N applied. Time of application had little effect on grain protein, except at the highest N rate, where the 3-way split application of N tended to produce higher grain protein content.

Plant height was increased by about 8 in. over the control when N was applied at 120 N/a. However, time of N application had no effect on plant height. Tiller population tended to peak at about 4 million tillers/a with 120 lb N/a. Time of N application affected tillering in that tiller population was less with the 3-way split treatment than with other treatments.

Table 1. Effects of time of N application and N rate on grain yield, grain protein, plant height, and tiller population of irrigated winter wheat, Garden City, KS 1991-1993.

Time of Appl.	N Rate	Grain Yield	Grain Protein	Plant Height	Plant Tiller Pop.
	lb/a	bu/a	%	in.	million/a
Fall	40	61	9.8	30	3.1
	80	75	11.0	33	3.3
	120	78	11.6	33	3.9
	160	77	12.2	34	4.0
GS3	40	69	10.0	31	3.4
	80	77	11.1	33	3.8
	120	83	11.8	34	4.0
	160	78	12.4	33	4.0
Fall (1/3)+	40	64	9.6	30	3.1
GS3 (2/3)	80	79	10.7	33	3.6
	120	80	11.8	34	3.9
	160	81	12.6	33	3.7
Fall (1/3)+	40	60	9.9	30	2.9
GS3 (1/3) +	80	75	11.2	33	3.1
GS8 (1/3)	120	83	11.7	33	3.4
	160	82	13.1	35	3.8
Control	0	33	10.0	26	2.0
$LSD_{.05}$		7	0.6	2	0.4
MAIN EFFECT MEANS					
Time of Application					
Fall		73	11.2	33	3.6
GS3		77	11.3	33	3.8
Fall+GS3		76	11.2	32	3.6
Fall+GS3+GS8		75	11.5	33	3.3
$LSD_{.05}$		4	0.3	1	0.2
N Rate					
40 lb/a		63	9.8	30	3.1
80		77	11.0	33	3.4
120		81	11.7	34	3.8
160		80	12.6	34	3.9
$LSD_{.05}$		4	0.3	1	0.2

PHOSPHORUS EFFECTS ON GRAIN MOISTURE AND PROFITABILITY

by

Kevin Dhuyvetter and Alan Schlegel

SUMMARY

Phosphorus (P) fertilization increases grain yields and hastens crop maturity. Crops that physiologically mature faster have lower grain drying cost and/or can be harvested quicker. The economic returns to P are the result of decreased drying costs and mainly increased yields. In addition to lower drying costs, there are intangible benefits of corn maturing faster, such as timeliness of field operations, reduced crop lodging, and increased marketing flexibility. These benefits of phosphorus should not be overlooked.

INTRODUCTION

Phosphorus fertilization is essential for optimum production and profitability from irrigated corn in western Kansas. Corn plants deficient in P yield less and mature later than plants receiving adequate P. The role of P in crop maturity is often overlooked when analyzing the economic benefits from P. A long-term N and P study is being conducted for irrigated corn to determine the effects fertilizer have on grain yield and moisture content at harvest.

The objectives of the study are to 1) determine the effect P fertilizer has on grain yield and moisture content at harvest at various N rates; 2) determine the grain drying cost with and without P; and 3) compare the economic benefits of P with regard to grain yield and drying cost.

PROCEDURES

Nitrogen and P fertilizers have been applied annually to irrigated corn grown on a Ulysses silt loam. Fertilizer treatments included N rates ranging from 0 to 200 lb N/a in 40 lb increments with and without P at 40 lb P_2O_5/a. Corn was not allowed to dry completely in the field. Grain moisture content was recorded at harvest and used to determine drying cost. Grain yields were adjusted to 15.5% moisture to reflect shrinkage.

Economic benefit of P was calculated for each level of N. Only costs that varied between treatments were considered in these calculations. Drying costs were calculated using a drying charge of $0.02/bu for each point of moisture above 15.5%. Fertilizer costs were based on $0.15/lb for N and $0.25/lb for P. Gross income was calculated using moisture-adjusted yields and corn prices of $1.75, $2.25, and $2.75/bu.

RESULTS AND DISCUSSION

A long-term N and P study has shown that the optimal N rate for irrigated corn is about 160 lb N/a (Figure 1). Over the past 6 years (1988-1993), application of P (40 lb P_2O_5/a) has increased grain yields by about 80 bu/a. With less than 80 lb N/a, the increase in yield from P fertilizer was much less than at the higher rates of N. This interaction between N and P indicates the need for a balanced fertility program to achieve maximum economic yields.

Phosphorus is essential for seed development and hastens crop maturity. In this study, the corn was harvested at relatively high moisture levels. Earlier harvest reduces the potential for crop losses from lodging and adverse weather conditions. Earlier harvest also can increase marketing flexibility and crop rotation alternatives. Application of P significantly reduced grain moisture (Figure 2), by an average of 5%. At the optimal N rate, grain moisture was reduced from 27% moisture without fertilizer P to 22% with P.

Figure 1. Phosphorus increases grain yield.

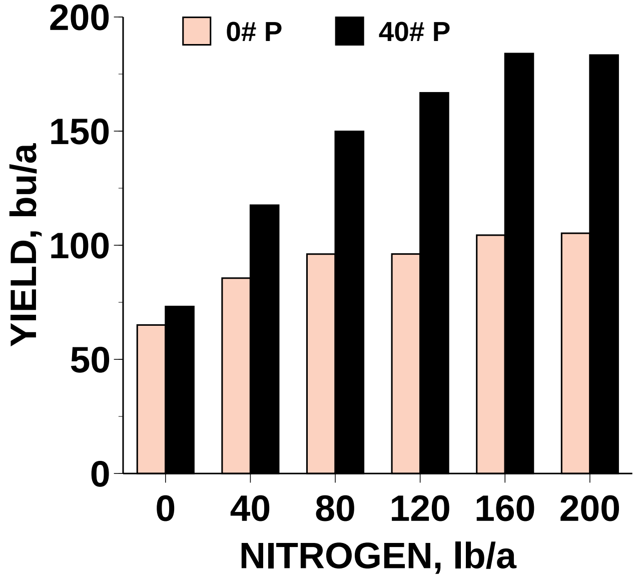
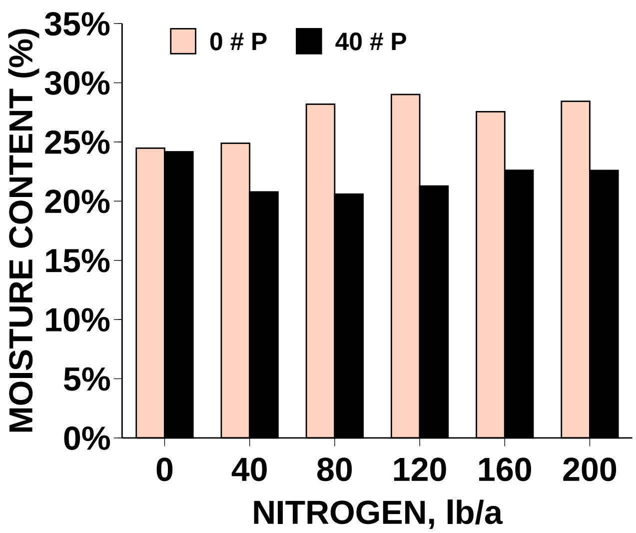
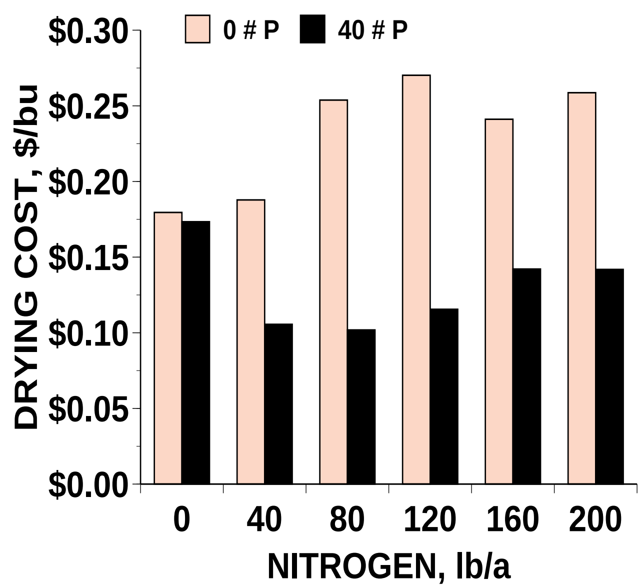


Figure 2. Phosphorus reduces grain moisture.



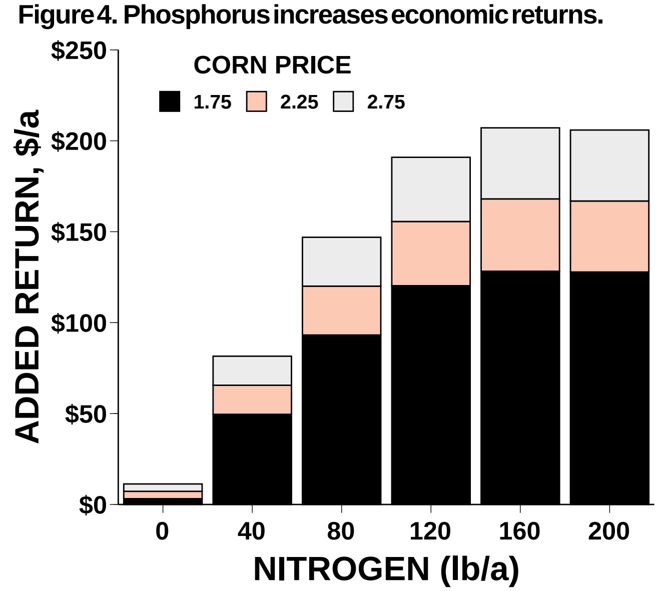
Artificial drying of corn consumes scarce natural resources and is expensive. The addition of P reduced drying costs by an average of $0.10/bu (Figure 3). The biggest savings in drying cost occurred at N rates of 80 and 120 lb/a, but these N rates do not represent the most economical levels because of lower yields. At the optimal N rate, the drying costs was $0.24/bu without fertilizer P compared to $0.14/bu with fertilizer P.

Figure 3. Phosphorus reduces grain drying costs.



The economic benefit from fertilizer P was calculated as the difference in net revenue at each N rate with and without P. Net revenue was calculated as gross revenue less drying and fertilizer costs. The economic benefit from P varied with corn prices and ranged from approximately $125/a with a corn price of $1.75/bu to over $200/a with a corn price of $2.75/bu (Figure 4). This indicates that, regardless of corn prices, returns on irrigated corn can be improved greatly with P when N is also applied at optimal rates.

Figure 4. Phosphorus increases economic returns.



CORN BORER MOTH FLIGHTS IN FINNEY COUNTY, KANSAS

by
Larry Buschman and Lisa Wildman

SUMMARY

Second generation ECB moths were captured in the light trap from 21 July through 31 August, with a peak of 711 moths on 9 August. Second generation SWCB moths were captured from 20 July through 29 August, with a peak of 19 on 8 August. Pheromone traps captured fewer moths than the light trap.

INTRODUCTION

European corn borer, *Ostrinia nubilalis* (Hubner), and southwestern corn borer, *Diatraea grandiosella* (Dyar), moths were monitored using a black light trap and pheromone traps at the Southwest Research-Extension Center.

PROCEDURES

The light trap was set up near electricity. The pheromone traps were set up next to the field in which the corn borer insecticide trial was conducted. ECB pheromone lures (Scentry-Iowa strain) were attached to the bases of metal and cloth *Heliothis* traps. SWCB pheromone lures (Scentry) were attached to the bases of different metal and cloth *Heliothis* traps. New lures were added every 2 weeks. The traps were monitored from 1 June through 31 Aug. (daily during flights).

RESULTS AND DISCUSSION

First generation ECB moths were captured in early June. Second generation ECB moths were captured in the light trap over an extended period, 21 July through 31 August, with a peak of 711 moths on 9 August (Figure 1). This was the largest moth flight observed in several years (peaks of 156 in 1991 and 114 in 1992). Moth numbers in the pheromone traps were not as high as in the light trap; the peak was only 180 moths. The peak captures in the pheromone traps were often several days ahead of the peak captures in the light traps. With such a heavy moth flight, it was surprising to find only an average of 1.0 ECB larvae per plant in the corn borer insecticide test.

First generation SWCB moths were not captured. Second generation SWCB moths were captured over an extended period, 20 July through 29 August, with a peak of 19 on 8 August (Figure 2). Catches in the pheromone traps were not as high as in the light trap, but the timing of peak catches was similar. SWCB larvae was barely detectable in the corn borer insecticide test.

Figure 1. ECB moth catches from black light trap and pheromone traps at SWREC, Finney County. Arrow indicates corn borer insecticide treatment on Aug. 7, 1993.

