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Southwest Research–Extension Center

Report of Progress
877

Kansas State University
Agricultural Experiment Station
and Cooperative Extension Service

Pat Coyne—Center Head. B.S. degree, Kansas State University, 1966; Ph.D. degree, Utah State University, 1969. He joined the KSU faculty in 1985 as Head of the Agricultural Research Center—Hays. He was appointed head of the three western Kansas ag research centers at Hays, Garden City, and Colby in 1994. Research interests have focused on plant physiological ecology and plant response to environmental stress.

Paul Hartman—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.

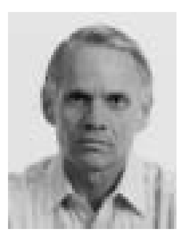
Mahbub Alam—Extension Specialist, Irrigation and Water Management. Mahbub received his M.S. from the American University of Beirut, Lebanon, and a Ph.D. from Colorado State University. He joined the staff in 1996. Mahbub previously worked for Colorado State University as an Extension Irrigation Specialist. His extension responsibilities are in the area of irrigation and water management.

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.

Troy Dumler—Extension Agricultural Economist. Troy received his B.S. and M.S. from Kansas State University. He joined the staff in 1998. His extension program primarily focuses on crop production and machinery economics.

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.



Charles Norwood—Agronomist–Dryland Soil Management. Charles has M.S. and Ph.D. degrees from Oklahoma State University. He joined the staff in 1972. Charles' primary research responsibilities include dryland soil and crop management, with emphasis on reduced and no-tillage cropping systems.

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2001 RESEARCH-EXTENSION CENTER STAFF

Patrick Coyne	Head
Paul Hartman	Area Extension Director
Mahbub Ul Alam	Extension Specialist-Irrigation
Larry Buschman	Corn Entomologist
Randall Currie	Weed Scientist
Les DePew	Professor Emeritus
Troy Dumler	Extension Agricultural Economist
Jeff Elliott	Research Farm Manager
Andy Erhart	Professor Emeritus
Gerald Greene	Professor Emeritus
George Herron	Professor Emeritus
Ray Mann	Professor Emeritus
Charles Norwood	Agronomist-Dryland Soil Management
Alan Schlegel	Agronomist-in-Charge, Tribune
Phil Sloderbeck	Extension Specialist, Entomology
Curtis Thompson	Extension Specialist, Crops and Soils
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Dennis Tomsicek, Agricultural Technician
John Wooden, Plant Science Technician II
Jennifer Wright, Agricultural Technician

Southwest Research-Extension Center
4500 East Mary, Bldg. 947
Garden City, KS 67846
620-276-8286
Fax No. 316-276-6028

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WEATHER INFORMATION FOR GARDEN CITY

by

Jeff Elliott

Total precipitation for 2000 was 17.71 inches. This is slightly below the 30-year average of 18.79 inches. Averages of the last 30 years are re-calculated every 10 years at the beginning of each new decade. The 1990s were wetter than normal and the new 30-year average annual precipitation is nearly one inch greater that the previous 30-year average, 18.79 vs. 17.91 inches for 1961-1990. Annual precipitation in 2000 was below average for the first time since 1990.

March and July were the wettest months, recording 3.96 and 3.75 inches respectively. September was the driest, with only 0.09 inches of precipitation. Snowfall totaled 13.78 inches, nearly 5 inches below normal. Measurable snowfall was recorded in January, March, and December. No precipitation records were broken in 2000, although March was the wettest that month has been since 1973.

August was the warmest month with an average mean temperature of 79.9° and an average high temperature of 96.4°. December was the coldest, with a mean temperature of 27.8° and a mean low temperature of 14.3°. Only the last two months of 2000 were cooler than the mean.

No temperature readings in 2000 fell below zero. Temperatures of 100° or higher were recorded on 23 days, with the highest being 105° on September 7. August 25 through 29 produced five consecutive days with maximum temperatures above 100°. Eight high temperature records were set or tied in 2000. Three record lows were set or equaled, occurring on consecutive days starting October 8.

The last spring freeze (31°) occurred on April 21, five days earlier than normal. The first fall freeze (28°) occurred on September 25. This was 16 days earlier than average. The frost-free period was 157 days, which was 10 days less than average.

Open pan evaporation from April 1 through October 31 totaled 80.21 inches. This is considerably above the average of 70.60 inchesfor the last 30 years. The mean wind speed was 5.1 mph, with 5.3 mph being the 30-year average.

Weather data for 2000 are summarized below.

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

	Precipitation inches		Temperature (°F) 2000 Average		Mean		2000 Extreme		Wind MPH		Evaporation inches	
Month	2000	Avg.	Max.	Min.	2000	Avg.	Max.	Min.	2000	Avg.	2000	Avg.
January	0.66	0.43	48.6	18.5	33.6	28.4	65	3	3.8	4.7		
February	0.25	0.48	57.4	24.6	41.0	33.7	78	10	4.7	5.4		
March	3.96	1.38	56.7	31.9	44.3	42.3	76	22	4.9	6.7		
April	1.88	1.65	69.2	35.0	52.1	52.1	93	23	6.0	6.7	10.28	8.35
May	2.50	3.39	80.4	49.5	64.9	62.0	101	34	5.2	6.0	11.22	9.93
June	0.65	2.88	86.8	58.7	72.7	72.4	98	45	6.6	5.6	12.87	12.32
July	3.75	2.59	93.1	65.1	79.1	77.4	104	57	4.7	4.9	13.70	13.41
August	0.96	2.56	96.4	64.3	79.9	75.5	103	57	4.2	4.2	13.31	11.19
September	0.09	1.25	88.8	52.2	70.5	67.0	105	28	5.4	4.6	12.66	8.88
October	1.92	0.91	71.4	44.2	57.8	54.9	97	22	5.1	4.8	6.17	6.52
November	0.89	0.86	49.7	23.3	36.5	40.5	71	15	5.4	4.9		
December	0.20	0.41	41.3	14.3	27.8	31.3	64	3	5.7	4.5		
Annual	**17.71**	**18.79**	**70.0**	**40.1**	**55.0**	**53.1**	**105**	**3**	**5.1**	**5.3**	**80.21**	**70.60**

Average latest freeze in spring	April 26	2000:	April 21
Average earliest freeze in fall	Oct. 11	2000:	Sept. 25
Average frost-free period	167 days	2000:	157 days

All averages are for the period 1971-2000.

WEATHER INFORMATION FOR TRIBUNE

by

Dewayne Bond[1] and Dale Nolan

Precipitation totaled 14.75 inches, which was 1.21 inches below normal, Therre were 7 months in which below-normal precipitation was recorded. October was the wettest month, withmore than 5 times the normal for that month. The largest single precipitation event was 2.59 inches on October 29. February was the driest month, with 0.05 inch precipitation. Snowfall for the year totaled 15.0 inches; 3.8 in January, 7.0 in March, 2.0 in November and 2.2 inches in December, for a total of 11 days with snow cover. The longest consecutive period of snow cover, 3 days, occurred from January 3 to January 5 and again from November 12 to November 14.

Record high temperatures were set January 18, February 3 and 22, May 30, and September 7. Record low temperatures were set October 8, 9, and 10. The hottest day of the year was July 6, 105°, and the coldest days were January 4 and 5 and December 12, -1°. December was the coldest month,with a mean temperature of 28.1°, and mean low of 13.9°. August was the warmest month, with a mean temperature of 78.8° and mean high temperature of 95.7°. For 7 months, air temperature was above normal. February, 6.3° above normal, and November, 6.3° below normal, had the greatest departures. There were 18 days of 100° or above (8 days above normal) and 86 days of 90° or above days (25 days above normal). The last freeze in the spring was May 13 (10 days later than normal) and the first freeze in the fall was September 25 (8 days earlier than normal). The frost-free period was 135 days, 18 days less than normal.

April through September open pan evaporation totaled 79.61 inches, 7.93 inches above normal. Wind speed for the same period averaged 5.5 mph, 0.2 mph less than normal.

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

	Precipitation inches		Temperature (°F) 2000 Average		Normal		2000 Extreme		Wind MPH		Evaporation inches	
Month	2000	Normal	Max.	Min.	Max.	Min.	Max.	Min.	2000	Avg.	2000	Avg.
January	0.34	0.36	48.5	17.2	43.3	14.2	69	-1				
February	0.04	0.40	58.1	21.8	48.7	18.7	78	10				
March	2.68	0.99	55.3	28.6	56.6	25.4	75	18				
April	1.30	1.13	69.6	32.5	67.5	35.1	89	18	6.0	6.6	9.36	8.82
May	0.25	2.69	79.9	46.5	76.0	45.3	103	28	5.3	6.0	13.07	10.95
June	0.64	2.71	86.9	53.9	86.9	55.3	101	41	6.6	5.7	15.19	13.71
July	3.08	2.60	94.6	61.5	92.7	61.3	105	54	5.3	5.5	15.76	15.64
August	1.24	1.98	95.7	61.8	89.9	59.2	103	55	4.7	5.2	14.40	13.01
September	0.43	1.54	85.8	48.4	81.3	49.9	104	27	5.1	5.4	11.83	9.55
October	4.00	0.74	70.1	37.3	70.4	37.3	93	17				
November	0.58	0.49	46.5	20.9	54.7	25.3	67	9				
December	0.17	0.33	42.3	13.9	44.9	16.6	64	-1				
Annual	**14.75**	**15.96**	**69.4**	**37.0**	**67.7**	**37.0**	**105**	**-1**	**5.5**	**5.7**	**79.61**	**71.68**
Average latest freeze in spring[1]					May 3		2000:	May 13				
Average earliest freeze in fall					October 3		2000:	September 25				
Average frost-free period					153 days		2000:	135 days				

[1]Latest and earliest freezes recorded at 32° F. Average precipitation and temperature are 30-year averages (1961-1990) calculated from National Weather Service. Average temperature, latest freeze, earliest freeze, wind, and evaporation are for the same period calculated from station data.

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

EFFECTS OF HYBRID MATURITY AND PLANT POPULATION ON LIMITED-IRRIGATED CORN

by
Charles Norwood and Troy Dumler

SUMMARY

Irrigated and dryland corn were compared in the wheat-corn-fallow rotation to determine if there was an advantage for early corn over full-season corn, both grown with very limited irrigation. Rainfall was above average during most of the growing season in 1998 and 1999, thus, full-season corn yielded more. Rainfall was below average in 2000 and short-season corn yielded more. When averaged across the three years, limited-irrigated corn produced sufficient yield to prevent a return to dryland. However, under the climatic conditions of this study, farmers growing limited flood-irrigated corn probably cannot afford to irrigate more than once, unless the corn price exceeds $2.50/bu and pumping costs are less than $5.00/inch.