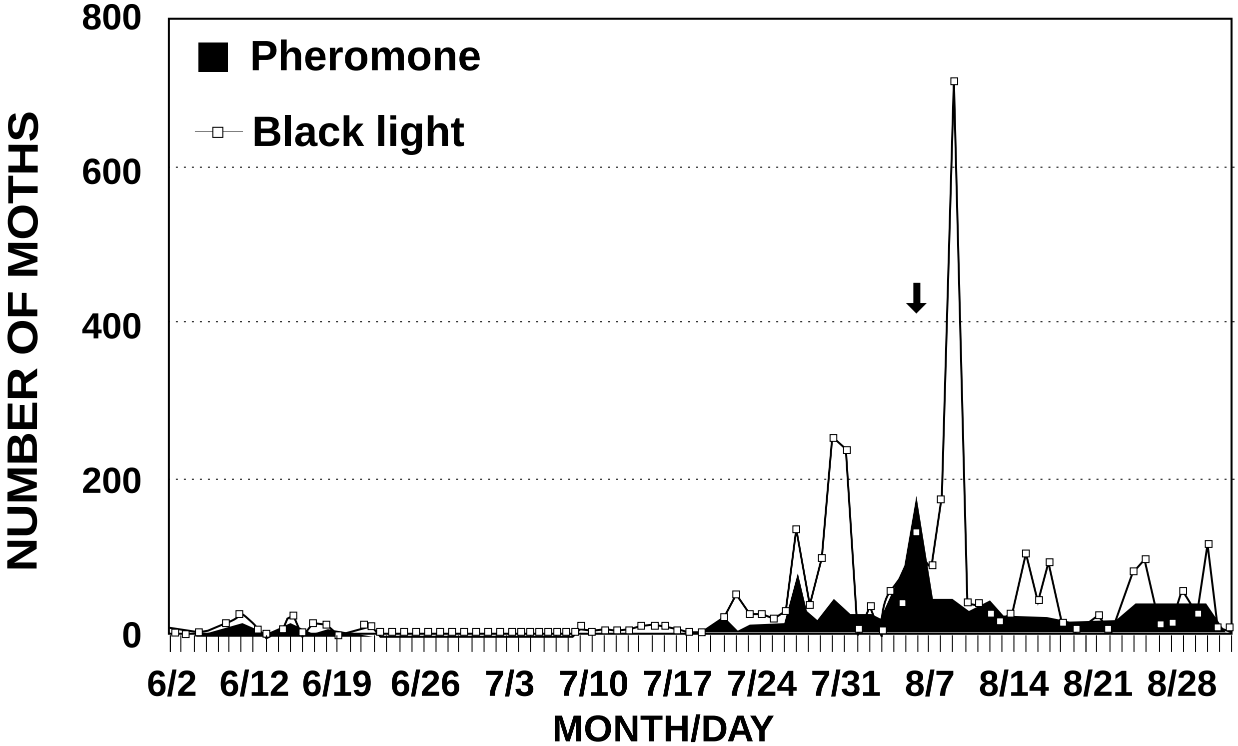
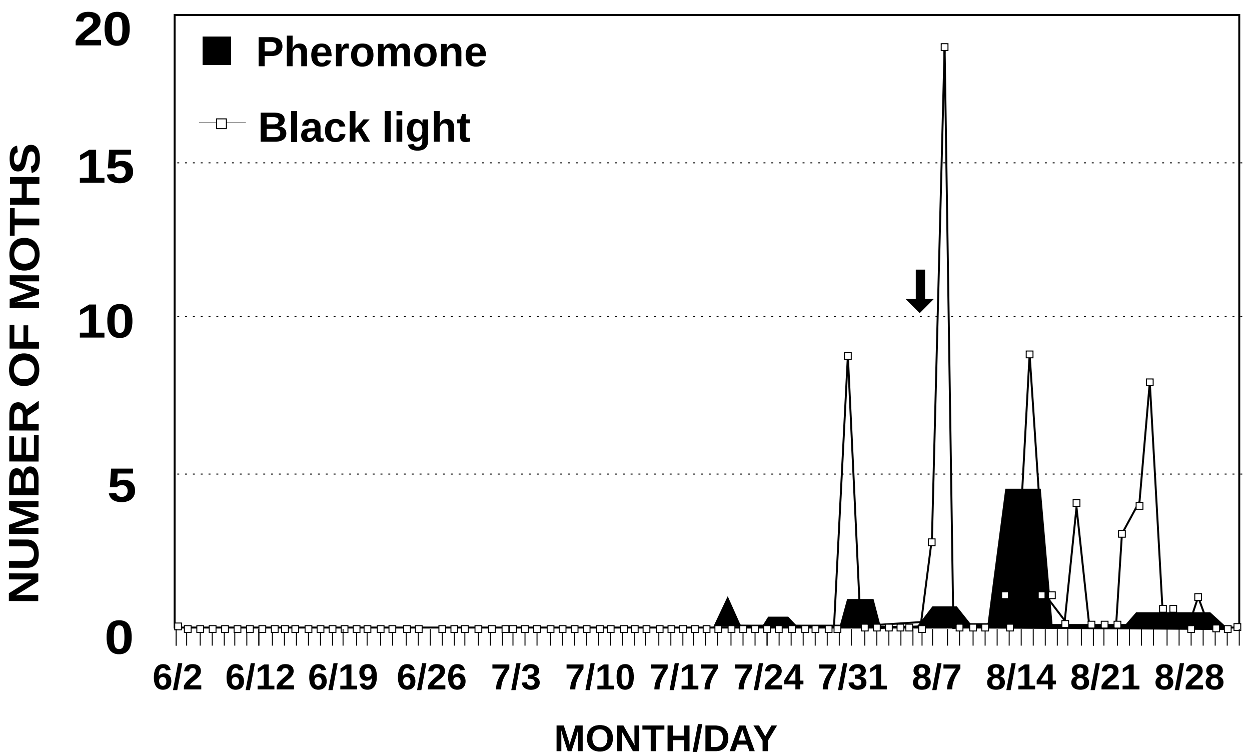


Figure 2. SWCB moth catches from black light trap and pheromone traps at SWREC, Finney County. Arrow indicates corn borer insecticide treatment on Aug. 7, 1993.



EFFICACY OF SELECTED INSECTICIDES AGAINST SECOND GENERATION EUROPEAN CORN BORER, 1993

by
Larry Buschman, Lisa Wildman, and Phil Sloderbeck

SUMMARY

European *Ostrinia nubilatis* (Hubner) averaged one larvae per plant in the untreated check. However, statistically significant reductions in the average number of corn borer larvae per plant, the percent of plants infested, and the amount of tunneling per plant were observed in the plots treated with Karate, RH-5992, RH-2485, Capture, and Furadan.

PROCEDURES

Field corn, Delta Pine 4673B, was planted on 19 May 1993 at a rate of 32,900 seeds per acre in a furrow-irrigated field (Finnup #11) at the Southwest Research Extension Center, Finney County, Kansas. Treatments were arranged in a randomized complete block design with four replications. Plots were l0 ft wide, four rows, and 50 ft long, with a four-row border of untreated corn on each side and a 10-ft alley at each end. The corn borer treatments were made on 6 & 7 August. Treatment timing was based on the Kansas State University European Corn Borer model, which predicted 25-50 % oviposition to occur between 31 July and 4 August. Corn borer moth flight was also monitored using a black light trap. (See previous article.)

Simulated chemigation applications of insecticides were made using three Delavan 100/140, 3/4 in., raindrop nozzles mounted on a high clearance sprayer at tassel height between rows. This system was calibrated to deliver the equivalent of a 0.21 in. irrigation on the two center rows (5730 gal/a). Standard insecticide treatments were applied with a high clearance sprayer using a 10-ft boom with three nozzles directed at each row (one on each side of the row on 16 in. drop hoses directed at the ear zone and a third directed at the top of the plant) and calibrated to deliver 20 gal/a at 2 mph and 40 psi.

Spider mite counts were taken on 30 July (pretreatment) and on 19 August (12 days post-treatment). The spider mite counts were made by visually examining four marked plants per plot and recording the number of large (adult female) mites. Notes also were made on common mite predators, such as predator mites, thrips, and *Orius*. On 15 September, spider mite damage was estimated by examining the leaves of the four marked plants and recording the percent of leaf area damaged.

Corn borer control was evaluated by dissecting 15 plants/plot between 8-16 September to determine the number of corn borer larvae and length of tunneling per plant. Grain yield was determined by machine harvesting two rows per plot and correcting to 15.5% moisture.

RESULTS AND DISCUSSION

European corn borer numbers were light, averaging 1 per plant in the untreated plots, but statistically significant differences occurred among the treatments (Table 1). All of the standard applications significantly reduced the average number of corn borer larvae/plant, the percent of plants infested, and the amount of total tunneling/plant when compared with the check plots. The Dipel and M-Peril treatments (applied by simulated chemigation) were not as effective as the standard insecticides; however, the control provided by M-Peril was similar to that provided by Dipel.

Spider mite numbers were fairly low throughout the study, and differences in spider mite and spider mite predator populations were

Table 1. Efficacy of selected insecticides against second generation European corn borer, Garden City, KS.

Treatment	Rate lb ai/a	ECB per Plant[3]	% of Plants Infested[3]	Tunneling (cm) Total[3]	Below Ear	Ear Shank	Grain Yield bu/a[3]
Check Plots							
Untreated	—	1.00 a	65 a	78 a	30	3.8	116.9 c
Standard Applications							
Karate 1.0EC	0.025	0.17 c	23 cde	19 bc	11	3.3	145.1 a
Karate 1.0EC	0.042	0.17 c	15 e	10 c	6	2.3	127.0 bc
RH-5992 2F	0.125[1]	0.28 bc	17 e	24 bc	11	1.5	130.7 abc
RH-5992 2F	0.25[1]	0.18 bc	15 e	18 bc	8	0.8	134.0 ab
RH-2485 2F	0.062[1]	0.30 bc	28 bcde	19 bc	10	0.0	137.9 ab
RH-2485 2F	0.125[1]	0.12 c	12 e	10 c	4	0.0	127.6 bc
Capture 2E	0.04	0.17 c	17 de	27 bc	17	0.8	130.5 abc
Furadan 4F	1.0	0.30 bc	25 cde	26 bc	16	1.3	130.7 abc
Simulated Chemigation							
Dipel ES	2pt	0.57 abc	40 bcd	41 bc	24	0.8	123.3 bc
M-Peril	2qt	0.63 ab	48 ab	52 ab	25	0.0	131.2 abc
M-Peril	2qt[2]	0.43 bc	45 abc	45 ab	12	0.3	130.0 abc
F-Test Prob.		0.0027	≤0.0001	0.0070	0.1390	0.202	0.0312
C.V.		78%	49%	75%	88%	175%	7%

[1] Plus Triton at 0.125%.
[2] Plus Agrodex at 2qt per acre.
[3] Means within this column followed by the same letter are not significantly different at the 5% level based on DMRT.

not significant (Table 2). A significant increase in spider mite damage was observed in the Karate treatments.

Statistically significant yield differences were observed among treatments; however they are not easily interpreted. As expected, the lowest yield occurred in the untreated plots; however, we did observe a direct correlation between corn borer control and yield. The highest yield was in the Karate 0.015 treatment, but one of the lower yields was in the Karate 0.025 treatment, which appeared to give equal or better control of corn borer. There was considerable inherent variability in yield within the field.

Table 2. Effects of selected corn borer insecticides on spider mites, spider mite predators and spider mite damage, 1993, Garden City, KS.

Treatment	Rate lb ai/a	Pretreatment[3] Spider Mites per Plant	Pretreatment[3] Predators per Plant	10 Days after Treatment[4] Spider Mites per Plant	10 Days after Treatment[4] Predators per Plant	Spider Mite Damage % of Plant[5]
Check Plots						
Untreated	—	0.0	0.0	123.5	0.63	15 bcd
Standard Applications						
Karate 1.0EC	0.025	3.5	0.13	59.4	0.13	29 a
Karate 1.0EC	0.042	2.6	0.06	65.8	0.13	31 a
RH-5992 2F	0.125[1]	11.6	0.13	14.8	0.13	13 cd
RH-5992 2F	0.25[1]	3.9	0.06	2.4	0.63	14 cd
RH-2485 2F	0.062[1]	3.6	0.06	5.1	0.63	13 cd
RH-2485 2F	0.125[1]	13.5	0.38	49.1	1.00	25 abc
Capture 2E	0.04	8.5	0.13	49.1	0.25	23 abcd
Furadan 4F	1.0	6.2	0.19	109.5	0.13	27 ab
Simulated Chemigation						
Dipel ES	2pt	2.0	0.38	10.5	0.25	12 d
M-Peril	2qt	13.3	0.19	5.5	0.13	16 bcd
M-Peril	2qt[2]	3.8	0.06	5.3	0.00	14 bcd
F-Test Prob.		0.5079	0.7381	0.4358	0.284	0.0030
C.V.		156%	185%	199%	164%	40%

[1] Plus Triton at 0.125%.
[2] Plus Agrodex at 2qt per acre.
[3] Sampling date 30 July.
[4] Sampling date 19 August
[5] Means within this column followed by the same letter are not significantly different at the 5% level based on DMRT.

EFFICACY OF MITICIDES AGAINST BANKS GRASS MITES AND TWOSPOTTED SPIDER MITES IN CORN

by
Larry Buschman, Lisa Wildman, and Phil Sloderbeck

SUMMARY

Two trials were conducted in corn to test the efficacy of selected miticides against the Banks grass mite and the twospotted spider mite. Several of the chemicals provided significant control of the Banks grass mite. Kelthane 4E, Comite, Capture + Furadan, and Capture + Cygon provided better than 80% control at both 12 and 21 DAT. Control of the twospotted spider mite was not as impressive. Only Comite and Kelthane WP provided over 70% control at 21 DAT.

INTRODUCTION

These trials were conducted to evaluate the efficacy of several miticides against the Banks grass mite (BGM), *Oligonychus pratensis* (Banks), and the twospotted spider mite, *Tetranychus urticae* Koch.

PROCEDURES

Two tests, (one for BGM and one for TSM) were established in a furrow-irrigated corn field (Finnup #11) at the Southwest Research-Extension Center, Finney County, KS. In each test, treatments were arranged in a randomized complete block design with four replications. Plots were four rows (10 ft) wide and 50 ft long with a four-row (10 ft) border of untreated corn on each side and a 10-ft alley at each end. Treatments were applied on 12 and 13 August with a high clearance sprayer using a 10-ft boom with three nozzles directed at each row (one on each side of the row on 16-inch drop hoses directed at the ear zone and a third nozzle directed at the top of the plant). The sprayer was calibrated to deliver 20 gal/a at 2 mph and 40 psi.

In each plot, four plants were flagged, two plants in each of two center rows. In the BGM test, sections of corn leaves infested with Banks grass mites, collected in Haskell Co., were placed in leaf axils of the flagged plants. In the TSM test, sections of corn leaves infested with twospotted mites from the laboratory colony were placed in leaf axils of the flagged plants.

Pretreatment spider mite counts were made on 9 August by visually searching all leaves of the flagged plants for large (adult female) spider mites. Posttreatment counts were made on 17 & 18 August, 23 & 24 August, and 1&2 September (approx. 5, 11, and 20 days after treatment [DAT] respectively) by searching every other leaf (one-half plant), except for the TSM test on 2 September, when only half of every other leaf (one-quarter plant) was searched. All spider mite counts were converted to mites per plant for presentation. Mite species was determined once pretreatment and once posttreatment by taking samples of spider mites from the four flagged plants in each plot using a vacuum sampler. These samples were mounted on glass slides for microscopic examination and determination of species. Grain yield was determined by machine harvesting two rows per plot, and the gross weight was adjusted to 15.5% moisture and converted to bu/a.

RESULTS AND DISCUSSION

Spider mite populations were low and variable on 9 August when pretreatment counts were made. The BGM test averaged 32-131 mites per plant, and they were 88% BGM (Table 1). The TSM test averaged 53-143 mites per plant, and they were 95% TSM (Table 2). Mite populations in the BGM test increased slowly to 166 mites per plant at 20 days posttreatment. Mite populations in the TSM test increased more rapidly to 805 mites per plant at 21 days

Table 1. Miticide efficacy trial with Banks grass mites at Southwest Research-Extension Center, 1993, Garden City, KS.

Treatment	Rate lb ai/a	9 Aug Pretreatment Spider Mites per Plant	17 Aug 5 Days after Treatment[1] Spider Mites per Plant	17 Aug % Control[2]	23 Aug 11 Days after Treatment[1] Spider Mites per Plant[3]	23 Aug % Control[2]	1 Sept 20 Days after Treatment[1] Spider Mites per Plant[3]	1 Sept % Control[2]	1 Sept % Damage	1 Sept % TSM	Grain Yield bu/a[3]
Check		32	18	—	79 b	—	166 b	—	27	54	144 abcd
Kelthane MF 4E +Triton CS-7	1.0 0.125%	49	5	83	20 cd	83	49 bc	81	10	59	130 cd
Kelthane 50W + Triton CS-7	1.0 0.125%	64	32	11	87 b	45	143 bc	57	15	47	141 bcd
Capture 2E	0.08	31	11	35	22 cd	71	110 bc	32	12	74	145 abc
Capture 2E + Furadan 4 F	0.08 0.5	47	17	34	13 cd	89	49 bc	80	9	53	163 ab
Capture 2E +Cygon 4E	0.08 0.5	94	1	98	0 d	100	40 bc	92	9	70	151 abc
Capture 2E + Thiodan 3E	0.08 0.5	131	28	62	20 cd	94	164 b	76	16	64	151 abc
Capture 2E + Thiodan 3E	0.06 0.5	61	9	73	18 cd	88	152 bc	52	15	72	166 a
MSR 2E	0.5	99	12	78	53 bcd	78	165 b	68	22	49	140 bcd
Furadan 4E	1.0	52	38	-30	142 a	-10	478 a	-77	21	61	147 abc
Comite 6.55E	2.46	47	12	55	6 d	95	20 c	92	6	31	149 abc
Cygon 4E	0.5	61	19	46	69 bc	54	183 b	42	14	53	122 d
F-Test Prob.		0.26	0.33		0.0002		≤0.0001		0.065		0.0073
C.V.		92%	112%		82%		60%		59%		10%

[1] Treatments applied 12-13 Aug.
[2] The percent control for each treatment was calculated using the Henderson & Tilton formula, which adjusts for changes in number of mites in the untreated check.
[3] Means within this column followed by the same letter are not significantly different at the 5% level based on DMRT.

Table 2. Miticide efficacy trial with twospotted spider mites at Southwest Research-Extension Center, 1993, Garden City, KS.

		9 Aug	17-18 Aug 5 Days after Treatment[1]		23-24 Aug 11 Days after Treatment[1]		2 Sept 21 Days after Treatment[1]				
Treatment	Rate lb ai/a	Pretreatment Spider Mites per Plant	Spider Mites per Plant[2]	% Control[3]	Spider Mites per Plant[2]	% Control[3]	Spider Mites per Plant[2]	% Control[3]	% Damage	% TSM	Grain Yield bu/a[2]
Check		84	61 a	—	489 a	—	805 ab	—	34	100	148 bcd
Kelthane MF 4E +Triton CS-7	1.0 0.125%	64	24 abcd	47	135 c	64	288 cd	53	15	100	144 cde
Kelthane 50W + Triton CS-7	1.0 0.125%	143	57 ab	44	210 bc	75	416 bcd	70	84	100	132 e
Capture 2E	0.08	56	9 d	78	192 bc	41	498 bcd	7	24	100	160 ab
Capture 2E + Furadan 4 F	0.08 0.5	76	8 d	85	123 c	72	446 bcd	38	17	99	162 a
Capture 2E +Cygon 4E	0.08 0.5	89	14 cd	78	186 bc	64	460 bcd	46	22	100	163 a
Capture 2E + Thiodan 3E	0.08 0.5	140	44 abcd	56	207 bc	75	635 bc	52	30	99	159 ab
Capture 2E + Thiodan 3E	0.06 0.5	151	26 abcd	77	176 bc	80	666 bc	54	75	100	159 ab
MSR 2E	0.5	68	48 abcd	2	387 ab	2	484 bcd	26	26	100	141 de
Furadan 4E	1.0	110	52 abc	34	385 ab	40	1047 a	0	27	96	154 abc
Comite 6.55E	2.46	53	16 bcd	58	54 c	82	115 d	77	16	97	143 cd
Cygon 4E	0.5	69	54 abc	-9	474 a	-24	545 bc	17	35	93	148 bcd
F-Test Prob.		0.36	0.048		0.001		0.001		0.2583	<0.0001	
C.V.		147%	75%		56%		45%		115%	5.2%	

[1] Treatments applied 12-13 Aug.
[2] Means within this column followed by the same letter are not significantly different at the 5% level based on DMRT.
[3] The percent control for each treatment was calculated using the Henderson & Tilton formula, which adjusts for changes in number of mites in the untreated check.

posttreatment.

Several of the treatments gave acceptable control of mites in the BGM test (Table 1). Kelthane MF and Comite (3 pt rate) gave effective BGM control through 20 days (81 and 92% control, respectively). All five Capture treatments gave significant control of BGM at 12 days post-treatment (71-100% control), but by 20 days post-treatment only the Capture + Cygon and the Capture + Furadan treatments were above 80% control. The ratio of TSM in these populations tended to increase in many of the Capture treatments but remained low in the Kelthane and Comite treatments.

In general, most of the treatments were less effective controlling mites in the TSM test than in the BGM test (Table 2). Only two of the treatments, Kelthane 50W and Comite (3 pt), gave effective control through 21 days (70 and 77% control, respectively). All five Capture treatments gave good control of TSM on day 5, but by day 11, control for Capture alone had fallen off, and by day 21, control for all five of the Capture treatments had declined to below 60%. The other registered miticides, MSR, Cygon and Furadan, gave very little control, even at 5 days posttreatment. The ratio of TSM in these populations remained high, 93-100%, in all the treatments.

Grain yield varied significantly among treatments in both tests, but did not correlate with miticide efficacy. Some of the yield difference probably was a result of the treatment effects on corn borers. Several of the treatments are known to be good corn borer insecticides, whereas others would be expected to have little effect on corn borer populations.

EFFICACY OF SOIL INSECTICIDES FOR ROOTWORM CONTROL

by
Larry Buschman, Lisa Wildman, Phil Sloderbeck, and Randall Currie

SUMMARY

Rootworm damage to corn was compared in plots treated with planting time applications of various formulations of Counter, Lorsban, Fortress, Thimet, Force, and Dyfonate. Significant reductions in rootworm damage were obtained with Counter 15G, Counter 20CR, Lorsban 15G, Lorsban NAF#1, and Force 1.5G.

PROCEDURES

Field corn, Pioneer 3162, was planted on 17 May 1993 at a rate of 32,900 seeds/a in a furrow-irrigated field (#17) at the Southwest Research Extension Center, Finney County, KS. The preplant herbicide Atrazine was applied to all plots at the rate of 2 lb ai/a The soil type was a Richfield silt loam with a pH of 7.5 and an organic matter content of 1.5%. Plots were three rows (7.5 ft) by 30 ft , arranged in a randomized complete block design and replicated four times. Treatments were applied either as a 7 in. band over the open seed furrow (T-band) or in the furrow with planter-mounted granule applicators. These plots were superimposed over a herbicide trial, so some variation occurred in the postemergent herbicide treatments that the insecticide treatments received. Most of the plots received an application of Accent (0.67 oz/a) on 15 June, but one set of the Counter 20CR treatments and one set of untreated plots received an application of Beacon (0.76 oz/a) (see Table 1).

Rootworm damage was rated on four plants/plot on 7 July 1993 using the six point Iowa scale, and plant height was recorded. Grain yield was determined by machine harvesting each plot and adjusting the yields to bu/a at 15.5% moisture.

RESULTS AND DISCUSSIONS

Rootworm injury in the untreated plots was rated only moderate, averaging 3.6; however, rootworm damage ratings differed significantly among treatments (Table 1). All four of the Counter treatments, two of the Lorsban treatments, and the Force treatment significantly reduced rootworm injury below that seen in any of the untreated treatments. Rootworm injury in the treatments receiving experimental Lorsban formulations, the low rate of Fortress, and the Thimet treatment did not differ significantly from that in the untreated check.

In rating the rootworm damage, malformed or stubby roots were observed in at least two of the replicates of the Counter-Beacon plots. Similar damage was not observed in the Counter-Accent plots. Data on plant height was not well correlated with treatment, but appeared to be more a result of plot location and degree of Johnson grass infestation and, therefore, was omitted from the analysis.

Grain yield averaged 83.5 bu/a and did not differ significantly among treatments. Rootworm damage above 3.0 usually is associated with significant yield reductions. However, large variations occurred across the plots because of differences in weed competition, which undoubtedly masked any yield differences caused by reductions in rootworm injury.

Table 1. Efficacy of soil insecticides on corn rootworms, Southwest Research-Extension Center, Garden City.			
Insecticide	Rate oz/1000 ft.[1]	Herbicide	Rootworm Ratings 1-6 [2]
Untreated	—	Beacon	3.7 a
Untreated	—	Accent	3.5 abc
Untreated	—	Accent	3.6 ab
Counter 20CR	6 B	—	2.6 efg
Counter 20CR	6 B	Beacon	2.4 fg
Counter 20CR	6 B	Accent	2.3 g
Counter 15G	6 B	Accent	2.5 fg
Lorsban l5G	6 B	Accent	2.3 g
Lorsban NAF#l	6 B	Accent	2.8 defg
Lorsban NAF#12	6 B	Accent	3.4 abcd
Lorsban NAF#13	6 B	Accent	3.2 abcde
Fortress 5G	3 IF	Accent	3.3 abcd
Fortress 5G	6 IF	Accent	2.9 cdefg
Thimet 20G	6 B	Accent	3.6 ab
Force l.5G	8 B	Accent	2.7 efg
Dyfonate II	6 B	Accent	3.0 bcdef
F-test prob.			<0.0001
CV			15%

[1] B = Band application, IF = in-furrow application.
[2] Means within this column followed by the same letter are not significantly different at the 5% level based on DMRT.

TANK MIXES TO ENHANCE KOCHIA CONTROL BY ACCENT OR BEACON

by
Randall Currie

SUMMARY

Accent provided poor kochia control when used alone. However, Banvel and Clarity tank mixed with Accent provided excellent kochia control. Atrazine or Permit plus Banvel tank mixed with Accent also provided good kochia control. The experimental compound M6316 and V-23031 did not appear to enhance Accents' kochia control.

INTRODUCTION

Accent and Beacon both provide excellent control of johnsongrass and shattercane and, under the right conditions, adequate control of some other grass species. However, on broadleaf weeds, they can be inconsistent and provide poor control. Previous field day reports have noted that, although these compounds have biological activity on kochia, Accent or Beacon provide unacceptable control under heavy kochia pressure. Therefore, the objective of this test was to test compounds that could be mixed with Accent or Beacon to enhance their kochia control.

PROCEDURES

Corn was planted as described in Table 1 and sprayed as described in Table 2. Percent control was calculated based on weed number per unit area. Yield was determined based on combine harvest of two 30-foot rows from the center of each plot. Data were analyzed as a randomized complete block.

Table 1. Planting information.

Crop:	Corn
Variety:	Pioneer 3162
Planting Date:	5/7/93
Planting Method:	JD Max Emerge II
Rate:	32,900 seed/A
Depth:	1 1/2"
Row Spacing:	30" row, 60" bed
Soil Temp.:	58°F
Soil Moisture:	Moist

Table 2. Application information.

Application Date:	6/8/93
Time of Day:	8:45 - 10:30 AM
Application Method:	Windshield Sprayer
Application Timing:	Postemergence, 4-5 leaf corn
Air Temp.:	79°F
Soil Temp.:	62°F
Soil Moisture:	Dry surface
Appl. Equipment:	Windshield Sprayer
Pressure:	30 # PSI
Nozzle Type:	XR FF
Nozzle Size:	8004
Nozzle Spacing:	20"
Boom Length:	10'
Boom Height:	18"
Ground Speed:	4 mph
Carrier:	H_2O
Spray Volume:	17 GPA
Propellant:	CO_2

RESULTS AND DISCUSSION

Field conditions in this test reduced the competitive ability of kochia. Corn emerged well ahead of kochia, which was present at less than one plant per 3 ft of row. At the time of application, kochia was 1 to 8 in. tall, and many plants were shaded by the corn. As expected, Accent provided poor kochia control 30 days after treatment (Table 3). One could expect equally poor kochia control with Beacon based on work not shown here. The addition of Banvel or Clarity provided excellent kochia control. The addition of atrazine, Permit, or low rates of Banvel plus Permit also provided acceptable control. Other tank mixes of Permit with other surfactants, which should have enhanced herbicidal activity, did not perform as well. This makes it difficult to draw strong conclusions about Permit's efficacy based on this test alone. The Accent-Beacon tank mix performed much better than expected. Under less favorable conditions, this tank mix might not perform as well. All other tank mixes performed poorly. In another test not shown here, Tough, performed well. It would be premature to draw conclusions about it's performance based on this test alone.

Shattercane pressure was erratic, and this test should not be used to differentiate between products. By 30 days after application, no statistically significant differences in the level of shattercane control were seen among the products.

Excellent johnsongrass control was seen in all treatments. All tank mixes dramatically enhanced yield. However, insufficient differences in weed competition were present to differentiate among the effects of these tank mixes on yield.

Table 3. Weed control with tank mixes of broadleaf control compounds with Accent or Beacon 15 and 30 days after postemergence treatment.

Trt #	Treatment	Rate lbs/ai/a	Kochia 15 DAT*	Kochia 30 DAT	Shattercane 15 DAT	Shattercane 30 DAT	Johnsongrass 15 DAT	Johnsongrass 30 DAT	Yield bu/a
					— % Control —				
1	Accent + Banvel + X-77 + UAN	.0312 + .125 + .25% + 4%	93.6	100.0	65.4	76.6	94.4	90.9	101.6
2	Accent + Clarity + X-77 + UAN	.0312 + .125 + .25% + 4%	97.9	98.0	60.0	58.9	79.1	100.0	94.7
3	Accent + V-23031(Resource) + X-77 + UAN	.0312 + .288 + .25% + 4%	46.8	50.0	62.1	88.9	99.4	100.0	91.0
4	Accent + Beacon + Scoil + UAN	.0312 + .018 +1% + 4%	78.7	74.0	91.1	67.8	99.4	100.0	90.7
5	Accent + Permit + X-77 + UAN	.0312 + .0312 + .25% + 4%	78.7	80.0	77.5	80.0	88.0	100.0	88.9
6	Accent + Permit + COC + UAN	.0312 + .0312 + 1% + 4%	19.1	26.0	76.4	72.2	97.7	100.0	92.4
7	Accent + Permit + Scoil + UAN	.0312 + .0312 + 1% + 4%	14.9	0.0	88.9	96.7	100.0	100.0	93.5
8	Accent + Permit + Banvel + X-77 + UAN	.0312 + .0156 + .0625 + .25% + 4%	89.4	84.0	60.0	57.8	98.0	100.0	91.2
9	Accent + M6316 + COC + UAN	.0312 + .0039 + 1% + 4%	0.0	4.0	56.3	55.5	94.7	100.0	87.1
10	Accent + M6316 + Atrazine +COC + UAN	.0312 + .0039 + .75 + 1% + 4%	72.3	80.0	84.2	66.7	92.0	100.0	103.4
11	Accent + COC + UAN	.0312 + 1% + 4%	17.0	26.0	62.1	78.9	95.8	100.0	96.3
12	Beacon + Tough EC + X-77	.0357 + .45 + .25%	38.3	36.0	45.2	57.8	82.0	100.0	88.2
13	Accent + Tough EC + X-77	.0312 + .45 + .25%	40.4	42.0	71.9	88.9	93.1	90.9	89.4
14	Beacon + Tough EC + X-77	.0357 + .70 + .25%	27.6	20.0	88.9	88.9	100.0	100.0	85.0
15	Accent + Tough EC + X-77	.0312 + .70 + .25%	29.8	42.0	94.4	81.1	90.1	100.0	102.3
16	Check		0.0	0.0	0.0	0.0	0.0	0.0	46.0
	LSD 0.05 =		4.3	8.0	36.9	48.6	17.9	36.4	20.4

* DAT = Days after treatment

EFFECTS OF GENE COPY NUMBER OF PIONEER'S IR GENE ON PURSUIT RESISTANCE IN CORN

by
Randall Currie

SUMMARY

A 4X rate of Pursuit did not injure corn containing two copies of Pioneer's IR gene. Although corn containing only a single copy of the IR gene was injured occasionally early in the season at a 4X rate, this injury did not translate into yield loss. At Garden City, the susceptible cultivar was not injured at normal use rates of Pursuit. However at Manhattan, severe injury was seen at 1/2X rate of Pursuit. Light absorption was a highly reproducible index of Pursuit injury early in the season.

INTRODUCTION

Pioneer presently markets Pursuit-resistant corn containing two copies of the IR gene, one from each parent. ICI seeds markets corn with a single copy of a similar gene from only one parent. The objectives of this test were to 1) determine the effect of the second copy of Pioneer's IR gene on Pursuit resistance of its corn cultivar and 2) determine appropriate methods to measure Pursuit injury with 0, 1, or 2 copies of the IR gene.