INTRODUCTION

Fully irrigated corn in western Kansas usually consists of full-season hybrids grown at populations of 30,000 to 35,000 plants/acre. Research has shown there is no advantage to short-season corn in terms of yield, average water use rates, and water use efficiencies. Full irrigation of corn has been proven more profitable than limited irrigation. However, some farmers are converting irrigated acres to dryland because of declining groundwater supplies. Very limited irrigation, meaning once or twice per season, may enable these farmers to conserve the remaining groundwater while still producing adequate yields. The objective of this study was to determine whether very limited irrigation is a viable alternative to returning acres to dryland.

PROCEDURES

Two corn hybrids with maturities of 104 and 116 days, respectively, were planted May 13, 1998, April 21, 1999, and May 8, 2000 at two plant populations. Target populations were 18,000 and 30,000 plants/acre, actual populations were about 18,000 and 28,000 plants/acre. Corn was planted in the stubble remaining from the previous wheat crops, following about 11 months of fallow. Irrigation treatments were applied at the tassel stage when irrigated once, and at the 8 leaf and tassel stages when irrigated twice. Each irrigation consisted of 6 inches of water applied through gated pipe. A dryland treatment was included. Plots were bordered to prevent runoff. Economic analysis was done using custom rates for tillage, planting, and harvest operations. Comparisons were made between pumping costs of $3.00, $5.00, and $7.00 per inch, and corn prices of $2.00, $2.50, and $3.00 per bushel.

RESULTS AND DISCUSSION

Yield -Table 1: One irrigation increased yield when compared to no irrigation. However, depending on rainfall, two irrigations did not significantly increase yield over that of one. Except for the 116-day hybrid in 2000, yields of both hybrids generally increased with population at each irrigation level in both years. This indicates that populations of limited-irrigated corn do not need to be reduced below 28,000 to 30,000 plants/acre. In 1998 and 1999, the 116-day hybrid yielded more than the earlier hybrid at both population levels when irrigated once or twice, although there were no significant differences in yield between the two hybrids with one irrigation at either population in 1999. When not irrigated, increased population increased the yield of the 104-day hybrid, but decreased the yield of the 116-day hybrid.

Growing-season rainfall was lower and distribution poorer in 2000 than in 1998 and 1999. At the low population, irrigated yields of the two hybrids were similar. At the high population, yields of the 104-day hybrid were 12 and 24 bu/acre greater

Table 1. Yield of limited irrigated corn as affected by number of irrigations, hybrid maturity, and plant population, Garden City, KS, 1998-2000.[1]

		1998			1999			2000		
		No. of irrigations[2]			No. of irrigations			No. of irrigations		
Hybrid	Population	0	1	2	0	1	2	0	1	2
	plants/a					bu/a				
NK4640Bt (104)[3]	18000[4]	119	133	136	91	113	103	82	122	140
NK4640Bt	28000	134	156	171	105	130	130	81	135	161
NK7333Bt (116)	18000	138	167	168	82	126	139	73	127	137
NK7333Bt	28000	129	174	193	72	148	159	57	123	137

[1]Date of planting: May 13, 1998, April 21, 1999, and May 8, 2000.

[2]Each flood irrigation consisted of 6 inches of water. When irrigated once irrigation was at the tassel stage. When irrigated twice irrigations were at the 8 leaf and tassel stages.

[3]Bracketed numbers indicate days to maturity.

[4]Average plant population for the 3-year period.

		1998	1999	2000
LSD (0.10)	Hybrid at same irrigation and population	13	20	17
	Irrigation at same hybrid and population	12	17	18
	Population at same hybrid and irrigation	9	10	11

than the 116-day with one and two irrigations, respectively. The 104-day hybrid also yielded more than the 116-day hybrid when not irrigated. Yield of the irrigated 104-day hybrid was increased by population, while population had no effect on the irrigated 116-day hybrid. The lack of response means that there was not enough water for the 116-day hybrid to attain its yield potential at the high population. Population had no effect on the yield of the non-irrigated 104-day hybrid, but the high population reduced the yield of the 116-day hybrid.

Corn was stressed prior to tassel in all years due to lack of rainfall. Stress was most severe in 2000. The combination of irrigation and rainfall during the remainder of the growing season resulted in excellent yields of the 116-day hybrid in 1998 and 1999 and from the 104-day hybrid in 2000, considering a maximum of only 12 inches of irrigation water was applied. There was an advantage to planting an early hybrid in only one of the three years.

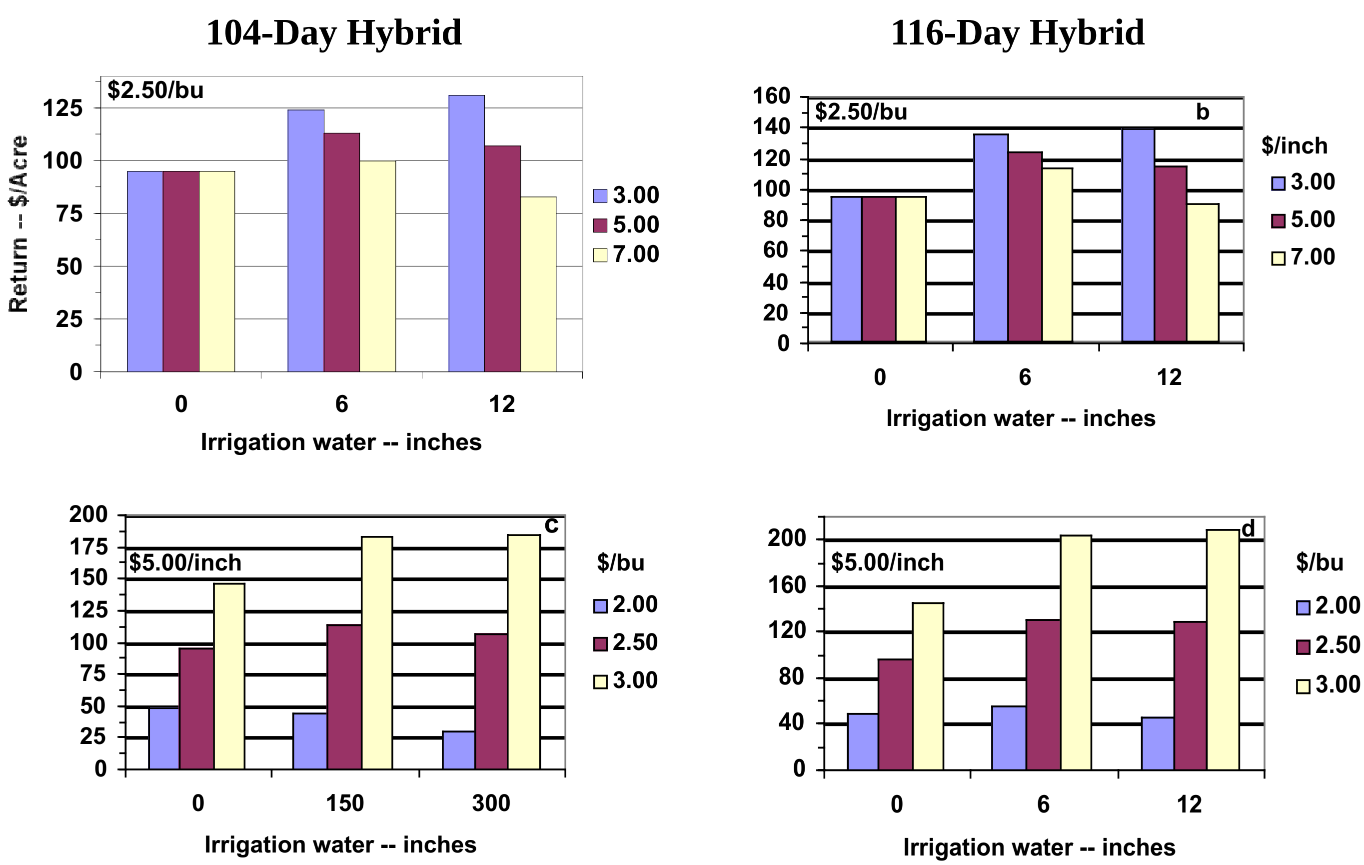
Economics - Figure 1: A simplified economic analysis using the 3-yr average is illustrated in Fig. 1. The top part of Fig. 1 consists of returns of the two hybrids at a corn price of $2.50 and pumping costs of $3.00, $5.00, and $7.00 per inch of irrigation water. The lower part of Fig. 1 consists of returns at a pumping cost of $5.00 and corn prices of $2.00, $2.50, and $3.00 per bushel. Data from the 104-day hybrid at a corn price of $2.50/bu (Fig. 1a) indicate that returns for both irrigation levels were greater than dryland at $3.00/inch pumping cost, but did not differ from each other. At $5.00/inch, return from 6 inches was greater than dryland, but return with 12 inches was the same as dryland. At the $7.00/inch pumping cost, return from 6 inches was the same as dryland and return from 12 inches was $24/acre less than dryland. Returns from the 116- day hybrid at a corn price of $2.50 (Fig. 1b) followed the same pattern as the 104-day hybrid ,except irrigated returns were $10 to $20/acre higher. With the 116-day hybrid and the $7.00/inch pumping cost, return from 6 inches of water was $17/acre greater than dryland but 12 inches returned $5/acre less than dryland.

For the 116-day hybrid at a pumping cost of $5.00 (Fig. 1c), dryland return was $10/acre more than 6 inches of water at a corn price of $2.00/bu. At a corn price of $2.50/bu, 6 inches of water resulted in $12/acre more return than dryland, but return from 12 inches was the same as dryland. At $3.00/bu corn price, return from 6 inches was $33/acre more than dryland, but the return from 12 inches was slightly less than that of 6 inches. With the 116-day hybrid at $5.00/inch pumping cost (Fig 1d) and $2.00/bu corn price, 6 inches returned only $3/acre more than dryland, while returns from 12 inches was $17/acre less than dryland. At the $2.50/bu corn price, return from 6 inches of water was $29/acre more than dryland and the return from 12 inches was $10/acre less than with 6 inches. At $3.00/bu, the 6 inch and 12 inch returns were similar, averaging $53/acre more than dryland.

The data indicate that returns from 12 inches of irrigation water were never more profitable than from 6 inches, regardless of hybrid maturity. Return from 6 inches of irrigation with the 104-day hybrid exceeded dryland return when pumping costs were $5.00/inch or less and corn price was $2.50/bu or more. With the 116-day hybrid, at $2/bu corn price and $5.00/inch pumping cost, return from 6 inches of water was slightly more than that of dryland (Fig 1d). At $3.00/bu and $3.00/inch pumping cost, return with 12 inches of irrigation from the 116-day hybrid was $10/acre greater than the return with 6 inches of irrigation (data not shown). However, that difference was not evident at a pumping cost of $5.00/inch.

Under the conditions of this study, producers probably would not want to apply more than 6 inches of water, unless corn prices exceed $2.50/bu and pumping costs are less than $5.00/inch. At the $5.00/inch pumping cost, a farmer irrigating a 104-day hybrid once would make $12/acre more than dryland at a corn price of $2.50 (Fig. 1c), and a farmer irrigating a 116-day hybrid once would make $29/acre more (Fig. 1d). This is enough return to prevent a return to dryland, at least with the 116-day hybrid. However, if the corn price drops to $2.00/bu, the 104-day hybrid hybrid results in a loss of $10/acre, and the 116-day hybrid returns only $3.00/acre more than dryland.

Fig. 1. Returns of limited irrigated corn as affected by pumping costs and corn price. Returns are based on custom rates for tillage, planting, and harvest, land costs are not included.



MANAGEMENT OF DRYLAND CORN

by
Charles Norwood

SUMMARY

Dryland corn studies were conducted from 1991 through 2000 to compare tillage and no tillage, dryland corn and grain sorghum, and corn planting date, hybrid, and plant population. No-till dryland corn yielded more than no-till grain sorghum in four of five years, indicating that corn responded more to no tillage than did sorghum. A mid-April planting date reduced corn yields well below those of an early-May planting date. Later hybrids yielded more than early hybrids. If early hybrids are planted , they can be planted late, up to June 1, without a yield reduction. Maturities of corn planted in early May probably should not exceed 100-105 days. Maturities of late-planted corn should not exceed about 92 days. Optimum population is about 18,000 plants/acre, regardless of planting date.

INTRODUCTION

The wheat-sorghum-fallow rotation produces more grain and is more profitable than the wheat-fallow rotation. A logical step up from wheat-sorghum-fallow is wheat-corn-fallow. Traditionally, corn is thought to lack sufficient heat and drought tolerance for dryland production in southwest Kansas. However, research at Garden City indicates that dryland corn may be feasible, if attention is given to tillage, hybrid maturity, planting date, and plant population. This study summarizes three dryland corn research studies that were done from 1991 through 2000. The objectives of these studies were to determine the effects of tillage, planting date, and plant population on dryland corn yield. Early in the study period, direct comparisons were made between dryland corn and grain sorghum.

PROCEDURES

Dryland corn was grown at Garden City, KS in a wheat-corn-fallow rotation from 1991 through 2000 to compare the effects of tillage, hybrid, planting date, and plant population on the yield of dryland corn. Corn was compared with dryland grain sorghum (hereafter referred to as sorghum) from 1991 through 1995. In that study, corn was planted about May 1 and sorghum was planted in late May to early June. Corn population was 18,000 plants/acre and sorghum population was 25,000 plants/acre. Tillage and no tillage were compared. Two other studies involved only corn. One study compared five Pioneer Brand corn hybrids having maturities of 75, 92, 98, 105, and 110 days. The hybrids were planted in mid-April and early May of 1996 through 1999 and thinned to populations of 12,000, 18,000, and 24,000 plants/acre. This study was no-till in 1996 through 1998, tillage was used to destroy a ground squirrel population in 1999. The other study consisted of three Pioneer hybrids having maturities of 75, 92, and 98 days, and an NK hybrid having a maturity of 88 days. The hybrids were selected for their maturities, no comparison between different seed companies was intended. These hybrids were planted on about May 1 and June 1 of 1998 through 2000. Target populations were 18,000, 24,000, and 30,000 plants/acre. This study was no till in 1998, with tillage used in 1999 and 2000 to avoid ground squirrels. The highest target population was not always attained because of soil crusting. Actual populations are in Table 3.

RESULTS AND DISCUSSION

Water use. Corn is perceived to be less drought tolerant than sorghum. To a certain extent, this is true. Sorghum can “wait longer” for rains to come at

Table 1. Corn and grain sorghum as affected by tillage. 1991-1995.			
	Yield		
Crop	Tillage	No tillage	Difference
	bu/a		
1991			
Corn	19	34	15*
Sorghum	45	63	18**
Difference	26***	29**	
1992			
Corn	143	148	4ns
Sorghum	101	103	3ns
Difference	42***	45***	
1993			
Corn	85	98	13*
Sorghum	97	93	4ns
Difference	12†	5ns	
1994			
Corn	74	118	44***
Sorghum	69	88	19**
Difference	5ns	30***	
1995			
Corn	77	110	33***
Sorghum	50	52	2ns
Difference	27**	58**	
Average			
Corn	80	102	22***
Sorghum	72	80	8*
Difference	8*	22***	

†, *, **, *** indicate a significant differenceat the 0.10, 0.05, 0.01, and 0.001 probability levels, respectively.

critical growth stages and with very dry conditions, will yield more than corn. However, the perception that corn depletes more water than sorghum from the soil profile is a myth. Figure 1 is an illustration of the depletion of soil water by corn and sorghum. Sorghum depleted more water than corn, because of its root system. Corn yields less than sorghum in dry years because it cannot remove enough soil water from the soil profile; therefore, the soil profile needs to be replenished more often for corn than sorghum.

Corn vs. sorghum. No-till corn yielded significantly more than no-till sorghum in every year but 1991 and 1993 (Table 1). In 1991, no-till sorghum yielded more than corn because of dry weather. In 1993, yields of no-till corn and sorghum were similar. The yield difference in favor of no-till corn compared to no-till sorghum ranged from 5 bu/a in 1993 to 58 bu/a in 1995, averaging 22 bu/a more for the 5-yr study period. The data were biased somewhat in 1995, part of the 58 bu/a difference was due to an early freeze that reduced yield of sorghum, but not corn. However, this is part of the risk of growing sorghum. Corn responded more to no tillage than did sorghum. On average corn yielded 22 bu/a more with no till, sorghum yielded only 8 bu/a more. In 1993, tilled sorghum yielded 12 bu/a more than corn, but with no till, corn and sorghum yielded about the same. Tilled sorghum and corn yielded about the same in 1994, but no-till corn yielded 30 bu/a more than no-till sorghum. These results emphasize the advantage for no-till corn. The only year in which no-till corn did not yield more than tilled corn was 1992, when above-average rainfall canceled the water conservation effects of no till.

Hybrid, planting date, and plant population. Other than tillage, the most important management practices consist of (in order of importance): 1. Planting date, 2. Hybrid maturity, 3. Plant population.

Table 2. Effects of hybrid, planting date, and plant population on dryland corn (wheat-corn-fallow rotation).

		Planting date														
		1996			1997			1998			1999			1997-1999		
Hybrid	Population	4/16	5/8	Avg	4/17	5/6	Avg	4/15	5/12	Avg	4/21	5/6	Avg	4/18	5/8	Avg
		bu/a														
3984 (75)[1]	12000	—	—	—	37	43	40	34	48	41	35	38	36	35	43	39
	18000	—	—	—	36	58	47	44	65	54	43	45	44	41	56	48
	24000	—	—	—	35	64	50	44	75	59	51	51	51	43	63	53
	Avg	—	—	—	36	55		41	63	51	43	44		40	54	
3860 (92)	12000	—	—	—	51	88	70	85	99	92	63	75	69	66	87	77
	18000	—	—	—	45	108	77	100	130	115	78	94	86	74	111	93
	24000	—	—	—	46	99	73	106	137	122	84	101	93	79	112	96
	Avg	—	—	—	47	98		97	122	110	75	90		73	103	
3737 (98)	12000	78	112	95	42	65	54	100	110	105	77	93	85	73	89	81
	18000	100	139	120	38	87	63	123	135	129	85	101	93	82	108	95
	24000	128	156	142	55	106	81	118	142	130	99	115	107	91	121	106
	Avg	102	136		45	86		114	129	121	87	103		82	106	
3514 (106)	12000	99	84	92	69	92	81	106	118	112	83	98	91	86	103	95
	18000	106	133	120	39	84	62	125	137	131	93	108	101	86	110	98
	24000	128	143	136	50	104	77	130	145	137	101	116	108	94	122	107
	Avg	111	120		53	93		120	133	127	92	108		88	111	
3394 (110)	12000	102	117	110	64	106	85	122	133	127	93	103	98	93	114	103
	18000	126	161	144	40	130	85	140	160	150	110	115	113	97	135	116
	24000	159	173	166	22	93	58	147	161	154	109	112	110	93	122	107
	Avg	129	150		42	110		136	151	144	104	110		94	124	

[1] Numbers in brackets are days to maturity

Table 2. Effects of hybrid, planting date, and plant population on dryland corn (wheat-corn-fallow rotation), continued.

		Planting date														
		1996			1997			1998			1999			1997-1999		
Hybrid	Population	4/16	5/8	Avg	4/17	5/6	Avg	4/15	5/12	Avg	4/21	5/6	Avg	4/18	5/8	Avg
		bu/a														
Hybrid avg	12000	93	104	99	53	79	66	89	102	96	70	81	76	71	87	79
	18000	111	144	128	40	93	67	107	125	116	82	93	88	76	104	90
	24000	138	157	148	41	93	67	109	132	121	89	99	94	80	108	94
	Avg	114	135		45	88		102	120		80	91		76	100	

		1996	1997	1998	1999	1997-1999
LSD (0.10)	Hybrid averaged populations and dates	—[2]	—	6	—	—
	Population averaged across dates and hybrids	—	ns	—	—	—
	Date within hybrid (averaged across populations)	11	22	ns	5	15
	Hybrid within date (averaged across populations)	10	19	ns	5	11
	Date within population averaged across hybrids)	11	17	8	ns	13
	Population within date (averaged across hybrids)	11	10	4	ns	6
	Hybrid within population (averaged across dates)	ns	18	ns	6	11
	Population within hybrid (averaged across dates)	ns	16	ns	5	9

[2] Dashes (—) indicate main effect means are not separated if there are interactions involving such means: ns = not significant.

Table 3. Effect of hybrid, planting date and plant population on early-season dryland corn, 1998-2000.