PROCEDURES

The Pursuit-resistant and -susceptible seed used were P3180 IR (containing a copy of the IR gene from each parent) and P3180 (containing no copies of the IR gene). Corn kernels containing a single copy of the IR gene for Pursuit resistance were produced under greenhouse conditions by multiple hand pollination of the P3180 IR with bulked pollen from P3180. Experiments were conducted on a Reading silt loam soil with 3.2% organic matter and a pH of 5.8 at the Kansas State University Ashland Field in Manhattan, KS, and at the Southwest Research-Extension Center in Garden City, KS on a Richfield silt loam with 1.5% organic matter and a pH of 7.5. Corn was planted in the first week in May in rows 30 in. apart with 1 seed/ft. Individual plots consisted of two 25 -ft rows of each cultivar.

Annual weeds were controlled with a preemergence application of Dual at 2 lbs/a plus atrazine at 1 lb/a over the entire plot area. Pursuit at 0, 2, 4, 8, and 16 oz/a with 1 qt/a crop oil concentrate was applied to corn in the 5-leaf stage. Corn injury was evaluated 1, 2, and 5 weeks after treatment.

Two indices of corn injury were used, light absorbance and plant height. The absorbance of photosynthetically active light of intact leaves was measured with a separate Minolta-502 hand held spectrometer at both locations. On four plants per plot, four successive absorbance readings were made starting at the leaf axil of the last fully expanded leaf. Corn height was based on measurement of four plants per plot. At maturity, ears from a single row of each plot were harvested and dried to 14% moisture. Total ear dry weight was reported as percent yield reduction.

The experimental design was a randomized complete block with four replications. Mean differences were evaluated using Fisher's protected LSD test at the 5% probability level.

RESULTS AND DISCUSSION

Reduction in absorption of photosynthetically active light proved to be a highly reproducible index of Pursuit injury. No location interaction was seen using this index, and the data are presented pooled over location (Fig. 1). This index was most sensitive 2 weeks after treatment, detecting reductions in light absorbance of plants treated with as little as 1/2 X rate of Pursuit. The rate of injury appeared to increase with each

Figure 1. Reduction in absorbance of photosynthetically active light of pursuit-susceptible (■), IR/S crosses (●), and Pursuit- resistant (▲) corn hybrids 1, 2 and 5 weeks after treatment (WAT).

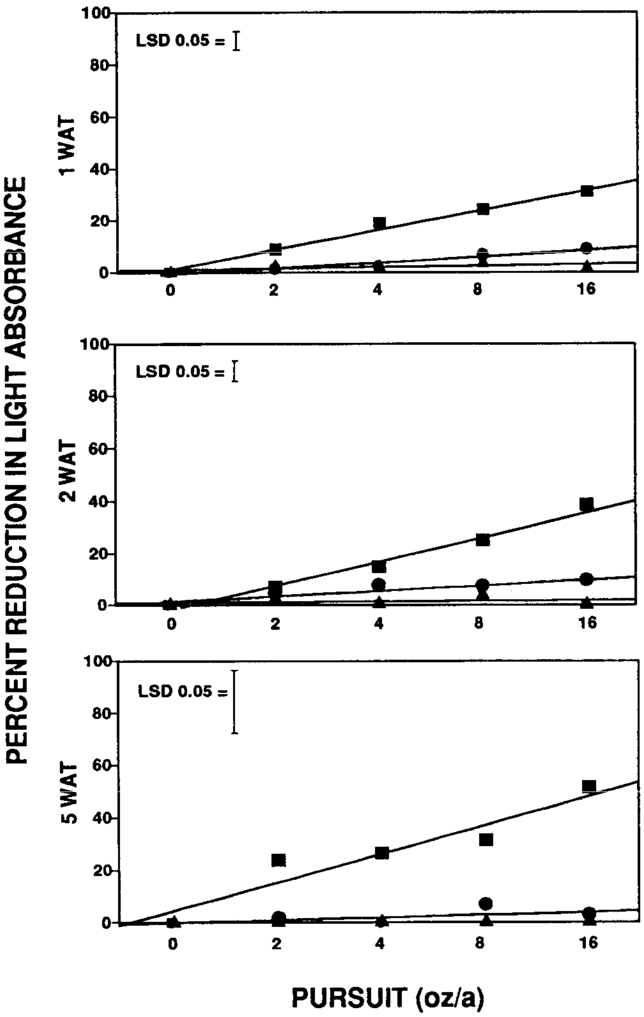
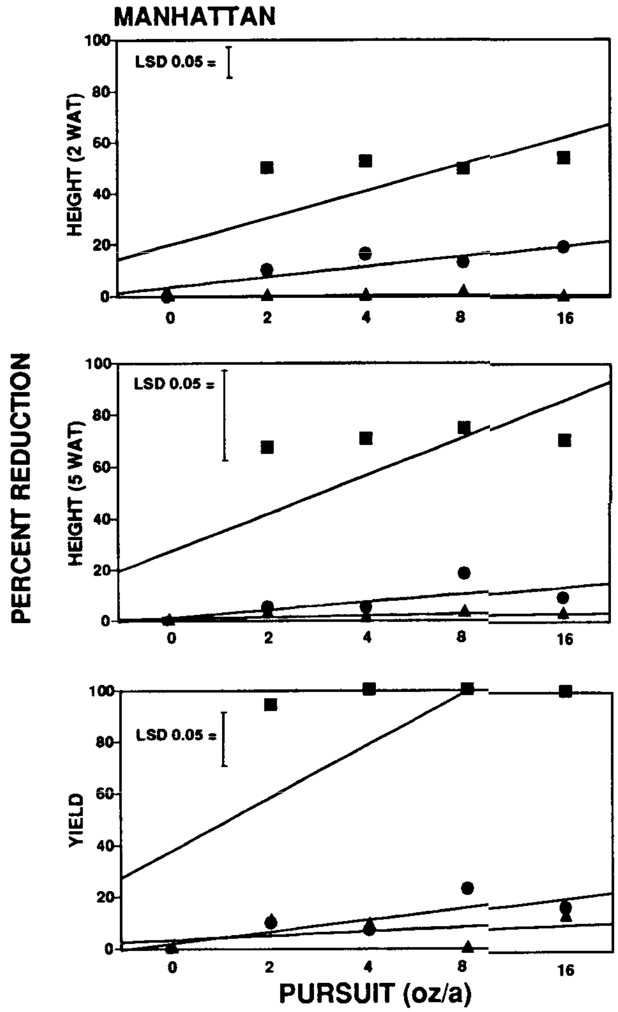


Figure 2. Reduction in height and yield of Pursuit-susceptible (■), IR/S crosses (●), and Pursuit-resistant (▲) corn hybrids at Manhattan 2 and 5 weeks after treatment (WAT).



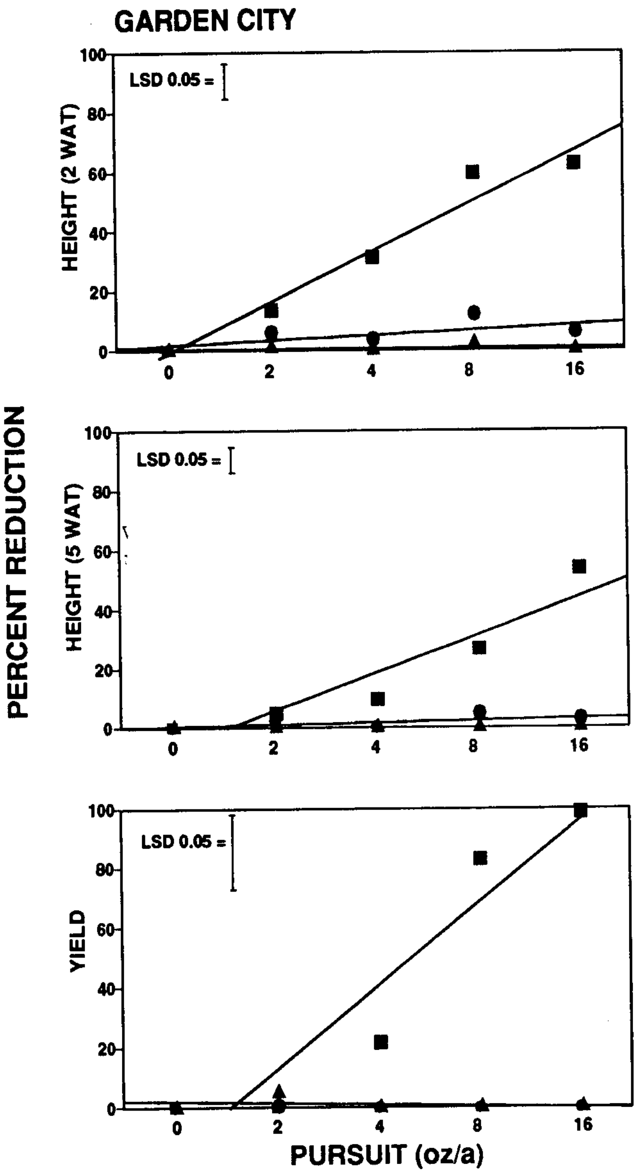
successive date. The corn containing a single copy of the IR gene recovered from any early-season injury by 5 weeks after treatment. The index showed no injury in the IR variety at any time. Clearly, light absorption is a powerful early-season index of Pursuit injury.

Height reduction produced a strong location interaction. This was due to the greater level of injury seen at Manhattan (Fig. 2). At all rates and dates, the susceptible variety was injured severely at Manhattan. Height was a very sensitive measure of injury. As with light absorption, using height reduction as an index showed no injury at any time in the IR hybrid.

As was seen for height reduction, yield reduction strongly interacted with location because of the severity of response at Manhattan. In general, at Garden City, all indices produced similar rates of reduction (Fig. 3). However, predicting yield loss across locations with any index was difficult.

In conclusion, light absorption was a most reproducible index of Pursuit injury and could be used very early in the season under field conditions. Later in the season, height reduction was a sensitive index of Pursuit injury. As might be expected, no index predicted the magnitude of yield reduction consistently across all locations. Injury was seen occasionally in the corn containing a single copy of the IR gene early in the season, but by 5 weeks after treatment, it recovered from this injury, and yield was not reduced. The second copy of the IR gene may be present only for cosmetic reasons.

Figure 3. Reduction in height and yield of Pursuit-susceptible (■), IR/S crosses (●) and Pursuit-resistant (▲) corn hybrids at Garden City.



AN ECONOMIC ANALYSIS OF SUBSURFACE DRIP IRRIGATION FOR CORN

by
Kevin C. Dhuyvetter

SUMMARY

Studies have been conducted to determine the effects of dripline spacing and dripline length on corn yield as well as water requirements of corn under drip irrigation. Data from these studies were analyzed to determine the economic optimal system design and irrigation amount for subsurface drip irrigation. Yields increased as dripline spacing decreased from 10.0 ft to 2.5 ft. However, the yield advantage at 2.5 ft was not large enough to offset the cost of the added driptape per acre. The economic optimal dripline spacing was 5.0 ft when corn prices were between $1.50 and $3.25/bu. Yields increased slightly as dripline length was shortened from 660 ft to 330 ft. However, the yield advantage at 330 ft was not large enough to offset the cost of the added submains, flushlines, and driptape ends. The economic optimal dripline length was 660 ft. The economic optimal irrigation amount, based on a corn price of $2.25/bu and irrigation pumping cost of $2.50/in., was 18.5 in. This represented about 93% of ET.

Based on the economic optimal system design and irrigation amount, drip irrigation was compared to a "typical" center pivot system from an economic standpoint. The center pivot system was more economical than the drip system with the initial assumptions. However, drip irrigation compared favorably to center pivot given a 5-6 bu/a yield advantage with drip irrigation. Reducing the annual cost, by lengthening the useful life or reducing the initial capital outlay of the drip system, also made the returns from the two systems comparable. The relative irrigation application efficiencies of the two systems had a very small effect on economic returns.

INTRODUCTION

Subsurface drip irrigation is a highly efficient delivery system. Through more uniform irrigation application and decreased percolation and evaporation losses, less overall water and energy are necessary compared to other irrigation delivery systems. Although the annual pumping costs of a drip system are low, the initial capital investment is high, relative to other delivery systems. Because of this, drip irrigation has been associated typically with high-value crops such as fruits and vegetables. But, as parts of the Ogallala Aquifer have continued to experience various levels of overdraft, drip irrigation has received increased attention as an alternative to present irrigation systems.

The objectives of this study were to 1) determine the economic optimal dripline spacing and dripline length for subsurface drip irrigation, 2) determine the economic optimal amount of irrigation water for subsurface drip irrigation, and 3) compare the economic returns from subsurface drip irrigation with the returns from a center pivot system.

PROCEDURES

Drip irrigation research in corn production has been conducted at the Southwest Research-Extension Center (SWREC) since 1989. The research has centered largely on various design and production management parameters, including dripline spacing, dripline length, and water use requirements. The economic feasibility of these various management parameters was analyzed using a marginal returns approach to identify the optimum drip irrigation system design for corn. Partial budgeting then was used to economically compare this optimum system to a "typical" center pivot irrigation system used in western Kansas. The value of water resource conservation and water quality protection was not considered in this analysis.

RESULTS AND DISCUSSION

A study was conducted at the SWREC from 1989 through 1991 examining the effects of dripline spacings on corn yields. In general, although a narrow spacing between driplines is necessary for high yields, it results in higher overall drip system costs. On the other hand, wider dripline spacings will reduce system costs, but also may reduce corn yields and profits.

Dripline spacings of 10.0, 7.5, 5.0 and 2.5 ft were included in the study. Corn yields increased as dripline spacings decreased from 10.0 ft to 2.5 ft (Table 1). An analysis of marginal returns was used, with marginal returns calculated as the additional income generated by increased yields, less the cost of additional driptape and connectors necessary to decrease the spacing between driplines. The added annual cost was based on the added investment amortized over 10 years at 9% interest. When marginal returns are positive, it pays to use the narrower 7.5-ft dripline spacing rather than the 10.0-ft spacing, for a marginal return of $25.08/a based on $2.25/bu

Table 1. Marginal returns to various dripline spacing levels in corn ($/a.)[1].

Year	Dripline Spacing (ft)	Driplines /qtr.	Driptape feet/a	Yield bu/a	Added Driptape	Added Cost[2]	Added Bushels	Added Income[3]	Marginal Return
1989	10.0	264	4,356	192.9					
	7.5	352	5,808	201.4	1,452	$6.72	8.5	$19.13	$12.41
	5.0	528	8,712	204.6	2,904	$13.44	3.2	$7.20	($6.24)
	2.5	1,056	17,424	217.4	8,712	$40.31	12.8	$28.80	($11.51)
1990/4	10.0	264	4,356	180.5					
	7.5	352	5,808	186.0	1,452	$6.72	5.5	$12.38	$5.66
	5.0	528	8,712	193.7	2,904	$13.44	7.7	$17.32	$3.89
	2.5	1,056	17,424	215.0	8,712	$40.31	21.3	$47.93	$7.61
1991	10.0	264	4,356	208.8					
	7.5	352	5,808	237.2	1,452	$6.72	28.4	$63.90	$57.18
	5.0	528	8,712	254.4	2,904	$13.44	17.2	$38.70	$25.26
	2.5	1,056	17,424	257.7	8,712	$40.31	3.3	$7.42	($32.89)
89-91 Avg.	10.0	264	4,356	194.1					
	7.5	352	5,808	208.2	1,452	$6.72	14.1	$31.80	$25.08
	5.0	528	8,712	217.6	2,904	$13.44	9.4	$21.08	$7.64
	2.5	1,056	1,7424	230.0	8,712	$40.31	12.5	$28.05	($12.26)

[1]Yield and irrigation data from:
Drip - Line Spacing and Plant Population for Corn, W. Spurgeon et al., SWREC, Garden City, KS, KSU Report of Progress 657

[2]Added cost is calculated as added driptape (ft/a) @ $.025/ft. + additional ends (8 ends/dripline/160 a) @ $1.55/end
($.75/connector & supply line + $.80 labor) ammortized over 10 years @ 9%.