Hybrid	1998 Population	1998 5/4	1998 6/1	1998 Avg	1999 Population	1999 4/30	1999 5/31	1999 Avg	2000 Population	2000 5/6	2000 5/30	2000 Avg
		—bu/a—				—bu/a—				—bu/a—		
Pioneer 3984 (75)[1]	17000	53	78	66	20000	44	67	56	18000	50	52	51
	21000	66	88	77	25000	48	72	60	23000	51	55	53
	26000	68	98	83	28000	50	71	61	30000	47	56	52
	Avg	62	88			47	70			49	54	
NK 2555Bt (88)	19000	104	148	126	20000	96	97	97	18000	72	71	72
	25000	126	160	143	25000	97	98	98	23000	70	69	70
	30000	141	155	148	28000	107	106	107	30000	69	65	67
	Avg	124	154			100	100			70	68	
Pioneer 3860 (92)[2]	18000	110	128	119	20000	90	98	94	18000	77	66	72
	24000	135	135	135	25000	99	99	99	23000	74	68	71
	28000	137	145	141	28000	101	101	101	30000	77	67	72
	Avg	127	136			97	99			76	67	
Pioneer 3737 (98)	17000	117	140	129	20000	109	91	100	18000	76	62	69
	22000	143	151	147	25000	110	84	97	23000	73	60	67
	27000	141	164	153	28000	114	95	105	30000	69	54	62
	Avg	134	152			111	90			73	59	

[1]Numbers in brackets are days to maturity

LSD (0.10)	1998	1999	2000
Date at same hybrid and population	11	7	—
Date at same hybrid (averaged across populations)	—	—	6
Hybrid at same date (averaged Across populations)	—	—	3
Hybrid at same population (averaged across dates)	—	—	4
Population at same hybrid (averaged across dates)	—	—	3
Hybrid at same date and population	12	6	—
Population at same date and hybrid	11	—	—
Population averaged across hybrids and dates	—	3	—

Much of the data presented in Table 2 can be summarized with a few main points. Dryland corn always yielded more when planted in early May rather than mid-April. Early planting of corn reduces yield because of stress caused by cold soil and air temperatures during germination and early growth. This stress is not canceled out by the "cooler" air temperatures that are present if the corn is planted early and pollinates earlier. Conversely, if the cold soil temperatures from April planting are followed by hot and dry conditions during pollination, yields from early planting are greatly reduced. That happened in 1997, when yields of all hybrids were substantially reduced by early planting. Depending on hybrid maturity and plant population, yields were reduced to one-third to one-half of those from the early-May planting. Averaged across all hybrids and populations yields were reduced by 16, 49, 15, and 12%, respectively, for the 1996 through 1999 period. Across years, the reduction was 23%.

Later hybrids yielded more than earlier hybrids. On a practical basis, a maturity of about 98 to 106 days will be optimum in most years. However, on average, yields increased with maturity, even for the 110-day hybrid. The longer the maturity, the more yield, at least in wet years. Dry years should reduce the yield of long-season hybrids more than short-season hybrids. However, the data in Table 2 do not support this assumption, except for the 22 bu/a yield of the 110-day hybrid at 24,000 plants/acre in 1997. Yield of the 75-day hybrid was less than yield of the other hybrids. Very short season hybrids, such as the one in this study, do not have enough yield potential to compete with longer-season hybrids.

Yield increased with hybrid maturity because later hybrids used more water than did earlier hybrids. This is illustrated in Fig. 2, which compares soil water depletion of the 92-day and 106-day hybrids. The 92-day hybrid did not use all of the water in the soil profile. Yield increased with water use. Thus, selection of hybrids should be made on the basis of water use. Hybrids having maturities of at least 100 days, perhaps up to 110 days will use most of the water in the soil profile, resulting in higher yields. In the absence of rainfall, hybrids maturing later than 105 to 110 days may run out of water before the corn is mature.

Yield increased with higher populations. Except for 1997, populations as high as 24,000 did not reduce yield. Climatic conditions favored the higher populations in this study; however, yield usually did not increase as much from 18,000 to 24,000 as it did from 12,000 to 24,000. Yield often leveled off at 18,000. One interpretation of this is that high populations will not reduce yield as much as low populations. It is definitely possible to have too high a population, particularly if a longer-season hybrid is grown. However, if corn is planted too thin, there simply are not enough plants to produce a decent yield. For this reason, 18,000 plants/acre is recommended. A population of 18,000 plants/acre will seldom reduce yield below that of 12,000 plants/acre. Higher populations may or may not reduce yield, depending on climatic conditions.

Late-planted short-season corn. Another study was implemented as a result of preliminary data from the above study. Since yield increased with later planting and higher populations, what would happen if a short-season hybrid was planted late at high populations? Results from this study are presented in Table 3.

The results differed between years, depending on rainfall distribution. In 1998, yields generally increased with planting date, plant population, and hybrid maturity. Yields in 1998 peaked at 164 bu/a for the 98-day hybrid at a population of 27,000 plants/acre. Yield of all hybrids increased with later planting except for the 93-day hybrid at 18,000 plants/acre. In 1999, yield of the 75-day hybrid increased with the later planting while yield of the 88- and 92-day hybrids was unaffected, and yield of the 98-day hybrid decreased. In 2000, yield of the 75- and 88-day hybrids were essentially unaffected by planting date, and the yields of the 92- and 98-day hybrids were decreased by late planting. Plant population did not have a great effect on yield in 1999 and 2000, although yield of the 98-day hybrid decreased at 30,000 plants/acre. Yields actually increased with population in 1998.

These data indicate that dryland corn can be planted as late as June 1. The maturity of late-planted corn hybrids probably should not exceed 92 days. High populations did not appear to be detrimental, even in the dry year of 2000. However, except in years of good rainfall distribution, such as 1998, there was no advantage to populations exceeding 18,000 plants/acre.

Fig. 1. Soil water depletion by corn and sorghum.

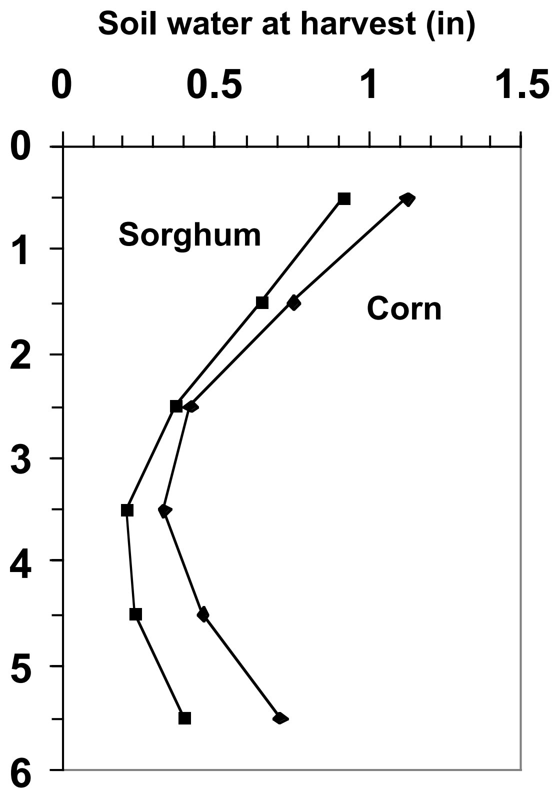
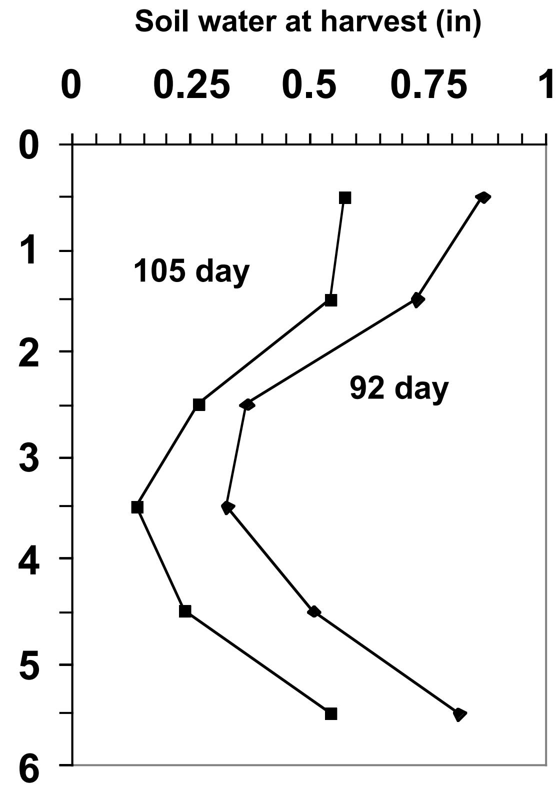


Fig. 2. Soil water depletion by 105-day and 92-day corn hybrid.



IMPACT OF ANIMAL WASTES ON IRRIGATED CORN

by
Alan Schlegel, H. Dewayne Bond, and Loyd Stone[1]

SUMMARY

It has been established that animal wastes can effectively recycle nutrients, build soil quality, and increase agricultural productivity. However, some concern has been expressed regarding land application of animal wastes. Specifically, there is concern that excessive applications may damage the environment. This study evaluates established best management practices for land application of animal wastes on crop productivity and soil properties. Swine (effluent water from a lagoon) and cattle (solid manure from a beef feedlot) wastes were applied at rates to meet corn P or N requirements (established best management practices), along with a rate double the N requirement. Other treatments were N fertilizer (60, 120, and 180 lb N/a) and an untreated control. Corn yields in 2000 were increased by application of animal wastes and N fertilizer; however, the type of waste or application rate had little effect on yield.

INTRODUCTION

The potential for animal wastes to recycle nutrients, build soil quality, and increase crop productivity is well established. A growing concern is that changes in livestock production systems, with larger and more concentrated operations, may create environmental problems because of excessive amounts of animal wastes in localized areas. Specific concerns are surface runoff of phosphorus (P), which can cause eutrophication (over-enrichment) of surface waters and leaching of NO_3-N through the soil, which in turn might contaminate groundwater. This study was initiated to evaluate best management practices for utilization of animal wastes for irrigated crop production.

PROCEDURES

This study was initiated in 1999 to determine the effect of land application of animal wastes on crop production and soil properties. The two most common animal wastes in western Kansas were evaluated; solid cattle manure from a commercial beef feedlot and effluent water from a lagoon on a commercial swine facility. The rate of waste application was based on the amount needed to meet the estimated crop P requirement, crop N requirement, or twice the N requirement (Table 1). The Kansas Dept. of Agriculture Nutrient Utilization Plan Form was used to calculate animal waste application rates. Expected corn yield was 180 bu/a. Soil test P and N values were from samples taken in the fall of 1999. Residual soil N in the N-based treatments was 77 lb/a for the cattle manure and 136 lb/a for the swine effluent. The 2XN treatments were twice the calculated rates of the 1XN treatments. The allowable P application rate for the P-based treatments was 105 lb P_2O_5/a, since soil test P was less than 150 ppm Mehlich-3 P. Nutrient values used for the animal wastes were 17.5 lb available N and 25.6 lb available P_2O_5 per ton of cattle manure and 6.1 lb available N and 1.4 lb available P_2O_5 per 1000 gallon of swine effluent. Other nutrient treatments were three rates of N fertilizer (60, 120, and 180 lb N/a) along with an untreated control. Treatments in 2000 were applied in the early spring and incorporated prior to planting of corn. The experimental design was a randomized complete block with four replications.

The study was established in border basins to facilitate effluent application and irrigation. Plot size was 12 rows wide by 45 ft long. All plots were irrigated to minimize water stress. The soil is a Ulysses silt loam. Corn (Pioneer 34D34) was planted

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

Table 1. Application rates of animal wastes, Tribune, KS, 2000.		
Application basis*	Cattle manure	Swine effluent
	ton/a	gal/a
P requirement	4.1	75,000
N requirement	6.6	9,400
2XN requirement	13.2	18,800

* The nutrient values used for the calculations were 17.5 lb available N and 25.6 lb available P_2O_5 per ton of cattle manure; and 6.1 lb available N and 1.4 lb available P_2O_5 per 1000 gallon of swine effluent.

on April 25 at 33,000 seeds/a. Ear leaf samples were collected at silking and analyzed for N and P content. The center four rows of each plot were machine harvested on September 19 with yields adjusted to 15.5% moisture.

RESULTS AND DISCUSSION

Grain yields were increased by application of animal wastes and commercial fertilizer in 2000 compared to the untreated control (Table 2). The type of animal waste or rate of application had little effect on corn yield. Nitrogen content of the ear leaf tended to be higher from application of animal wastes than N fertilizer, although there were no differences between manure type or application rate. Leaf P content was higher from applications of cattle manure than from swine effluent. No yield measurements were taken in 1999 because of severe hail damage. The study will be continued in 2001 to evaluate the multi-year impact of repeated animal waste applications.

Table 2. Effect of animal wastes and N fertilizer on irrigated corn, Tribune, KS, 2000.				
Nutrient source	Rate*	Leaf N	Leaf P	Grain yield
		%	%	bu/a
Cattle manure	P	2.59	0.29	197
	N	2.64	0.29	195
	2XN	2.52	0.29	195
Swine effluent	P	2.56	0.27	189
	N	2.61	0.26	194
	2XN	2.62	0.27	181
N fertilizer	60	2.25	0.24	178
	120	2.63	0.27	186
	180	2.46	0.26	184
Control	0	2.35	0.25	158
$LSD_{0.05}$		0.21	0.02	22

* Rate of animal wastes are calculated based on meeting P requirement, N requirement, or twice the N requirement of the crop. The N fertilizer rates are in lb N/acre.

LONG-TERM FERTILIZATION OF IRRIGATED CORN AND GRAIN SORGHUM

by
Alan Schlegel

SUMMARY

Long-term research shows that phosphorus (P) and nitrogen (N) fertilizer must be applied to optimize production of irrigated corn and grain sorghum in western Kansas. In 2000, N and P fertilization increased corn yields up to 90 bu/a. Averaged across the past 8 years, corn yields were increased more than 100 bu/a by N and P fertilization. Application of 160 lb N/a generally is sufficient to maximize corn yields. Phosphorus increased corn yields by 70 bu/a when applied with at least 120 lb N/a. Application of 40 lb P_2O_5/a has been adequate for corn until this year, when yields were increased by a higher P rate. Grain sorghum yields averaged across 8 years were increased 50 bu/a by N and 20 bu/a by P fertilization. Application of 80 lb N/a was sufficient to maximize yields in most years. Potassium (K) fertilization had no effect on sorghum yield.

INTRODUCTION

This study was initiated in 1961 to determine responses of continuous corn and grain sorghum grown under flood irrigation to N, P, and K fertilization. The study was conducted on a Ulysses silt loam soil with an inherently high K content. No yield benefit to corn from K fertilization was observed in 30 years and soil K levels remained high so the K treatment in the corn study was discontinued in 1992 and replaced with a higher P rate.

PROCEDURES

Initial fertilizer treatments in 1961 to corn and grain sorghum in adjacent fields were N rates of 0, 40, 80, 120, 160, and 200 lb N/a without P and K; with 40 lb P_2O_5/a and 0 K; and with 40 lb P_2O_5/a and 40 lb K_2O/a. In 1992, the treatments for the corn study were changed with the K variable being replaced by a higher rate of P (80 lb P_2O_5/a). All fertilizers were broadcast by hand in the spring and incorporated prior to planting. The soil is a Ulysses silt loam. The corn hybrid was Pioneer 3379 (1992-94), Pioneer 3225 (1995-97), Pioneer 3395IR (1998), and Pioneer 33A14 (2000) planted at 32,000 seeds/a in late April or early May. The 1999 corn crop was lost to hail. Sorghum (Mycogen TE Y-75 from 1992-1996, Pioneer 8414 in 1997, and Pioneer 8505 from 1998-2000) was planted in late May or early June. Both studies were furrow-irrigated to minimize water stress. The center 2 rows of each plot were machine harvested after physiological maturity. Grain yields were adjusted to 15.5% moisture for corn and 12.5% for sorghum.

RESULTS AND DISCUSSION

Corn yields in 2000 were higher than the long-term average (Table 1). Nitrogen and P fertilization increased corn yields by up to 90 bu/a. Grain yield in the control treatments were 131 bu/a, approximately twice as high as in any of the previous 7 years. Only 80 lb N/a was required to obtain near maximum yields compared to the long-term average of about 160 lb N/a. Hail severely damaged the corn in 1999 and the study was not harvested. This appears to have increased the amount of residual N for the 2000 crop. Corn yields were 10 bu/a greater with 80 compared to 40 lb P_2O_5/a. This was the first year that yields were significantly more with the higher P rate.

Grain sorghum yields in 2000 were similar to the long-term average (Table 2). Maximum sorghum yields were obtained with only 40 lb N/a when applied with P. Phosphorus increased yields by about 20 bu/a for all treatments receiving N, which was similar to the long-term average. Potassium fertilization had no effect on yield.

Table 1. Effect of N and P fertilizers on irrigated corn. Tribune, KS, 1992-2000.

Nitrogen	P_2O_5	1992	1993	1994	1995	1996	1997	1998*	2000	Mean
		Grain Yield								
lb/a		bu/acre								
0	0	73	43	47	22	58	66	49	131	61
0	40	88	50	43	27	64	79	55	152	70
0	80	80	52	48	26	73	83	55	153	71
40	0	90	62	66	34	87	86	76	150	81
40	40	128	103	104	68	111	111	107	195	116
40	80	128	104	105	65	106	114	95	202	115
80	0	91	68	66	34	95	130	95	149	91
80	40	157	138	129	94	164	153	155	205	149
80	80	140	144	127	93	159	155	149	211	147
120	0	98	71	70	39	97	105	92	143	89
120	40	162	151	147	100	185	173	180	204	163
120	80	157	153	154	111	183	162	179	224	165
160	0	115	88	78	44	103	108	101	154	99
160	40	169	175	162	103	185	169	186	203	169
160	80	178	174	167	100	195	187	185	214	175
200	0	111	82	80	62	110	110	130	165	106
200	40	187	169	171	106	180	185	188	207	174
200	80	165	181	174	109	190	193	197	218	178
ANOVA										
N		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Linear		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Quadratic		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
P_2O_5		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Linear		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Quadratic		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
N x P		0.013	0.001	0.001	0.001	0.001	0.001	0.001	0.008	0.001
MEANS										
N, lb/a	0	80	48	46	25	65	76	53	145	67
	40	116	90	92	56	102	104	93	182	104
	80	129	116	107	74	139	146	133	188	129
	120	139	125	124	83	155	147	150	190	139
	160	154	146	136	82	161	155	157	190	147
	200	154	144	142	92	160	163	172	197	153
$LSD_{0.05}$		14	7	13	7	10	12	11	10	5
P_2O_5, lb/a	0	96	69	68	39	92	101	91	149	88
	40	149	131	126	83	148	145	145	194	140
	80	141	135	129	84	151	149	143	204	142
$LSD_{0.05}$		10	5	9	5	7	9	7	7	4

*Note: There was no yield data for 1999 because of hail damage.

Table 2. Effect of N, P, and K fertilizers on irrigated sorghum, Tribune, KS, 1992-2000.

N	P_2O_5	K_2O	1992	1993	1994*	1996	1997	1998	1999	2000	Mean
			Grain yield								
lb/a			bu/acre								
0	0	0	27	46	64	74	81	77	74	77	65
0	40	0	28	42	82	77	75	77	85	87	69
0	40	40	35	37	78	79	83	76	84	83	69
40	0	0	46	69	76	74	104	91	83	88	79
40	40	0	72	97	113	100	114	118	117	116	106
40	40	40	72	92	112	101	121	114	114	114	105
80	0	0	68	91	96	73	100	111	94	97	92
80	40	0	85	105	123	103	121	125	113	116	112
80	40	40	85	118	131	103	130	130	123	120	118
120	0	0	56	77	91	79	91	102	76	82	82
120	40	0	87	120	131	94	124	125	102	116	113
120	40	40	90	117	133	99	128	128	105	118	115
160	0	0	62	93	105	85	118	118	100	96	97
160	40	0	92	122	137	92	116	131	116	118	116
160	40	40	88	123	125	91	119	124	107	115	112
200	0	0	80	107	114	86	107	121	113	104	105
200	40	0	91	127	133	109	126	133	110	114	118
200	40	40	103	123	130	95	115	130	120	120	118
ANOVA											
Nitrogen			0.001	0.001	0.001	0.003	0.001	0.001	0.001	0.001	0.001
Linear			0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001
Quadratic			0.001	0.001	0.001	0.116	0.001	0.001	0.227	0.001	0.001
P-K			0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zero P vs. P			0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
P vs. P-K			0.431	0.888	0.734	0.727	0.436	0.649	0.741	0.803	0.858
N x P-K			0.420	0.006	0.797	0.185	0.045	0.186	0.482	0.061	0.035
MEANS											
Nitrogen											
0 lb/acre			30	42	75	77	80	76	81	82	67
40			64	86	100	92	113	108	105	106	97
80			80	104	117	93	117	122	110	111	107
120			78	105	118	91	114	118	95	105	103
160			81	113	122	89	118	124	108	110	108
200			91	119	126	97	116	128	115	113	113
$LSD_{0.05}$			10	10	14	9	10	8	13	7	7
P_2O_5 - K_2O											
0-0 lb/acre			56	81	91	79	100	103	90	91	86
40-0			76	102	120	96	113	118	107	111	106
40-40			79	102	118	95	116	117	109	112	106
$LSD_{0.05}$			7	7	10	7	7	6	9	5	5

*Note: There was no yield data for 1995 because of early freeze damage.