[3]Added income is calulated as added bushels x $2.25/bu.

[4]Plots received hail in 1990.

corn and a driptape cost of $0.025/ft. In this case, the benefit of increased yields was greater than the increased costs associated with the narrower spacing. In addition, the marginal return of a 5.0-ft dripline spacing compared to a 7.5-ft was $7.64, indicating that the increased income from the 9.4 bu average increase in corn yield was greater than the $13.44 of additional driptape and connectors. The 2.5-ft dripline spacing had a negative marginal return of ($12.26/a) showing that, despite a 12.5 bu average increase in corn yields, doubling the number of driplines (5.0-ft to 2.5-ft spacing) was not profitable. The 5.0 ft dripline spacing was the economic optimal with corn prices between $1.50 and $3.25/bu. If prices were below $1.50, the 7.5-ft spacing was the most profitable, and with prices above $3.25, the 2.5-ft spacing was the most profitable.

A study examining the effect of dripline lengths on corn yields was conducted at the SWREC in 1990 and 1991. Longer driplines will decrease the initial investment because fewer submains, flushlines, and connectors will be needed. Dripline lengths of 330 ft (1/16 mile) and 660 ft (1/8 mile) were included in the study. The study also looked at pumping water downslope, upslope, or from both ends. No consistent differences were found in yields based on dripline length or water-flow entry point. Yields averaged 6.5 bu/a higher at the 330-ft dripline length (Table 2). However, the increase in yield was not sufficient to justify the added expense of additional submains, flushlines, and required connectors. Using marginal returns analysis, the optimal dripline length was found to be 660 ft based on a corn price of $2.25 and an added cost per acre of $26 for the dripline length of 330 ft. The price of corn would have to be greater than $4.00 before the 330-ft dripline length was more profitable than the 660-ft length. Although it is doubtful that dripline lengths could be as long as row lengths commonly used by furrow irrigators (1/4 and 1/2 mile runs), it might be economical to have dripline lengths longer than 660 ft (1/8 mile) with proper management and slope. The results from this study indicate the need for further research to determine economic optimal dripline lengths.

A study examining the water requirements for corn using drip irrigation was conducted at the SWREC in 1990 and 1991. Yields increased as irrigation amount increased up to 100% ET (Table 3). As irrigation amount increased above 100% ET, yields actually decreased. Based on actual yields and irrigation amounts, a yield response curve was estimated (Figure 1). Using marginal returns analysis, the optimal economic yield was achieved at 18.5 in. of irrigation water based on corn price of $2.25/bu and a pumping cost of $2.50/in. This irrigation amount represents approximately 93% of ET. Maximum

Table 2. Marginal returns to various dripline lengths in corn ($/a.)[1].

Year	Dripline Length (ft)	Number of Submains	Yield bu/a	Added Cost[2]	Added Bushels	Added Income[3]	Marginal Return
1990[4]	660	4	187.2				
	330	8	196.0	$26.00	8.8	$19.80	($6.20)
1991	660	4	218.2				
	330	8	222.5	$26.00	4.3	$9.56	($16.44)
90-91 Avg.	660	4	202.7				
	330	8	209.2	$26.00	6.5	$14.68	($11.32)

[1] Yield and irrigation data from:
Drip-Line Length Study, W. Spurgeon et al., SWREC, Garden City, KS, KSU Report of Progress 657

[2] Added cost is the added investment necessary to shorten dripline length ammortized over 10 years @ 9% (see Table 4).

[3] Added income is calculated as added bushels x $2.25/bu.

[4] Plots received hail in 1990.

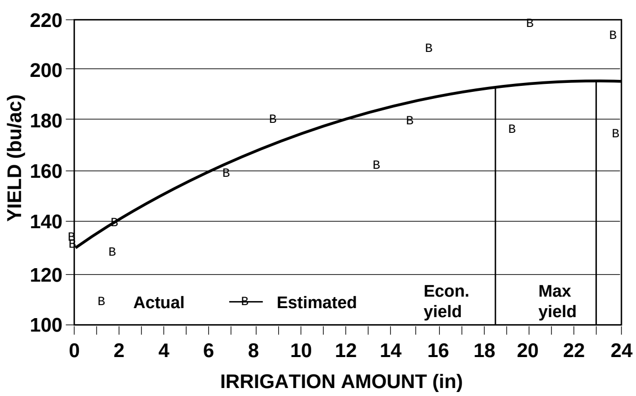
Year	Irrigation % of ET	Irrigation In.	Yield bu/a	Added Irr. (in.)	Added Bushels
1990[2]	0.00	0.0	134.3		
	0.25	1.8	140.3	1.8	6.0
	0.50	6.8	159.3	5.0	19.0
	0.75	13.4	162.5	6.6	3.2
	1.00	19.3	176.3	5.9	13.8
	1.25	23.8	174.3	4.5	-2.0
1991	0.00	0.0	131.8		
	0.25	1.8	129.0	1.8	-2.8
	0.50	8.8	180.5	7.0	51.5
	0.75	15.7	207.8	6.9	27.3
	1.00	20.1	217.8	4.4	10.0
	1.25	23.7	213.0	3.6	-4.8
90-91 Avg.	0.00	0.0	133.1		
	0.25	1.8	134.7	1.8	1.6
	0.50	7.8	169.9	6.0	35.3
	0.75	14.6	185.2	6.8	15.3
	1.00	19.7	197.1	5.2	11.9
	1.25	23.8	193.7	4.1	-3.4

Table 3. Water requirements in corn with drip irrigation[1].

[1] Yield and irrigation data from: Water Requirement for Corn with Drip Irrigation, T. Weis, et al., SWREC, Garden City, KS, KSU Report of Progress 657

[2] Plots received hail in 1990.

Figure 1. Yield vs. irrigation amount.



yield was achieved at almost 23 in. of irrigation water.

The economic feasibility of a drip irrigation system was compared with a low pressure center pivot system for corn using average investment and production figures. It is critical that every producer conduct his or her own individual analysis when considering system conversions, because yields and costs will vary significantly by producer and location. The first step was to identify the systems for comparison and determine their respective investment requirements. For this analysis, a 160-a field was used, and the investment requirements were based on this crop unit size. The investment for the drip system was based on irrigating the full 160 a at 18.5 in./a, with 5.0-ft dripline spacings and 660 ft dripline lengths (Table 4). The investment for the center pivot system was based on a “typical system” in the area irrigating 126 a (Table 5).

The irrigation system costs used were based on a dealer survey in 1992. Annual ownership costs were calculated by amortizing the system cost over its estimated useful life, 10 years for the drip system and 15 years for the center pivot system, at 9% interest. A subsurface drip system would have a low salvage value, where as a center pivot system may have a relatively high salvage value at the end of 15 years. However,

Table 4. Capital requirements: drip irrigation system (160 a).

Item	Feet	Price/ft	Subtotal	Single Items	Total	Your Farm Total
8" Mainline pipe	1,980	$1.25	$2,475		$2,475	_________
8" Submain pipe	2,640	$1.25	$3,300		$3,300	_________
6" Submain pipe	1,360	$0.65	$884		$884	_________
4" Submain pipe	1,280	$0.65	$832		$832	_________
4" Flushline pipe	10,560	$0.65	$6,864		$6,864	_________
Driptape	1,399,200	$0.025	$34,980		$34,980	_________
Driptape connectors (spyl tbg & slv lock)				$3,168	$3,168	_________
2- 8" PIP crosses”				$140	$140	_________
4- 8" PVC butterfly gate valves				$1,600	$1,600	_________
4- 8-6" PVC reducers				$60	$60	_________
4- 6-4" PVC reducers				$40	$40	_________
12- 4" PVC elbows				$84	$84	_________
12- 4" PVC removable endcaps				$66	$66	_________
PVC glue & solvent				$200	$200	_________
Filter- 900 Gpm, automated sand media				$8,525	$8,525	_________
26- Pressure gages (0 - 30 Psi)				$416	$416	_________
Trenching	15180	$0.60	$9,108		$9,108	_________
Producer labor (995.4 hrs @ $8/hr)				$7,963	$7,963	_________
Producer-provided tractors (62 hrs)				$512	$512	_________
Total					$81,217	_________
System costs per irrigated acre					$507.61	_________

** All charges based on producer installation.

Table 5. Capital requirements: center pivot irrigation system (126 a).

Item	Feet	Price/ft	Subtotal	Single Items	Total	Your Farm Total
Pivot system				$34,000	$34,000	_________
8″ Underground pipe	1,320	$2.30	$3,036		$3,036	_________
Electrical wiring	1,320	$2.00	$2,640		$2,640	_________
Connectors				$350	$350	_________
12 KVA generator				$2,200	$2,200	_________
Total					$42,226	_________
System costs per irrigated acre					$335.13	_________

** All charges on an installed basis.

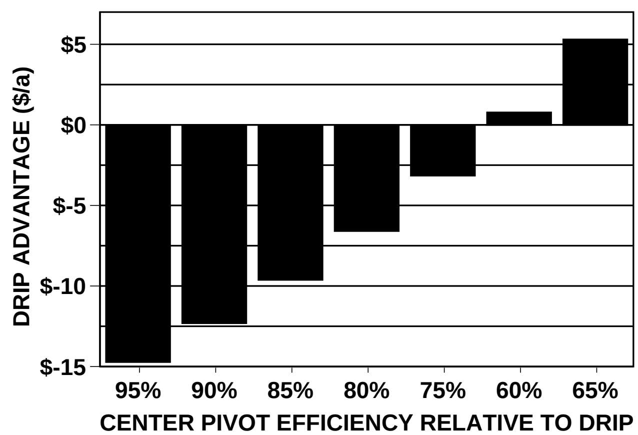
because of the uncertainties associated with depth to water, energy costs, and potential obsolescence at the end of the payback period, a zero salvage value was assumed for both systems in this analysis.

The second step in the irrigation system feasibility comparison was to decide upon three key production parameters; crop acreage breakdown, crop yields, and the amount of irrigation water applied. These figures are intertwined and vary by well size (gpm), irrigation system, field size, farm, and location. The drip system in this comparison was assumed to irrigate 160 a versus 126 for the center pivot system. The corners of the center pivot system, 34 a, were assumed to be in a wheat-fallow rotation with 17 a planted to wheat each year. Well size was assumed adequate to support either system at full capacity. Thus, irrigated corn yields were equal for both systems at 195 bu. The amount of irrigation necessary for optimal yields will vary by year, location, management, and system. For this analysis, 18.5 acre inches of irrigation were assumed for the subsurface drip system, which were the economic optimal irrigation level from the water use requirement study. It is generally assumed that center pivot systems are not as efficient as drip systems and, as a result, require higher levels of irrigation for equal yields. However, how much additional irrigation is difficult to ascertain. This analysis initially compared the feasibility of a drip system versus a center pivot system that had an application efficiency of 90% of the drip system. The analysis showed that over a 160-a field, the center pivot system had a $12.31/a return advantage over the subsurface drip irrigation system (Table 6). Although the drip system irrigated more acres and generated greater returns to management and investment, $27,032 versus $21,586, it could not overcome the greater annual ownership costs associated with the higher initial investment. Annual ownership costs were calculated as the cost of the system ($81,217 versus 42,226) amortized over the expected life (10 versus 15 years) at 9% interest.

If the system life were equal for both systems, 15 years, the drip system had a $3.81/a return advantage over the center pivot system. In the initial comparison, the investment difference was $38,991 ($81,217 - $42,226). The returns from the two systems would be equal if the investment value of the drip system were lowered to $68,575, holding all other variables constant.

The economic returns of the two systems also were compared with an application efficiency for the center pivot of 95% to 65% that of the drip system's 18.5 acre inches (Figure 2). The irrigation efficiency of the center pivot system relative to the drip system had little impact on the relative economic returns. The relative application efficiency of the center pivot would have to decrease to 70% of that of the drip system before the drip system would have an economic advantage, given the assumptions used.

Figure 2. Economic advantage of drip system.



Additional economic comparisons were made varying both annual crop prices and corn yields. These analyses were conducted to determine the potential income advantage the drip system had over the center pivot system because of more irrigated acres (160 vs 126), given the field size used. These comparisons found that overall returns per acre could be equated between the two systems with relatively small changes in annual corn yields or crop prices. For example, a 5.5 bu increase in drip system corn yields compared to those of the center pivot (200.5 vs 195) would equate annual per acre returns, holding all other variables constant. In addition, a $0.35 increase in both corn and wheat prices ($2.60 and $3.35) was enough to equate annual per acre returns between the drip and center pivot irrigation systems.

Table 6. Subsurface drip irrigation feasibility comparison.

Variable	Drip		Pivot
NET INVESTMENT	$81,217		$42,226
Interest rate on investment	9.0%		9.0%
Years for payback	10		15
IRRIGATION MANAGEMENT			
Annual repairs[1]	$500		$500
Pumping cost/inch of water[2]	$2.50		$2.71
Inches of water pumped/a[3]	18.50		20.60
Pumping energy cost/a	$46.30		$55.64
ACREAGE BREAKDOWN			
Irrigated corn acres	160		126
Dryland wheat acres			17
Dryland fallow acres			17
TOTAL ACRES	160		160
RETURNS ANALYSIS[4]			
Crop Income:			
Irrigated acres	$70,200		$55,283
Dryland acres	0		2,040
TOTAL INCOME	$70,200		$57,323
Crop Expenses:			
Irrigated acres	$41,752		$33,694
Dryland acres	0		767
Total property taxes[5]	$ 1,416		$ 1,276
TOTAL EXPENSES	$43,168		$35,737
Returns to Management and Total Investment	$27,032		$21,586
Annual Cost of Irrigation Equipment (P & I)[6]	$12,655		$ 5,239
Returns to Management, Land and Mach. Investment	$14,377		$16,347
DIFFERENCE		$1,970	
Returns to Mgmt, Land and Mach. Investment/a	$89.86		$102.17
DIFFERENCE/ACRE		$12.31	

[1] Because little is known concerning annual repair costs, they are assumed equal for this analysis.
[2] Based on 25 PSI for drip and 35 PSI for the center pivot system.
[3] Assuming the center pivot has an application efficiency of 90% of the drip system.
[4] Acres x income and expenses from Table 7.
[5] 1% of the value of land (irrigated = $885/a and dryland = $472/a).
[6] Annual payment based on the net investment value amortized over the number of years for payback at 9% interest.

Table 7. Per acre crop income and assorted expenses[1].

Variable	Irrigated Corn	Dryland Wheat
Crop yield	195	40
Crop price/bu	$2.25	$3.00
Crop sales/a	$438.75	$120.00
Seed	$32.00	$3.12
Herbicide	26.25	9.40
Insecticide	49.04	0.00
Fertilizer	33.45	3.60
Crop fuel and oil	8.05	5.55
Machinery repairs	21.50	11.90
Crop consulting	6.00	0.00
Total crop expenses/a[2]		$45.11
drip corn	$260.95	
pivot corn	$267.42	

[1] The listed crop expenses are from MF-585, Center-Pivot-Irrigated Corn, and MF-257, Summer Fallow Wheat in Western Kansas, Kansas State University.

[2] Total crop expenses include all expenses listed, plus irrigation pumping costs and repairs, labor, and interest on 1/2 of variable costs at 9%.

END-OF-SEASON COMPLETION DATES FOR CORN IRRIGATION

by
William Spurgeon, Marvin Cronin, and Dennis Tomsicek

SUMMARY

Irrigation for corn was completed on August 5, 10, 15, 20, 25, and 30, 1993. Yield increased with later irrigation completion dates. The earlier completion dates reduced yield slightly, but increased the irrigation water use efficiency.