EFFECT OF TILLAGE INTENSITY IN A WHEAT-SORGHUM-FALLOW ROTATION

by
Alan Schlegel, Troy Dumler, and Curtis Thompson

SUMMARY

Grain yields of wheat and grain sorghum increased with decreased tillage intensity in a wheat-sorghum-fallow (WSF) rotation. Yields for no-till (NT) wheat were 8 bu/acre greater than conventional-till (CT), whereas reduced-till (RT) yields were 5 bu/acre more than CT. Grain sorghum yields for NT and RT were 25 to 30 bu/acre greater than with CT. Production costs also increased with reductions in tillage. For wheat, the RT system was the most profitable while NT was the least profitable. However, for sorghum, both RT and NT were considerably more profitable than CT. Averaged across the past 10 years, conservation tillage doubled net returns in a WSF rotation.

INTRODUCTION

In the semi-arid regions of western Kansas and the Great Plains, research has shown that reduced tillage often results in increased grain yields. With increased grains yields arises the opportunity for increased returns. This study was conducted to determine the impact of three tillage intensities (CT, RT, and NT) on crop productivity and profitability in a WSF rotation near Tribune, Kansas.

PROCEDURES

Research on different tillage intensities in a WSF rotation at the K-State Southwest Research-Extension Center at Tribune was conducted from 1991-2000. The three tillage intensities were CT, RT, and NT. The CT system was tilled as needed to control weed growth during the fallow period. On average, this resulted in 4 to 5 tillage operations per year, usually with a blade plow or field cultivator. The RT system used a combination of herbicides (1 to 2 spray operations) and tillage (2 to 3 tillage operations) to control weed growth during the fallow period. The NT system exclusively used herbicides to control weed growth during the fallow period. All tillage systems used herbicides for in-crop weed control.

The tillage operation and herbicide application costs were based on average custom rates for southwest Kansas. Custom rates were also used for planting, harvesting, and fertilizer application costs. The remaining costs including seed, fertilizer, and herbicides, were based on historical costs over the study period. Wheat and grain sorghum prices were average yearly prices for southwest Kansas from 1991 to 2000. Land costs and government payments were not included in the study.

RESULTS AND DISCUSSION

Conservation tillage increased wheat yields (Table 1). On average, wheat yields across the 10-year period were 8 bu/acre more for NT (46 bu/acre) than for CT (38 bu/acre). Wheat yields for RT were 5 bu/acre greater than CT. Production costs were also higher for NT ($111/acre) compared to RT ($83/acre) or CT ($82/acre). Net returns from wheat were greatest with RT ($44/acre) because of greater yields than CT without increased costs. NT wheat ($28/acre) was least profitable because the increased yield did not offset the increased cost, although CT wheat ($31/acre) was not much more profitable.

The yield benefit from reduced tillage was greater for grain sorghum than for wheat. Grain sorghum yields for RT averaged 25 bu/acre more than CT, while NT averaged 6 bu/acre more than RT (Table 2). Similar to wheat, production costs for grain sorghum increased as tillage decreased. Sorghum production costs were $92/acre for CT, $114/acre for RT, and $125/acre for NT. The higher costs for the conservation tillage systems were primarily because of higher herbicide and fertilizer costs. Although tillage costs decrease with reduced tillage, herbicide costs increase more than tillage costs decrease, thereby increasing total costs per acre. Even with increased production costs, RT and NT sorghum returned $30/acre more than CT. Across the 10-year period, net returns from sorghum were $7/acre for CT compared to $36/acre for RT and $38/acre for NT. Across the 3-yr rotation, conservation tillage doubled net returns with returns per tillable acre for NT, RT, and CT of $22, $27, and $12, respectively.

Table 1. Wheat response to tillage in a WSF rotation, Tribune, KS 1991-2000.

Tillage	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Mean
	bu/acre										
Conventional	16	26	43	48	49	16	34	52	76	20	38
Reduced	14	14	55	48	51	25	42	68	77	32	43
No-till	15	21	58	46	56	26	52	64	83	44	46
$LSD_{0.05}$	6	10	4	7	7	9	17	9	7	6	2

Table 2. Grain sorghum response to tillage in a WSF rotation, Tribune, KS 1991-2000.

Tillage	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Mean
	bu/acre										
Conventional	23	38	47	20	37	97	71	87	19	13	45
Reduced	39	41	83	38	54	117	94	105	88	37	70
No-till	39	27	68	57	59	119	115	131	99	51	76
$LSD_{0.05}$	18	15	11	9	5	12	33	37	10	6	5

NON-TRADITIONAL PRODUCTS: AN EVALUATION OF 'SUPER BIO' IN CORN AND 'MESSENGER' IN WHEAT

by
Curtis Thompson and Alan Schlegel

SUMMARY

Non-traditional products are not herbicides, insecticides, fungicides, or fertilizers. Like all other inputs in crop production, these products need to be evaluated for their merit in crop production.

In this study, SuperBio was evaluated in irrigated corn. SuperBio was soil surface applied at varying rates prior to planting irrigated corn. SuperBio did not affect corn nutrient uptake, grain yield, or soil profile characteristics evaluated with a penetrometer in this large-scale replicated field study, conducted in 1997 in Finney County. The study site was uniform and provided an excellent set of statistics indicating this was a good test.

The Messenger wheat seed treatment study, established in 1999 near Tribune, experienced very difficult climatic conditions with a very dry late fall, winter, and spring. Hot weather and drought pushed the crop growth and development in late May and through June, thus, wheat harvest was nearly 2 weeks ahead of normal. In addition to the dry weather, freezes occurred in April and May that adversely affected the wheat crop. Wheat test weights in this study were acceptable but not exceptional. Yields in this study were below average relative to the previous 3 years' wheat crops; however, yields in this study were only slightly below the long-term average. It does not appear that Dividend or Messenger had any effect on wheat growth, development, disease tolerance, or grain yield. These results would concur with previous seed treatment data collected on wheat planted in fallow at the Tribune research station. It is possible that wheat planted after corn or into no-till wheat stubble, where conditions present a greater risk for disease problems compared to fallow, would create a better opportunity for seed treatments to show a positive effect.

INTRODUCTION

From time to time, non-traditional products are marketed for crop production in Kansas and do not fit into the categories of herbicide, insecticide, fungicide, or fertilizer. The merits of the product may not be fully understood, even by the marketer, and these products often lack research-based data from the land grant institution or from producers in the local area. These products are often marketed as soil amendments or seed treatments. In some instances, the marketer claims the product increases yield because of some mechanism that enhances nutrient uptake or improves soil characteristics. Although, in other cases, the mechanism is not fully understood, only that use of the product will increase grain yield.

SuperBio was evaluated in irrigated corn. SuperBio is a solution containing a collection of beneficial aerobic and facultative anaerobic microbes claimed to improve the soil profile structure, reduce compaction layers, and perhaps affect nutrient uptake.

In a second study, Messenger seed treatment was evaluated in wheat. Messenger is a harpin protein that is claimed to enhance plant growth, protect against plant diseases, and increase yield. Messenger has most extensively been tested in vegetable, fruit, and ornamental crops.

PROCEDURES

SUPERBIO

The SuperBio study was conducted on a silt loam soil at a cooperator's site in Finney County. SuperBio was applied on May 1, 1997 to the soil surface with a high-boy sprayer delivering 20 gallons per acre (gpa) on a cloudy day with a 45° F air temperature. SuperBio was applied at 0, 0.5, 0.75, and 1.0 gpa. All treatments were repeated four times and arranged in a randomized complete block design. Mycogen 7250CB corn was planted into good soil moisture on 60-inch beds in 30-inch rows the same day. Within 24 hours of corn plantin, 0.63 inches of rain fell. The previous crop was soybean. Corn was flood-irrigated as needed. Leaf tissue samples were taken from each plot at silking to determine nutrient content of the ear leaf. Soil penetrometer readings were made in each plot during September to evaluate any changes in soil compaction layer or the tightness of the soil. Plot size was 24 rows (60-ft wide) by the length of the field. Seventeen feet of row in each plot was hand harvested for grain yield on October 31. The center 8 rows by 1,290 feet of each plot were combine harvested for grain yield on November 18.

MESSENGER

The Messenger study was conducted on a silt loam soil, at the Southwest Research Extension Center near Tribune, KS. Winter wheat (2137) was treated with Messenger and other seed treatments, as shown in Table 2. Wheat was planted September 18, 1999, the day after treatment, at 60 lb/a and 2 inches deep with a hoe drill on 10-inches spacing. Soil moisture conditions were very good at the time of planting. The number of wheat seedlings in 6 ft of row were counted in each plot on October 6, 1999 to determine plant population. On the same day, 10 plants per plot were dug and the crown diameter was measured, shoots were separated from the crown and roots at the soil line, and then the soil was washed from the roots. All plant parts were oven dried and weighed. Crown&root weight, shoot weight, and root (crown&root) to shoot ratios were determined. Postemergence Messenger was applied at 2.2 oz product/acre to fully tillered, but not jointed, wheat on March 11, 2000. Application was made in 20 gpa water with 0.25% v/v nonionic surfactant. Temperature was 46° F and 45% relative humidity. Disease pressure was monitored during late May and early June. Light to moderate infestations of leaf rust and speckled leaf blotch were present. Wheat was harvested for grain on June 21, 2000. Moisture and test weight were determined with a Dickey-John tester. Protein analysis was conducted by Servi-Tec laboratories in Dodge City, Kansas.

RESULTS AND DISCUSSION

SUPERBIO

Nutrient analysis of the ear leaf at tasseling showed no differences between the SuperBio treatments and the untreated check (data not shown). Results from the penetrometer readings made during September indicated no soil profile differences between treatments (data not shown).

Grain yield from the large plot harvest was not affected by SuperBio treatment (Table 1). SuperBio treated corn yielded from 190 to 199 bushel per acre while the untreated corn yielded 198 bushel per acre. Corn that received SuperBio at 1 gpa yielded the least of all treatments; however, statistical analysis indicates that treatment yields did not differ. The low CV (3.75) indicates that this was a very uniform test. Moisture and test weight did not differ between treatments.

Grain yields from the small plot hand harvest areas were more variable that the large plot harvest. However, results and conclusions were the same (Table 1). Yield, moisture, and test weight were not affected by SuperBio treatment.

MESSENGER

Disease pressure, evaluated visually, did not differ among treatments. (Data not shown) Leaf rust and speckled leaf blotch were present at moderate levels. Barley yellow dwarf virus was also present in the plots. Treatments did not appear to affect the level of disease on the wheat.

Plant population ranged from 773,000 to 878,000 plants/acre (Table 2). Populations were very good regardless of treatment. Although the control treatment had somewhat fewer plants, statistically there were no differences in plant stands among treatments.

Crown diameter and weight (root+crown) did not differ among treatments (Table2). The crown weight refers to the plant tissue from below the soil surface. Similarly, shoot weight, the above ground portion of the plant, did not differ among treatments (Table 2). Only when calculating root to shoot ratio, was the data significant. However, the highest and lowest ratios were exactly the same treatment since the spring postemergence Messenger had not been applied at the time the sampling and measurements were taken.

Grain yield, moisture, protein, and test weight did not differ among treatments (Table 3). The data gathered was quite uniform over replicates, indicating that variability was low ensuring an excellent test. No yield differences were found.

Table 1. Irrigated corn response to soil applied SuperBio, Finney County 1997.

Treatment	Test Rate	Large plot Yield	Large plot Mois.	Large plot Test weight	Small plot Yield	Small plot Mois.	Small plot weight
	gallon/a	(bu/a)	(%)	(lb/bu)	(bu/a)	(%)	(lb/bu)
Check		199	13.2	58.4	209	15.4	58.8
SuperBio	0.5	197	13.4	58.8	217	15.7	58.9
SuperBio	0.75	199	13.5	58.6	215	15.3	58.4
SuperBio	1.0	190	13.4	58.5	207	15.7	58.5
LSD (0.05)		NS	NS	NS	NS	NS	NS
CV		4	1.7	0.5	6	1.6	1.0

Note: Yield is based on 15.5% moisture.

Table 2. Wheat seedling response to Messenger and fungicide seed treatments, October 6, Tribune, KS 1999-2000.

Treatment	Rate	Plt/a	Crown diam.	Crown weight	Shoot weight	R/S ratio
		(X1000)	(mm)	(g)	(g)	
Check		773	8.3	0.218	0.636	0.344
Dividend XL RTA	5oz/cwt	878	7.7	0.187	0.617	0.304
Messenger	2oz/cwt	849	8.0	0.179	0.616	0.291
Messenger Dividend XL RTA	2oz/cwt 5oz/cwt	812	8.0	0.193	0.681	0.289
Messenger Dividend XL RTA Messenger (Post app.)	2oz/cwt 5oz/cwt 2.2oz/a	856	7.4	0.217	0.548	0.394
LSD (0.05)		NS	NS	NS	NS	0.057

Note: Plt = plants, diam. = diameter, Crown weight is actually crown+root weight, R/S = root (root+crown) to shoot ratio;

Table 3. Wheat response to Messenger and other seed treatments, Tribune, KS 1999-2000.					
Treatment	Rate	Yield	Moisture	Test weight	Protein
		(bu/a)	(%)	(lb/bu)	(%)
Check		37	9.4	57.5	15.3
Dividend XL RTA	5oz/cwt	36	9.5	57.9	15.6
Messenger	2oz/cwt	37	9.4	57.9	15.5
Messenger Dividend XL RTA	2oz/cwt 5oz/cwt	38	9.5	57.7	14.6
Messenger Dividend XL RTA Messenger (Post app.)	2oz/cwt 5oz/cwt 2.2oz/a	37	9.5	58.1	14.9
LSD (0.05)		NS	NS	NS	0.7

ECONOMIC OPTIMUM IRRIGATION WITH HIGH ENERGY PRICES

by
Troy Dumler

SUMMARY

Using current natural gas prices, the economic optimum amount of irrigation water to apply to full season corn was determined. Irrigation water should continue to be applied as long as the benefit of applying the water is greater than the cost of applying it. Even with unusually high irrigation pumping costs, the amount of irrigation water applied to full season corn should not be reduced by a large amount.

INTRODUCTION

Irrigated corn is an important crop in southwest Kansas, with more than 1 million acres planted in 1999. Because of rising energy costs in 2000, many farmers have been exploring alternative production strategies such as limited input use or alternative crops. When looking at the irrigation production alternatives, farmers have four basic options: (1) continue typical production, (2) limit input use, (3) plant an alternative crop, or (4) revert to dryland. This report will focus on the second option and will explain the economic principle that determines the optimum amount of input use.

PROCEDURES

A production function based on agronomic research was estimated to determine the economic optimum amount of irrigation water to apply to full season corn. The research used to estimate the production function was conducted over a period of 15 years at three sites in western Kansas. From this research, a corn water use curve was estimated, illustrating the relationship between irrigation application and corn yield.[1] Because the yield potential of corn has increased since this research was concluded in the early 1990s, the yields were proportionally adjusted from a maximum yield of 210 bu/acre to 235 bu/acre. Figure 1 shows the predicted corn yields at different levels of water application. Once the yields at the various irrigation levels were determined, gross returns (yield*corn price) and irrigation pumping costs were calculated. With this information, the optimal level of water application was determined.

RESULTS AND DISCUSSION

The marginal value vs. marginal cost economic principle governs determination of the optimum application of yield-increasing inputs. This principle states that an input should continue to be applied as long as the value of applying an additional unit of that input is greater than the cost of applying it. The value of applying an additional unit of input is referred to as the marginal value product (MVP). The cost of applying an additional unit of input is referred to as the marginal cost (MC). Thus, when deciding how much irrigation water to apply, a farmer must ask the question: Is the MVP greater than the MC? In other words, is the yield gain from 1 acre inch of water times the crop price greater than the cost of applying 1 acre inch of water. Table 1 shows the predicted yields, gross income, MVP, total pumping cost, MC, and net returns of varying levels of irrigation application.

Gross Income is calculated using a corn price of $2.10/bu. MVP is the difference between gross income at one level of water application and an additional inch of water. For example, gross income at 15 inches of water is $473.41. Gross income at 16 inches of water is $480.44. The difference ($7.03) is the MVP. Pumping costs are based on $5.50/mcf natural gas, which equates to a pumping cost of $4.80/inch (including maintenance). Once again, the marginal value/marginal cost principle states that water should continue to be applied as long as the MVP is greater than the MC. In Table 1, MVP is greater than MC up to 17 inches. At 17 inches, returns are maximized at

[1]Danny H. Rogers. "Corn Production Handbook." C-560, Kansas State University. pp. 23-28. May, 1994.

Table 1. Economic optimum irrigation application.

Inches of Water Applied	Predicted Yield	Gross Income	Marginal Value Product (MVP)	Total Pumping Cost	Marginal Cost (MC)	Returns (Income - Pumping Costs)
10	198.4	$416.65	$15.68	$48.00	$4.80	$368.65
11	205.2	$430.89	$14.24	$52.80	$4.80	$378.09
12	211.3	$443.68	$12.79	$57.60	$4.80	$386.08
13	216.7	$455.04	$11.36	$62.40	$4.80	$392.64
14	221.4	$464.95	$9.91	$67.20	$4.80	$397.75
15	225.4	$473.41	$8.46	$72.00	$4.80	$401.41
16	228.8	$480.44	$7.03	$76.80	$4.80	$403.64
17	231.4	$486.02	$5.58	$81.60	$4.80	$404.42
18	233.4	$490.16	$4.14	$86.40	$4.80	$403.76
19	234.7	$492.85	$2.69	$91.20	$4.80	$401.65
20	235.3	$494.10	$1.25	$96.00	$4.80	$398.10
21	235.3	$494.10	$0	$100.80	$4.80	$393.30

$404.42. If more than 17 inches of water is applied, returns begin to decrease. Thus, with pumping costs at $4.80/inch, 17 inches of irrigation water is the economic optimum.

The above example does not imply that 17 inches of water is the optimal amount for everyone. For some farmers, more water may be required to maximize returns. Conversely, lower quality land may produce lower yields, which would result in less water being needed to maximize returns. Also, as corn and natural gas prices fluctuate, the economic optimum will change. Figure 2 shows the level of irrigation water that maximizes returns at different corn prices and pumping costs. As the figure indicates, the optimal amount of irrigation increases as the price of corn increases. However, that increase is much more dramatic when pumping costs are high. For instance, with pumping costs at $8.00/inch, the optimal amount of irrigation increases from 12.6 inches when corn is $1.50/bushel to 17.0 inches when corn is $3.50/bushel. If pumping costs were only $2.00/inch, the optimal amount of irrigation increases from 18.4 inches when corn is $1.50/bushel to 19.5 inches when corn is $3.50/bushel.

Finally, when determining how much water to apply to irrigated corn with high energy prices, the most important item to consider is the relationship between yield and water application. The point at which the corn water use curve begins to flatten is most likely the point where returns will be maximized. On the steeper sections of the water use curve, significant losses may occur if irrigation is limited. Consequently, sharp reductions in irrigation water may not be the answer with high energy costs.

Fig. 1. Predicted corn yields as a function of water application

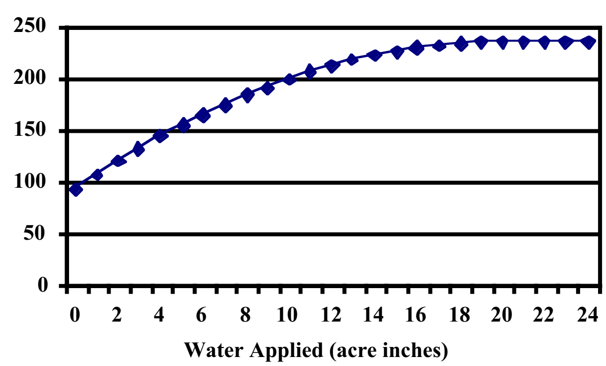
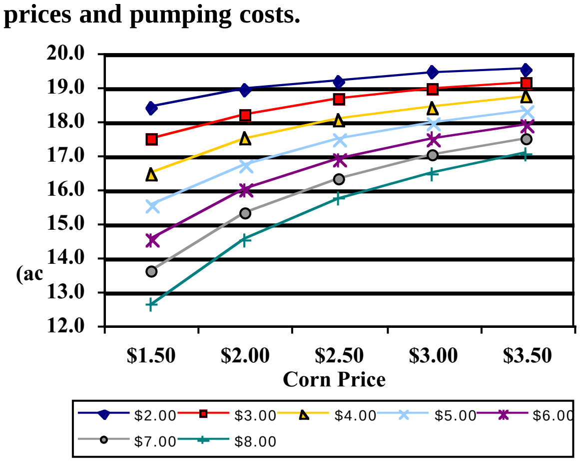


Fig. 2. Economic optimum irrigation at varying corn prices and pumping costs.