INTRODUCTION

A study of end-of-season completion dates for corn irrigation was initiated in 1993. The intent was to examine the elimination of unnecessary late-season irrigations. Maintaining high soil water levels late in the season can increase irrigation cost as well as the potential for leaching of fertilizers and pesticides.

The objective of this study was to determine the effect of different completion dates on yield and water use of corn.

PROCEDURES

The study was conducted in 1993 on a silt loam soil with a field slope of 0 to 1%. Field preparation began with stalk shredding and disking in late March. The field was fertilized with 180 lbs of nitrogen (anhydrous ammonia) on April 26 followed by another disking on May 5. Full-season corn was planted in circular rows on May 7, and plant emergent on May 17.

Six completion-date treatments were used in the study: August 5, 10, 15, 20, 25, and 30. These dates occurred during the growth stage period from early milk to dent. All treatments were fully irrigated (1.0 times the base irrigation (BI) requirement) until the completion dates were reached, and irrigation was terminated. The treatments were replicated three times, with borders installed between the replications.

Access tubes were installed in the center of each plot to measure soil water with a neutron probe. Measurements were taken weekly to a depth of 5 ft to calculate changes during the season.

Forty ft of row were hand harvested from each plot. The samples were taken from the center of each plot. Yields were adjusted to 15.5% moisture and are reported in bu/a.

Table 1. Corn yield, irrigation, and total water use for end-of-season completion dates.

Completion Treatment Date	Yield bu/a	Irrigation in.	Soil Water Change in.	Total Water Use in.	TWUE bu/ a-in.	IWUE bu/ a-in.
August 5	154	7.5	4.1	23.0	6.7	20.5
August 10	164	8.3	3.4	23.1	7.1	19.9
August 15	166	9.0	2.9	23.3	7.1	18.4
August 20	177	10.5	2.8	24.7	7.2	16.9
August 25	172	12.0	2.2	25.7	6.7	14.3
August 30	185	12.0	1.9	25.3	7.3	15.4

RESULTS AND DISCUSSION

Figure 1 shows average yield by completion date treatment. Yield increased with the later completion dates because those treatments were not underwatered.

Yield and water use data are shown in Table 1. Rainfall for the season (May 28 to September 21) was 11.42 in. Irrigation amounts for the respective treatments ranged from 7.5 to 12.0 in. Total water use included rainfall, irrigation, and change in soil water from beginning to end of the season. The seasonal change is based on soil water measurements as shown in Figure 2.

Total water use efficiency (TWUE) is calculated by dividing yield by the total water use. Irrigation water use efficiency (IWUE) is calculated by dividing yield by the total irrigation water applied. TWUE was found to be slightly greater for the later completion dates. The more important factor from an irrigation standpoint is the irrigation water use efficiency. The IWUE was found to be highest for the August 5 completion date at 20.5 bu/a-in. as compared to 15.4 bu/a-in. for the August 30 completion date.

Additional data are needed for a range of climatic conditions to evaluate how completion date affects yield. Limited irrigation treatments always result in higher irrigation water use efficiency. However, as the availability of water decreases, these limited data will aid producers in making management decisions to minimize water use and maximize profit.

Figure 1. Yield for end-of-season completion dates.

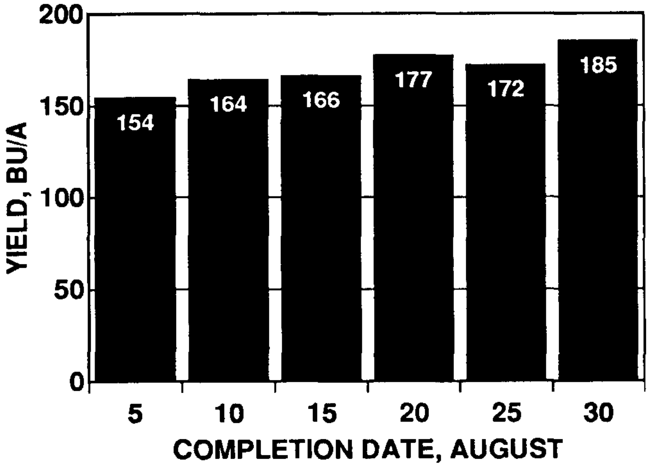
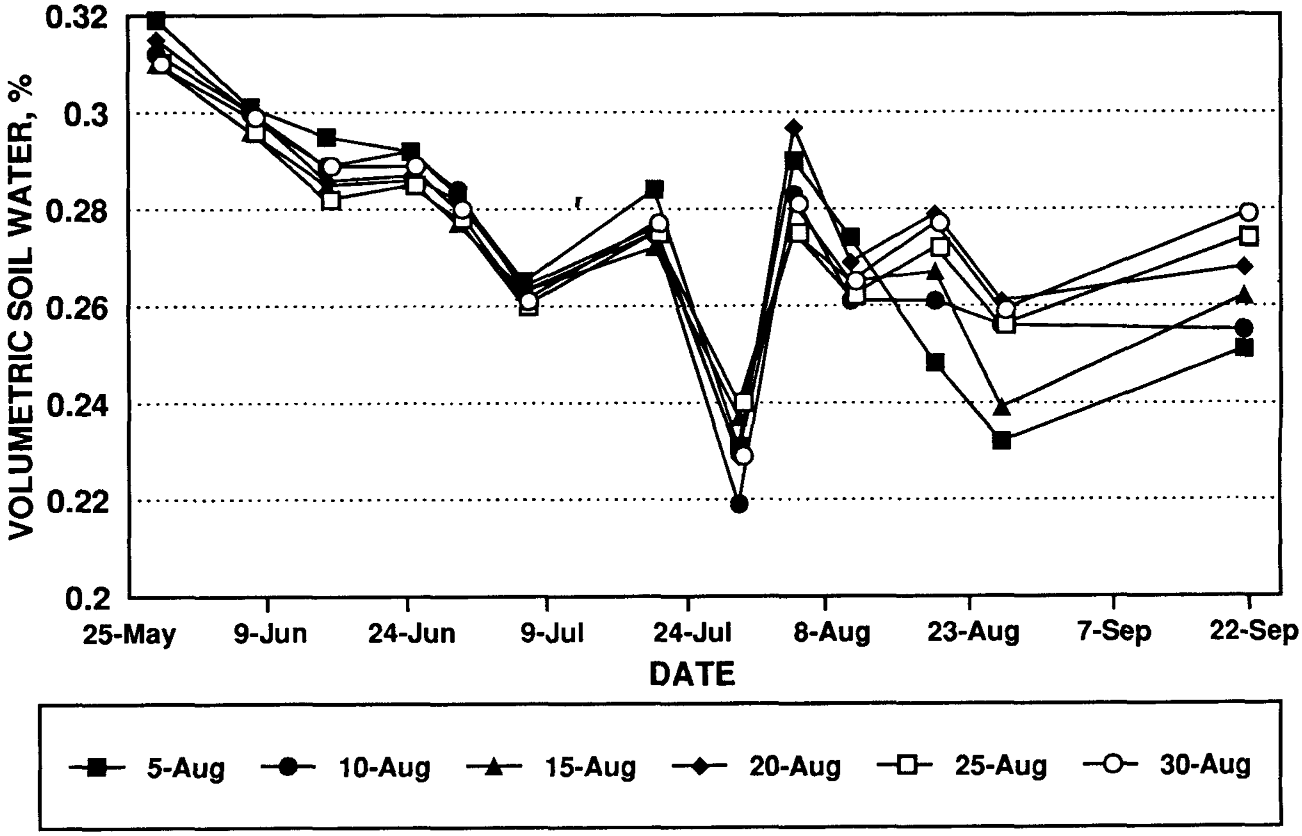


Figure 2. 1993 soil water content during the season for completion-date treatments.



HIGH-FREQUENCY, LOW PRESSURE IN-CANOPY SPRINKLER IRRIGATION

by
Marco Vela-Reyes[1], William Spurgeon, and Dennis Tomsicek

ABSTRACT

Data for 1 year, 1993, have been collected concerning degradation of reservoir tillage (Dammer-Diker), irrigation frequency, and performance of various in-canopy application modes. Field slope ranged from 0 to 6% (average = 2.6%) for a deep silt loam soil. Although the data are limited, implanted reservoirs had nearly no storage volume left in the nozzle row by August 9 for the concentrated application modes of bubble and double-ended sock. Nozzles spaced 5 and 10 ft and operated in the flat-spray mode helped to retain 35% of the initial storage volume of the reservoirs, in the nozzle row, by the end of August. Corn yield was generally smaller for the treatments where storage volume was reduced.

INTRODUCTION

LPIC (Low Pressure In-Canopy) irrigation is gaining popularity in the Central High Plains. This irrigation method reduces evaporation loss and energy cost. LPIC may increase application efficiency, but runoff can be a significant problem. When field slope begins to exceed 1-2%, even moderate irrigation amounts (0.75 to 1.0 in.) can cause runoff. Research is being conducted to evaluate the performance of LPIC for various application modes in conjunction with reservoir tillage on field slope greater than 1%.

The study was initiated to 1)determine the combination of application mode and irrigation frequency that maximizes corn yield for moderate field slopes and 2)evaluate the degradation of implanted reservoirs through the season.

PROCEDURES

Corn (Pioneer 3162) was planted on May 7 (emerged on May 17) in circular rows to allow nozzles to track down the center of 30-in. rows. The rows were aligned in the same direction as the field slope. Borders were installed between each block of treatments perpendicular to the corn rows (and thus field slope) to allow runoff water to exit the study area.

The study was conducted with field slopes ranging from 0 to 6%, and averaging 2.6%. Reservoir tillage (ripping and pitting from a dammer-diker) was installed on all plots on June 24 to help minimize runoff from both rainfall and irrigation.

Nozzles were approximately 2 ft above the ground surface. The four application mode treatments used were bubble, sock, flat-spray mode with nozzles spaced 5 ft, and flat-spray mode with nozzles spaced 10 ft. The bubble mode concentrates the water into a small area directly beneath the nozzle (approximately 1.7 ft in diameter). The sock mode also concentrates the water directly beneath the nozzle, with the difference that it delivers water directly to the ground surface by dragging a double-ended sock. The flat spray modes spread the water out over a greater area. Wetted diameters were approximately 20 and 28 ft for the 5- and 10-ft spacings, respectively. The diameter was influenced by the crop, whose interference caused a narrower pattern perpendicular to the rows.

Daily irrigation amounts were 0.27 in., and 3-day amounts were 0.80 in. These amounts were based on a simulated system capacity of 5 gpm/a. This capacity is less than the average peak water use rate of 6.6 gpm/a for the region.

The reduced capacity was used to limit daily application amounts. Yield loss could occur with this reduced capacity in high water use years.

Two irrigations were applied, 0.75 in. on June 16 and 0.50 in. on June 26, in the 5-ft flat-spray mode to all plots prior to initiating the various application mode treatments. The first irrigation was applied to keep depletion down until the application mode treatments could be applied. The second was applied after the reservoirs were installed to help consolidate the air spaces between clods and form more stable reservoirs. Application mode treatments began on July 3. A large amount, 0.75 in., was applied mistakenly to daily treatments during this first irrigation and may have reduced dike volumes more than the standard 0.27 in. amount.

The amount of water applied was based on calculated evapotranspiration (ET or estimated crop water use), which was accumulated daily in a water budget. Irrigation and rainfall were subtracted from the accumulated ET (if the daily balance was negative, it was reset to zero). Irrigation began as soon as the calculated depletion exceeded the appropriate irrigation amount. Soil water measurements were taken weekly at 1-ft increments to a depth of 5 ft for each plot.

Implanted reservoir volume was determined by placing plastic in the pits and measuring the amount of water needed to fill the pits. The volume of four pits in each of four rows was measured. Therefore, measurements from two nozzle rows (average of eight pits) and two nonnozzle rows, for the nozzles spaced 5 ft, were used to determine pit volume. Volume measurements were taken on July 2, July 20, August 9, and August 30.

Forty feet of row were hand harvested from each plot. The samples were taken from the center of each plot. Yields were adjusted to 15.5% moisture and are reported in bu/a.

RESULTS AND DISCUSSION

The cumulative percent reduction in reservoir volume through the irrigation season is shown in Table 1. Reservoir volume in the nozzle row, for sock and bubble modes, was reduced to nearly zero by early August regardless of irrigation frequency. This reduction was due to the combination of field slope (average 2.6%) and the high application rate that both application modes produce. The flat spray application modes

Table 1. Percent cumulative reservoir volume reduction for the 1993 season. NZ=nozzle row, NX=row next to the nozzle, FR=row halfway between 10 ft nozzles. The 10 ft average is a weighted average. The last column is the average cumulative reduction for both irrigation frequencies.

	Daily Irrigation				3 Day-Irrigation				
Treatment	NZ	NX	FR	Avg	NZ	NX	FR	Avg	Avg
Bubble									
July 2-20	**68**	23	--	46	**83**	36	--	60	53
July 2-Aug 9	**97**	44	--	71	**94**	56	--	75	73
July 2-Aug 30	**100**	60	--	80	**100**	67	--	84	82
Sock									
July 2-20	**72**	26	--	49	**75**	33	--	54	52
July 2-Aug 9	**94**	37	--	66	**94**	42	--	68	67
July 2-Aug 30	**95**	48	--	72	**97**	51	--	74	73
5-ft Flat									
July 2-20	**32**	16	--	24	**33**	38	--	36	30
July 2-Aug 9	**45**	36	--	41	**57**	55	--	56	49
July 2-Aug 30	**66**	52	--	59	**65**	67	--	66	63
10-ft Flat									
July 2-20	**23**	31	20	26	**45**	35	34	37	32
July 2-Aug 9	**52**	45	37	45	**57**	55	59	57	51

resulted in approximately 65% volume reduction in the nozzle row by the end of August.

Peak application rates for the double-ended sock were the highest and were difficult to estimate. Application rates were approximately 94 in./hr for the bubble mode (assumed wetted diameter of 20 in.) and 7.8 in./hr for the 5-ft flat-spray mode (assumed wetted diameter of 20 ft). Peak application rates drop to approximately 5.6 in./hr for the 10-ft flat-spray mode (assumed wetted diameter of 28 ft). All these intensities greatly exceed the long-term soil infiltration rate, which ranges from 0.3 to 0.5 in./hr.

Reservoir pits averaged 2 ft apart down the furrow. Average initial volume was 1.3 gal/pit. Pit volume averaged over the representative area, one row (2.5 ft) and distance between pits (2 ft), results in a storage depth of 0.42 in. This is the amount of water that could have been stored by the pits initially during rainfall or flat-spray events. The concentrated application modes of bubble or sock reduced the available storage by half. Only 0.21 in. could have been stored initially during an irrigation because half of the pits did not receive any irrigation water. Because soil infiltration rates are high initially, larger amounts than the calculated storage depths can be applied.

Irrigation and rainfall amounts during the various time periods and for the season are shown in Table 2. Irrigation was slightly greater, 0.82 in., for the daily irrigation as compared to the 3-day irrigation. Rainfall during the measurement period, July 2 to August 30, totaled 4.88 in. The seasonal cumulative percent reduction in volume of nonnozzle rows for the sock treatment is an indicator the rain's effect. Cumulative seasonal reduction averaged 50% over both frequency treatments.

Because these rows did not receive irrigation water, this is a baseline value of reservoir degradation caused by rainfall. Volume reduction in the row next to the nozzle was slightly higher for the bubble mode (64%), because alignment problems caused the bubble pattern to overlap occasionally into the adjacent row.

Table 3 shows corn yield and average field slope for the different treatments. Yield was generally greatest for the flat-spray treatments, as expected. The 3-day/bubble mode treatment combination tended to yield less than most treatments. This was due partly to reservoir volume degradation and subsequent runoff from plots. Daily irrigations with the bubble mode performed well because the applied water was either infiltrated or stored, so runoff was minimized.

Daily irrigations with socks quickly eroded a channel because of constant contact of the sock with wet soil. Double-ended socks are designed to work for large dikes (furrow dams). This treatment was included to evaluate the effectiveness of socks with the implanted reservoirs. Yield was lowest for daily irrigations with socks. Daily irrigations quickly eroded the small pits, forming a channel.

CONCLUSION

Daily irrigations with double-ended socks and implanted reservoirs performed poorly. A large, 0.75 in., initial irrigation to the daily plots may have caused increased degradation. The effect of field slope was difficult to evaluate with

Table 2. Rainfall and irrigation amounts, inches, for various periods of the 1993 season.

Time Period	Rain	Daily Irr.	3-Day Irr.	Daily Total	3-Day Total
May 17-June 23	2.89	0.75	0.75	3.64	3.64
June 24-July 1	1.68	0.50	0.50	2.18	2.18
July 2-July 19	2.18	4.34	3.90	6.52	6.08
July 20-August 8	1.00	4.59	4.00	5.59	5.00
August 9-August 29	1.70	4.59	4.80	6.29	6.50
August 30-September 29	3.10	0.00	0.00	3.10	3.10
Total for Season	12.55	14.77	13.95	27.32	26.50

the limited data. As expected, yield was generally greatest when field slope was small and either the 5-ft or 10-ft flat spray mode was used.

Implanted reservoir volume was reduced to nearly zero in the nozzle row by August 9 for sock and bubble mode treatments regardless of irrigation frequency. Reservoir volume in the nozzle row for flat spray modes was reduced 65% by the end of August. Reservoir volume was reduced 50% in nonnozzle rows of the sock treatment, indicating the degradation effect of the 4.88 in. of rainfall during July and August.

Table 3. Average corn yield and field slope for frequency and application mode treatments.

Application Mode Treatment	Daily Irrigation		3-Day Irrigation		Average	
	Yield bu/a	Slope %	Yield bu/a	Slope %	Yield bu/a	Slope %
Bubble	173	1.9	152	3.0	163	2.5
Sock	146	2.5	163	2.8	155	2.7
5-ft Flat	176	2.2	166	2.8	171	2.5
10-ft Flat	167	2.5	172	2.8	170	2.7
Average	166	2.3	163	2.9	165	2.6

[1] Marco Vela-Reyes, Graduate Student, Kansas State University, Manhattan.

SPACING FOR IN-CANOPY, LOW PRESSURE, SPRAY NOZZLES

by
William Spurgeon and Dennis Tomsicek

SUMMARY

Low pressure spray nozzles were placed 2 ft off the ground on 5-, 10-, and 15-ft spacings. Plots were on a low sloping (0 to 1%), deep, silt loam soil. Little difference occurred in corn yield for any spacing treatment. Yield was higher for samples taken from rows next to the nozzles in the 10- and 15-ft spacing treatments as compared to the rows between nozzles. The 15-ft spacing is not expected to work well in hot dry years. More information is needed to verify that the 10-ft spacing is adequate.

INTRODUCTION

Interest in low pressure spray devices has increased greatly in recent years. Greater management is necessary because of the increased potential for runoff. In some cases, the nozzles have been placed just above the ground surface. This introduces an additional problem of interception of the spray by the crop for nozzle spacings that do not provide every row with an equal opportunity for water (i.e., spacings greater than 5 ft-every other row for circular rows). The amount of water saved (approximately 6%) by moving the nozzles from the truss rod height to 2 ft off the ground may not justify the additional cost, especially if runoff (nonuniformity within the field) becomes a problem.

Most systems do not fit the definition of LEPA (Low Energy Precision Application). LEPA systems by design must use reservoir tillage to maximize capture of rainfall in and out of season. Reservoir tillage is used on all slopes to maximize uniformity of rain and irrigation water. LEPA systems also should keep every other row dry (i.e., use the bubble mode or double-ended socks) to minimize evaporation of water from the soil surface. Another requirement for LEPA is keeping all traffic out of the row receiving water to minimize compaction and maximize intake rates. Very little LEPA irrigation is being done in southwest Kansas. The efficiency of the water delivered to the soil can be improved, but it may take several years to pay for the additional hardware with water and energy savings.

The objective of this study was to determine the effect of spacing of in-canopy flat-spray nozzles on corn yield and soil water distribution.

PROCEDURES

Corn was planted in circular rows in a deep silt loam soil. The nozzles tracked well between corn rows. Soil slope was generally 0 to 1 percent. The field was furrow diked in 1991 and dammer-diked in 1993 to minimize runoff. Wet soil conditions prevented diking in 1992.

Treatments consisted of LEPA nozzles (6 psi) operated in the flat spray mode placed in every other row (5 ft spacing), Low Drift Nozzles (LDN) (10 psi) placed in every 4th row (10 ft spacing), and spinners (20 psi) placed in every 6th row (15 ft spacing). All nozzles were 2 to 3 ft from the ground surface.

Access tubes were installed near the center of each plot to measure soil water with a neutron probe. The tubes were installed in one row next to the nozzle (N) for each of the spacing treatments. Tubes also were installed in the row furthest from the nozzle (O) for the 10- and 15-ft treatments. A tube also was installed in the middle row (M) of the 15-ft treatment. Measurements were taken weekly to a depth of 5 ft to calculate soil water changes during the season.

Irrigation depth generally was kept at 0.75 to 1 in. to ensure that no runoff occurred. The treatments were replicated 10 times. Borders were installed between replications to prevent any runoff from going to adjacent replications.

Forty feet of row were hand harvested from each plot. The samples were taken from rows in each of the relative nozzle positions (N, M, and O). Yields were adjusted to 15.5% moisture and are reported in bu/a.

RESULTS AND DISCUSSION

Irrigation for all plots totaled 16.5, 7.75, and 12.0 in. for 1991, 1992, and 1993, respectively. Rainfall amounts for the season were 8.5, 13.8 and 11.0 in. for 1991 (June 5 to September 19) and 1992 (May 20 to September 25), and 1993 (June 10 to Sept. 22), respectively. Water use from rain and irrigation totaled 25.0, 21.7, and 23.0 in. for 1991, 1992, and 1993, respectively.

Yield from the study by row position relative to the nozzle position is shown in Table 1. Very little yield difference was seen in 1992 because of higher than normal rainfall and low irrigation amounts. Yield was higher in corn rows closest to the nozzles in the drier years. More information is needed in dry years to verify that the 10-ft spacing is performing adequately. No statistics were run on the data because of the small difference in yield.

Yield for the 5-ft spacing treatment tended to be low in all 3 years of the test. This was not expected and is difficult to explain. More water falls in the nozzle row for the wide spacing, which could increase yield for the rows next to the nozzle. However, past research indicates a slight yield increase for overwatering and a significant yield decrease for underwatering.

The average volumetric soil water content for the 5-ft profile is shown in Figures 1 and 2. Yield was lower for the samples taken furthest from the nozzles for the 10- and 15-ft nozzle spacings. The soil water content for these treatments was the lowest of the six sample locations. This implies interception of water by the growing plant.

An important concern is slope greater than 1% in fields. Steeper slopes will cause more runoff, especially for the 10- and 15-ft. nozzle spacings, because the spray gets intercepted by the growing crop.

Table 1. Corn yields for low pressure in-canopy spacing study (bu/a).

	Treatments							
Year	5N	10N	10O	10 Avg.	15N	15M	15O	15 Avg.
1991	205	218	205	212				
1992	183	196	194	195	196	197	192	195
1993	165	190	173	182	189	181	160	177
2-year average (92-93)								
	174	193	184	188	193	189	176	186

Figure 1. 1992 soil water content during the season for spacing treatments.

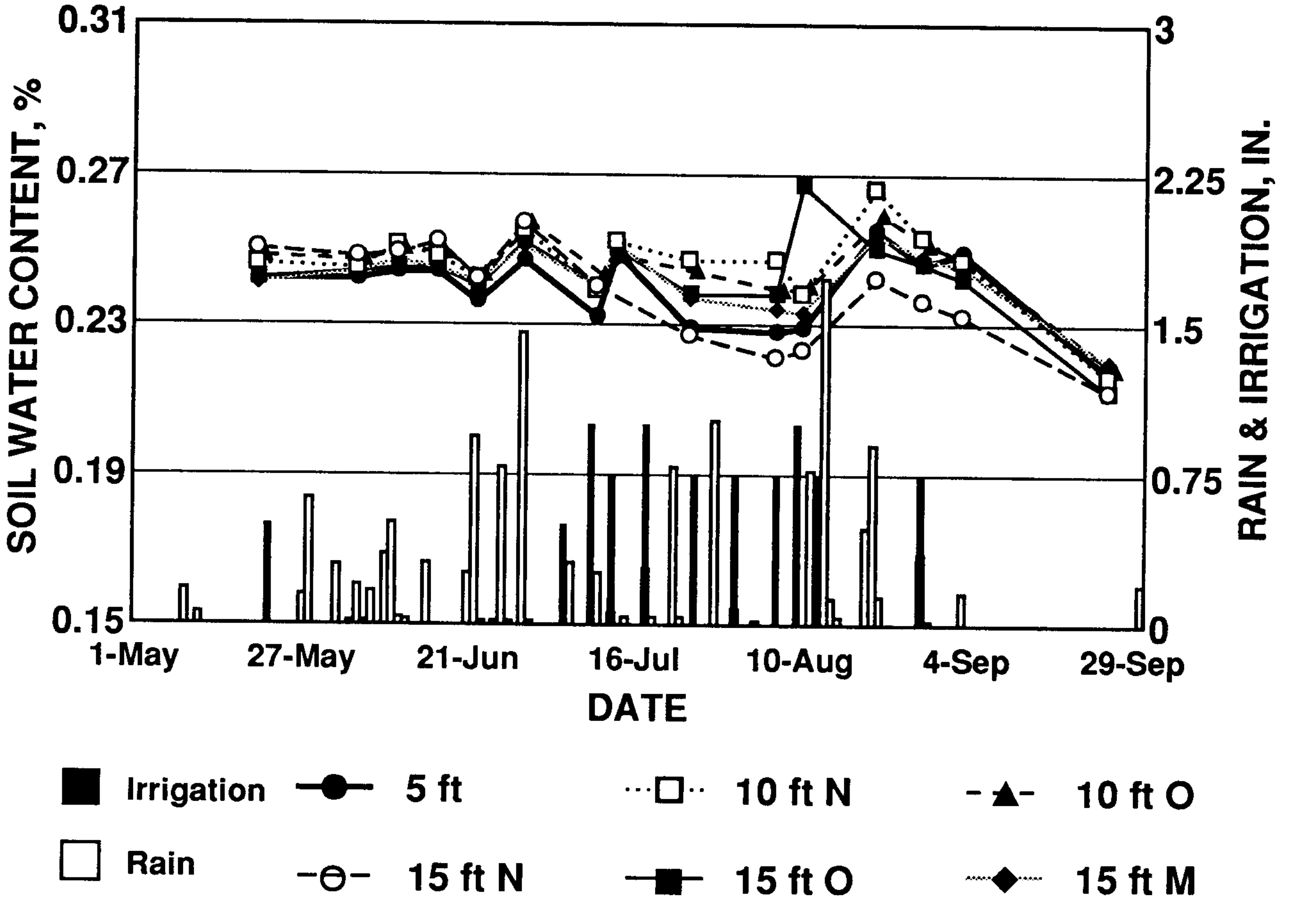
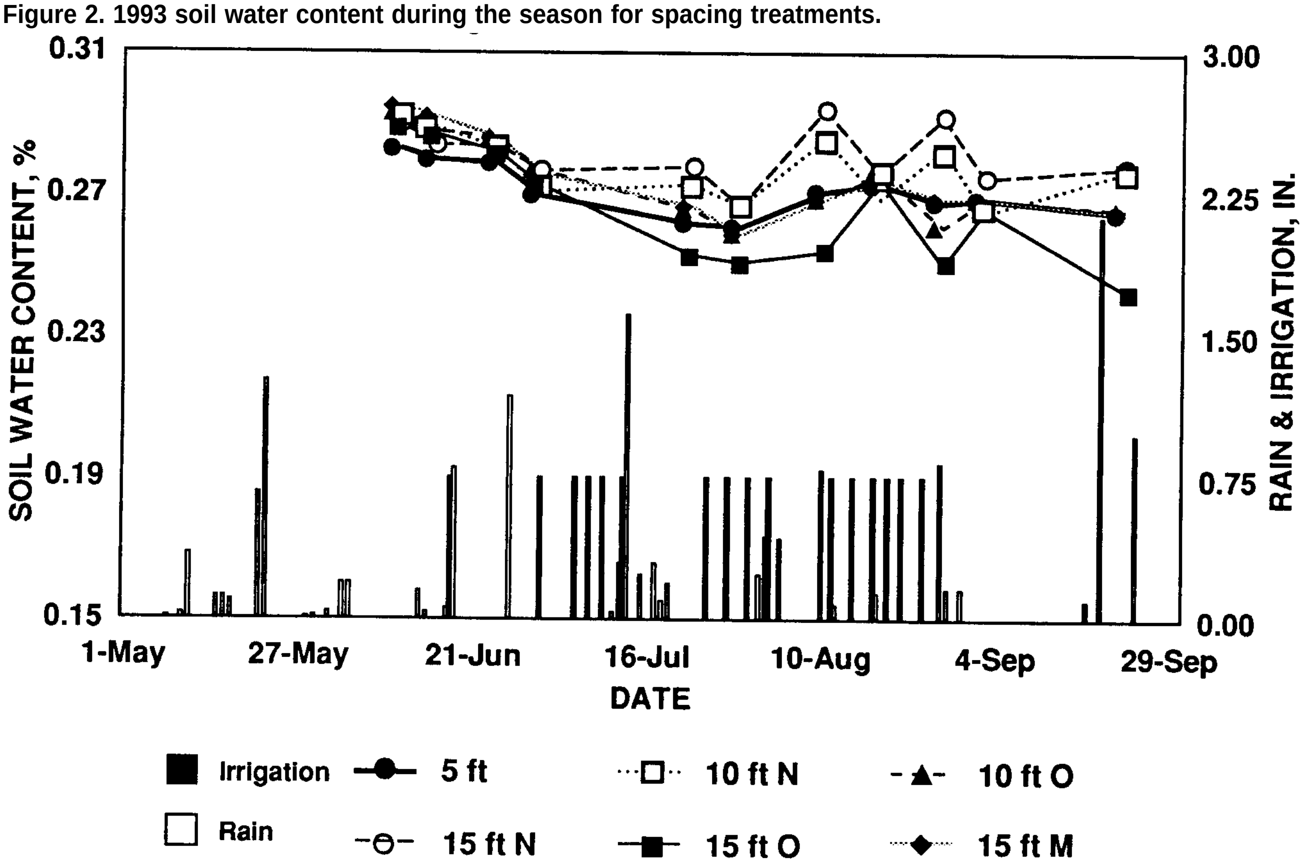


Figure 2. 1993 soil water content during the season for spacing treatments.



FUNGICIDES FOR LEAF RUST CONTROL IN DRYLAND WHEAT

by

Merle Witt and Robert Bowden[1]

Fungicide evaluations for wheat leaf rust control were conducted in western Kansas during 1992-93. Plots at Garden City were established to estimate disease losses and to evaluate commercial fungicides under dryland conditions. Plots received 50 lb/a of preplant nitrogen fertilizer each year. Seed was drilled at 40 lb/a into 5 ft X 40 ft plots in late September or early October.

Each year, the experiment was arranged as a randomized complete block factorial with six replications, two cultivars (TAM 107 and Thunderbird), and four fungicide treatments. Two standard commercial fungicides were compared to an untreated control and a "rust-free control" (two applications of Folicur). Foliar applications of Tilt and Folicur were applied each year in late April as flag leaves emerged (Feekes growth stage 8) and of Bayleton and Folicur in mid-May at anthesis (Feekes growth stage 10.5.1) using a back-pack sprayer with 35 gal/a water and flat fan nozzles at 30 psi. Treatments except Tilt were applied with 0.0625% (v/v) X-77 surfactant.

By using the nonsprayed control in comparison to the Folicur "rust-free control", the 2-year average, estimated losses of grain yield were 5.7 bu/a (13.2%) for the highly rust susceptible variety TAM 107 and 2.4 bu/a (5.5%) for the moderately rust susceptible variety Thunderbird. Tilt enhanced yield by an average of 3.9 bu/a and the tank mix of Bayleton-Dithane enhanced yield by an average of 2.5 bu/a. Test weight of TAM 107 showed an average loss of 1.2 lb/bu without rust control, and Thunderbird showed an average loss of 0.5 lb/bu.

Table 1. Grain yield responses of dryland winter wheat to fungicide applications.

	TAM 107			Thunderbird		
Treatment	1992	1993	2-yr Av	1992	1993	2-yr Av
Rusted check	26.7A*	47.7A	37.6	38.4A	42.6A	40.5
Tilt 3.6E, 4 fl. oz.	28.6A	57.6B	43.1	39.0A	46.6A	42.8
Bayleton 50DF, 2 oz. + Dithane 75DF, 2 lb.	30.0A	53.7B	41.9	37.8A	44.3A	41.1
Folicur 3.6F, 4 fl. oz.	30.2A	56.4B	43.3	39.0A	46.7A	42.9

Table 2. Test weight responses of dryland winter wheat to fungicide applications.

	TAM 107			Thunderbird		
	1992	1993	2 -yr Av	1992	1993	2-yr Av
Rusted check	55.4A*	58.0A	56.7	57.9A	60.7A	59.3
Tilt 3.6E, 4 fl. oz.	55.5A	59.3B	57.4	57.8A	61.2BC	59.5
Bayleton 50DF, 2 oz. + Dithane 75DF, 2 lb.	55.2A	58.4A	56.8	57.8A	61.1AB	59.5
Folicur 3.6F, 4 fl. oz.	55.5A	60.2C	57.9	57.9A	61.6C	59.8

*Column means with the same letter do not significantly differ at the 5% level.

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FUNGICIDES FOR LEAF RUST CONTROL IN IRRIGATED WHEAT

by
Merle Witt and Robert Bowden

Fungicide evaluations for wheat leaf rust control were conducted in western Kansas during 1991-93. Plots at Garden City were established to estimate disease losses and to evaluate commercial fungicides under flood-irrigated conditions. Plots received 100 lb/a of preplant nitrogen fertilizer each year and were preirrigated with approximately 8 in. of water in early September. Seed was drilled at 75 lb/a into 5 ft X 25 ft plots in late September or early October. Plots were flood-irrigated with 8 in. of water in April during 1991 and 1992. Spring watering in 1993 was deleted because of abundant rainfall.

Each year, the experiment was arranged as a randomized complete block factorial with six replications, two cultivars (TAM 107 and Thunderbird), and four fungicide treatments. Two standard commercial fungicides were compared to an untreated control and a "rust-free control" (two applications of Folicur). Foliar applications of Tilt and Folicur were made each year in late April as flag leaves emerged (Feekes growth stage 8) and of Bayleton and Folicur in mid-May at anthesis (Feekes growth stage 10.5.1) using a back-pack sprayer with 35 gal/a. water and flat fan nozzles at 30 psi. Treatments except Tilt were applied with 0.0625% (v/v) X-77 surfactant.

By using the nonsprayed control in comparison to the Folicur "rust-free control", the 3-year average, estimated loss of grain-yield were 15.5 bu/a (19.8%) for the highly rust susceptible variety TAM 107 and 6.2 bu/a (9.5%) for the moderately rust susceptible variety Thunderbird. Tilt enhanced yield by an average of 8.0 bu/a, and the tank mix of Bayleton-Dithane enhanced yield by an average of 8.6 bu/a. Test weight of TAM 107 showed an average loss of 2.1 lb/bu without rust control, and Thunderbird showed an average loss of 0.7 lb/bu.

Table 1. Grain yield responses of irrigated winter wheat to fungicide applications.

	TAM 107				Thunderbird			
	1991	1992	1993	3-yr Av	1991	1992	1993	3-yr Av
Rusted check	71.4A*	47.5A	69.6A	62.8	71.1A	53.0A	53.3A	59.1
Tilt 3.6E, 4 fl. oz.	85.2B	55.9B	76.4AB	72.5	71.1B	58.3A	60.5A	65.3
Bayleton 50DF, 2 oz. + Dithane 75DF, 2 lb.	85.0B	59.6B	74.4AB	73.0	77.7B	58.0A	62.3A	66.0
Folicur 3.6F, 4 fl. oz.	93.1B	61.2B	80.5B	78.3	76.5B	58.2A	61.2A	65.3

Table 2. Test weight responses of irrigated winter wheat to fungicide applications.

	TAM 107				Thunderbird			
	1991	1992	1993	3-yr Av	1991	1992	1993	3-yr Av
Rusted Check	58.6A*	53.3A	58.2A	56.7	61.2A	55.5A	59.1A	58.6
Tilt 3.6E, 4 fl. oz.	59.6B	53.8A	59.0A	57.5	61.2A	56.1A	59.6A	59.0
Bayleton 50DF, 2 oz. + Dithane 75DF, 2 lb.	60.2C	55.2B	59.0A	58.1	61.2A	56.4AB	59.7A	59.1
Folicur 3.6F, 4 fl. oz.	60.5C	56.5C	59.3A	58.8	60.8A	57.2AB	59.8A	59.3

* Column means with the same letter do not significantly differ at the 5% level.

EARLY CORN - DATES OF PLANTING

by
Merle Witt

The date of planting studies for corn in 1992 and 1993 was located in a leveled flood irrigated basin. The corn hybrid, Pioneer 3751 (98 days to black layer), was planted on three dates. Plots of each date of planting consisted of four 30-inch rows 40 feet long. Seeds were placed 7 1/2 inches apart (27,878 seeds/a) within rows. The center two rows were harvested for grain yields on each of four replications.

Nitrogen fertilizer was applied at the rate of 150 lbs/a. Irrigations were made as necessary to maintain adequate moisture for all planting dates. Ramrod-Atrazine preemergence herbicide was applied to all dates of planting within a day of planting. Buctril/Accent was later applied to each date for additional weed control as needed. Counter insecticide was applied at planting time for rootworm control.

Grain yields were adjusted to 15.5% moisture and calculated in bushels per acre. These and other plant growth responses are given in Table 1.

The greatest yield in both years was obtained with the 5/25 planting date.

Table 1. Short-season corn responses to three planting dates.

Date Planted	Plant Height		Ear Height		Grain Bu/A		Grain Lb/Bu	
	1992	1993	1992	1993	1992	1993	1992	1993
4-25	91	72	37	28	157	137	57.8	56.7
5-25	103	97	44	38	164	173	56.2	56.8
6-25	103	106	41	42	117	108	53.4	52.4
LSD (.0 5)					10	14		

CROP VARIETY TESTS HIGH YIELDERS 1994

by
Merle Witt and Alan Schlegel

Brief lists of "high" yielding varieties at Garden City over 2-3 years are presented as quick references to some top- performing crop choices. More complete information on these and other crops is published in Crop Performance Test Reports available at your county extension office. Results follow for: Alfalfa, Barley - Dryland, Barley - Irrigated, Corn-Full Season, Corn-Short Season, Oats, Sorghum - Dryland, Sorghum - Irrigated, Soybeans, Sunflowers, Wheat - Dryland, Wheat - Irrigated

CORN HYBRIDS

GARDEN CITY

High 10 (3-yr av 1991-1993)	Bu/A
Deltapine 4581	241
ICI 8272	238
ICI 8315	238
DeKalb DK715	237
Co-op 2315 WC	236
Ohlde 300	236

High 10 (2-yr av 1991-1992)	Bu/A	% Lodged
Coop 2315WC	252	0
Deltapine 4581	252	T
ICI (Garst) 8272	249	0
ICI (Garst) 8315	249	T
Ohlde 300	249	0
Northrup-King N8318	244	0
Asgrow RX899	240	0
Crows 682	240	1
DeKalb DK715	240	0
Oro 188	239	0
Pioneer 3162	239	0

TRIBUNE

High 10 (3-yr av)	Bu/A	% Lodged
Pioneer 3162	227	1
Deltapine G-4673B	226	6
Northrup-King N6330	222	3
Bo-Jac 612	219	2
Cargill 6227	215	2
Triumph 1265	214	1
Stine 1163	213	3
Oro 120	212	3
Casterline CX1237	211	2
Horizon 9110	211	2
Hyperformer HS 9773	211	10

High 10 (2-yr av)	Bu/A	% Lodged
Pioneer 3162	225	1
Deltapine 4581	224	3
Bo-Jac 629	223	2
Casterline CX 1237	221	2
Northrup-King N6330	220	3
Bo-Jac 615	219	3
Deltapine G-4673B	218	6
Triumph 1270	217	1
Deltapine 4450	216	2
L. Herried 8915	216	2

CORN—SHORT-SEASON HYBRIDS

GARDEN CITY

High 5 (2-yr av. 1992-1993)	Bu/A
NC+ 4275	231
NC+ 4616	218
Ohlde 104	204
Pioneer 3563	197
Golden Harvest H-2322	187
Casterline CX1185	187

GRAIN SORGHUM—IRRIGATED

GARDEN CITY

High 5 (3-yr av. 1990-1991,1993)	Bu/A
Mycogen GSC1313	137
Casterline SR 324E	135
Dekalb DK-56	132
Hyperformer HSC Cherokee	131
DeKalb DK-56	128

High 5 (2-yr av. 1991, 1993)	Bu/A
Casterline SR 324E	153
Mycogen GSC 1313	153
Casterline SR 319E	151
Agripro ST 686	150
ICI 5503	149

TRIBUNE

High 5	3-yr av	Days to Bloom
TX3042 TX2737	136	76
Dekalb DK-48	133	82
Casterline SR319E	128	88
Mycogen T-E Y-75	125	89
RS 610	112	76

High 5	2-yr av	Days to Bloom
TX3042 X TX2737	126	76
Pioneer 8505	125	78
DeKalb DK-48	119	82
Deltapine 1506	119	82
Mycogen T-E Y-75	108	89

GRAIN SORGHUM—DRYLAND

GARDEN CITY

High 5 (3-yr av 1991-1993)	Bu/A
Casterline SR-319E	51
Deltapine 1506	50
Northrup-King KS-714Y	50
DekalbDK-41Y	48
Hyperformer HSC Cherokee	48
Northup-King KS 383Y	48

High 5	2-yr av
Northrup King KS-560Y	51
Pioneer 8505	51
Northrup King KS-714Y	48
Casterline SR 319E	46
Asgrow Seneca	46
Cargill 607E	46
Pioneer 8771	46

TRIBUNE

High 5	3yr av	Days to Bloom
Cargill 607 E	80	69
TX3042 X TX2737	77	68
Pioneer 8699	74	66
DeKalb DK-40Y	70	72
Asgrow Seneca	65	78

High 5	2yr av	Days to Bloom
Cargill 607E	94	69
Pioneer 8699	94	66
Deltapine 1482	89	71
ICI 5616	89	72
ICI 5712	89	69

OATS—IRRIGATED

GARDEN CITY

High 5 (3-yr av 1991-1993)	Bu/A	High 5 (2-yr av 1992-1993)	Bu/A
Don	95	Armor	98
Bates	89	Don	97
Premier	89	Premier	94
Dane	86	Bates	89
Hazel	82	Ogle	86

SOYBEANS—IRRIGATED

GARDEN CITY

High 5 (3-yr av 1991-1993)	Bu/A	Maturity Group
Deltapine DP 3456	56.1	IV
DeKalb CX 458	54.6	IV
Pioneer 9341	54.1	III
Flyer	52.4	IV
Ohlde 3750A	52.2	III

ALFALFA

GARDEN CITY

High 5 (3-yr av 1991-1993)	Tons/A
Drussel Reward	11.3
ICI 645	11.3
Dairyland Magnum III	11.2
W-L Research	11.1
MBS 4112	11.0

SUNFLOWERS

GARDEN CITY

High 5 (3-yr av 1989, 1991-1992)	Lbs/A	% Oil	High 5 (2-yr av 1991-1992)	Lbs/A	% Oil
Triumph 565	2462	47.1	Triumph 565	3014	18.0
Triumph 560A	2041	47.9	Kaystar 9101	2852	38.5
ICI Seeds Hysun 33	1730	42.7	Kaystar 8807	2761	46.0
ICI Seeds Hysun 354	1529	45.2	Triumph Seed 560A	2575	49.4
Triumph Seed 548A	1527	46.1	Interstate IS3311	2254	46.4

WHEAT—DRYLAND

GARDEN CITY

High 5 (3-yr av 1991-1993)	Bu/A	High 5 (2-yr av 1992-1993)	Bu/A
Quantum 562	41	AGSECO 7846	49
Arapahoe	41	IKE	48
Agripro Tomahawk	40	Arlin (white)	48
AGSECO 7805	40	Yuma	46
AGSECO 7846	40	Quantum 562	46

TRIBUNE

High 5 (3-yr av 1991-93)	Bu/A	High 5 (2-yr av)	Bu/A
AGSECO 7805	47	TAM 200	50
TAM 200	46	AGSECO 7805	48
Quantum 562	45	Quantum 562	48
Karl	44	Karl	48
Newton	44	AgriPro Tomahawk	47
TAM 107	44	Cimarron	47
		Rawhide	47
		TAM 107	47

WHEAT—IRRIGATED

GARDEN CITY

High 5 (3-yr av 1991-1993)	Bu/A	High 5 (2-yr av 1992-1993)	Bu/A
Cimarron	72	IKE	79
2163	72	Cimarron	74
Agripro Sierra	71	2163	72
Agripro Tomahawk	70	Karl	72
Karl	69	Agripro Laredo	71
AGSECO 7853	69		

TRIBUNE

High 5 (3-yr av)	Bu/A	High 5 (2-yr av)	Bu/A
TAM 200	88	Agripro Laredo	93
Cimarron	83	IKE	91
AgriPro Tomahawk	81	TAM 200	91
AGSECO 7846	79	Cimarron	89
2163	79	AGSECO 7833	86
		AGESCO 7846	86

WINTER BARLEY—IRRIGATED

GARDEN CITY

High 3 (3-yr av 1990-1992)	Bu/A	High 3 (2-yr av 1991-1992)	Bu/A
Perkins	70	Perkins	84
Post	70	Hitchcock	82
Hitchcock	65	Weskan	76

WINTER BARLEY—DRYLAND

GARDEN CITY

High 3 (3-yr av 1990-1992)	Bu/A	High 3 (2-yr av 1991-1992)	Bu/A
Post	46	Perkins	55
Hitchcock	45	Post	52
Kanby	44	Kanby	51

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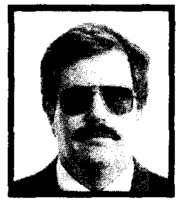

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