SUBSURFACE DRIP IRRIGATION FOR ALFALFA: AN EXTENSION APPROACH TO ADDRESS KANSAS FARMERS' QUESTIONS

by
Mahbub Alam, Todd P. Trooien[1], Danny H. Rogers[2], Troy J. Dumler

SUMMARY

A two-year study on suitability of using subsurface drip irrigation (SDI) for alfalfa provided some answers to alfalfa producers of Kansas. The study was conducted on an alfalfa producer's field established for demonstration purpose. The soil type is a sandy loam. The demonstration included three drip tape spacing and two drip tape depths. The treatments were drip tape spacing and depths, (a) 60 inches spacing at 18 and 12 inches depth of placement, (b) 40 inches spacing at 18 and 12 inches depth, (c) 30 inches spacing at 18 inches depth, and (d) monitoring of a center pivot sprinkler-irrigated plot seeded to alfalfa. Emergence of seedlings was adversely affected, showing 'striping' at 60 inches drip tape spacing. Total yield was reduced for spacing of drip tapes at 60 inches in both 1999 and 2000. The depth of placement of the drip tapes (18 and 12 inches) did not affect yields. Extension Educational benefits from the site have been two fold. The site served as a focal point for area producers to observe alfalfa production under SDI ,and allowed some preliminary comparison between SDI system options and a center pivot system.

INTRODUCTION

Subsurface Drip Irrigation (SDI) may be a viable alternative for irrigating alfalfa in western Kansas. A demonstration site was established prior to the 1999 alfalfa growing season to study the suitability of SDI. The site was located on a working farm, owned by Steven Stone in Finney County, KS, and, although results are preliminary in nature, the site should provide some guidance for area farmers considering SDI for alfalfa. This was a joint project involving a farmer, industry, and the local groundwater management district. This study will provide an example to the Extension professionals considering field research when basic research results are not readily available for local farmers.

Producers have adopted SDI for row crops, especially corn, and studies have shown that SDI is feasible for field crops in the High Plains. Research has shown that SDI is economically feasible for small fields, up to 80 acres, and could be feasible for fields up to 160 acres. However, little study has been conducted regarding the economic feasibility of SDI for alfalfa. Given the increased interest in alfalfa as a feed crop, such research could provide needed answers for farmers interested in SDI.

Alfalfa was grown in 272,000 acres in western Kansas in 1998, which is an increase of an 11 percent from the previous year. Livestock feeding operations have expanded tremendously and the feedlot industries have created a great demand for feed grain and hay. In addition, large-scale dairy industries have recently located in western Kansas, bringing with them an increase in demand for high quality alfalfa hay. This increased demand suggests that producers need to find means of improving alfalfa yields, as well as yields of other feed crops. However, in many areas where alfalfa is grown, availability of water can limit yields and traditional irrigation may not consistently meet crop demands.

The net irrigation requirement of alfalfa exceeds the pumping allocation of 24 inches in most years in water-limited western Kansas. This means that any increase in irrigation efficiency should result in increased yields, due to an increase in available water to meet evapotranspiration requirements in the season. A study in California reported a 22 to 35% increase in alfalfa yields due to subsurface drip irrigation compared to furrow irrigation.

[1]Formerly, Research Engineer at SWREC, and presently Natural Resource Engineer at South Dakota State University.
[2]Department Biological and Agricultural Engineering, Kansas State University.

Alfalfa growth is reduced by water stress that occurs during hay-cutting, drying, and baling. The critical stage to meet water needs of alfalfa is after harvest when the crop starts the regrowth. An immediate regrowth of alfalfa helps compete with any germinated weeds. Use of SDI may allow irrigation to continue during harvest and right after harvest to help start a quick regrowth, since the water is applied below the surface.

In SDI, no wetting of the surface should occur. Lack of surface wetting helps reduce the competition from annual weeds that may germinate with surface wetting from sprinkler irrigation. Suppressed weed growth results in improved dairy-quality hay, improving net return to the producer. Alfalfa yields can also be improved by eliminating scalding of leaves that may occur from water left ponded on the surface of the alfalfa leaves after sprinkler irrigation during hot weather. In addition, irrigation efficiency is improved since SDI eliminates evaporation losses.

The application of water by SDI is uniform and efficient since it eliminates losses associated with canopy and soil surface evaporation. The scope of losses from deep percolation is also greatly reduced. Research from Kansas State University indicates that it is possible to save 25 percent of total water diverted in a season by using SDI in corn. Subsurface drip irrigation, however, is an emerging technology in the Great Plains, and needs to be studied further to assess its suitability for raising alfalfa.

The objectives of this study were to: demonstrate SDI for alfalfa in a cooperator's field; measure alfalfa dry matter yields for various SDI drip tape spacings and depths; compare yields of SDI to a nearby sprinkler-irrigated field seeded at the same time; measure soil water content at the midway point between drip tapes to observe the spread of water moving away from the immediate tape area.

PROCEDURES

The SDI system was installed in the corner of a center pivot sprinkler irrigated corn field. The study site is located south of Garden City, Kansas, in the sand hills south of the Arkansas River valley. The soil belongs to the Otero-Ulysses complex and has undulating slopes. The soil texture for the SDI site is sandy loam. The field had been previously leveled for flood irrigation.

In September 1998, drip tapes were plowed in using a deep shank ripper equipped with a tube guide. The largest expense for an SDI system is the drip tape. The closer the spacing of the drip tapes, the more length needed to irrigate a given area of ground and thus greater cost for the system. The treatments were spacing and the depth of placement of drip tapes as follows: 60 inches spacing by 18 inches depth; 60 inches spacing by 12 inches depth; 40 inches spacing by 18 inches depth; 40 inches spacing by 12 inches depth; 30 inches spacing by 18 inches depth; and the final treatment was a nearby center pivot irrigated field, which served as the control.

Nelson 7000 path drip tape was installed. The drip tape diameter was 7/8th inch, with 24 inches emitter spacing. Emitter flow rate was 0.372 gallons per hour per emitter at 8 psi. A 200-mesh rotary disk filter with semiautomatic flush system, provided by Rain Bird, was installed to meet filtration requirements.

Alfalfa was seeded at 6 inches row spacing in the fall of 1998. Water was applied for germination. Seed germination showed distinct lines that indicated where the drip tapes were buried in the plot, especially for the wider spaced drip placements. Fluidyne vortex flow meters, operated by 12 volt DC batteries, were installed,along with a solar panel for continuous recharging. Irrigation application was recorded during the growing season of 1999.

Four samples were collected from each of the six treatment plots to obtain dry matter yields. A one square meter sample area was harvested. The harvest samples were hand clipped during the growing season. The harvest area was randomly selected across the block.

The 1999 growing season started with a relatively wet spring. Early growth was supported by rainfall. Irrigation was started on July 1. Gypsum block soil water sensors were installed at the midpoints between two laterals to represent the furthest point from the wetted line. The depth of placement was 12, 24, and 36 inches below the soil surface. The midpoint location was chosen to represent the worst case scenario from the standpoint of irrigation water being able to recharge that portion of the soil profile. This placement would provide some insight on the ability of the water to migrate from the drip tape outward.

RESULTS AND DISCUSSION

1999

The total water budget from July 1 through September 29, 1999 was: irrigation by SDI -- 13.50 inches (average 0.15 inch/day); sprinkler -- 19.80 inches (average 0.22 inch/day); rainfall -- 6 inches; estimated modified Penman ET -- 20.70 inches (average 0.23 inch/day)

Dry matter yields obtained in 1999 are presented in Table 1. Results are preliminary, nonreplicated, and did not undergo any statistical evaluation.

The first two harvests for center pivot are missing, because there were too many weeds and not enough alfalfa to cut during the first harvest. The second harvest was missed due to timing difference in growth period. Comparison of corresponding total yields for last two cuttings indicate a lower yield for sprinkler-irrigated alfalfa. The greatest total yield was 5.16 ton/acre for the treatment of 40 inches drip tape spacing with 18 inches depth of placement.

Figure 1 shows that the drip tape spacing of 40 inches had a slight advantage over 60 inches spacing The yield difference was 0.45 ton/acre in 1999.

The depth of placement of the drip tapes showed similar dry matter yields (Figure 2), which were approximately 4.9 ton/acre.

Gypsum block readings for soil water distribution to the midpoint between drip tapes at 60 inches spacing placed 18 inches below the surface are presented in Figure 3 for 1999. Soil water was always low at the midpoint between two drip tapes for 60 inches drip tape spacing and the yield was lower. A 'striping' appearance was visible for the 60 inches spacing during the growing season. Water from the 60 inches spacing did not reach the midpoint between the tapes for soils at 36 inches depth until a rain of 2 inches in early August (Figure 3).

Drip tape spacing of 40 inches placed at 12 inches depth provided better water distribution for soils at 1- and 2-ft depths from the beginning of the season, and improved for soils at a depth of 3 feet

Table 1: Alfalfa yields of SDI and sprinkler irrigated plots.

	Date of Harvest and Dry Matter ton/acre					
Treatment*	6-22-99	7-23-99	8-27-99	10-1-99	Total	Total B**
60 (S) by 18 (D)	1.90	0.62	1.14	0.94	4.60	2.08
60 (S) by 12 (D)	1.51	0.92	1.36	0.94	4.73	2.30
40 (S) by 18 (D)	1.65	1.06	1.20	1.25	5.16	2.45
40 (S) by 12 (D)	1.73	1.04	1.25	1.03	5.05	2.28
30 (S) by 18 (D)	1.48	1.00	0.86	1.12	4.46	1.98
Sprinkler (Center Pivot)	---	---	1.03	0.75	---	1.78

*All are inches; S=Spacing and D=Depth ** Total B - Total for last two (2) harvests.

Fig. 1. Dry matter yield as affected by spacing.

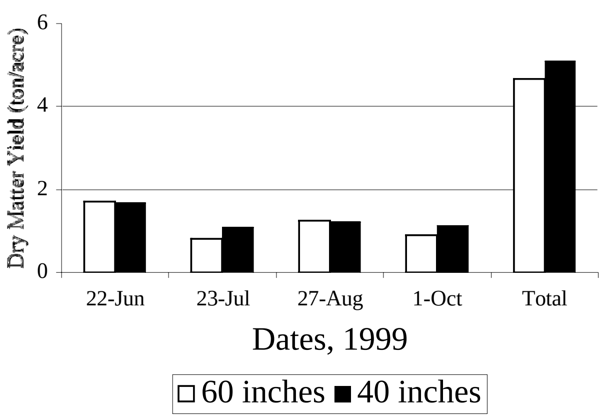
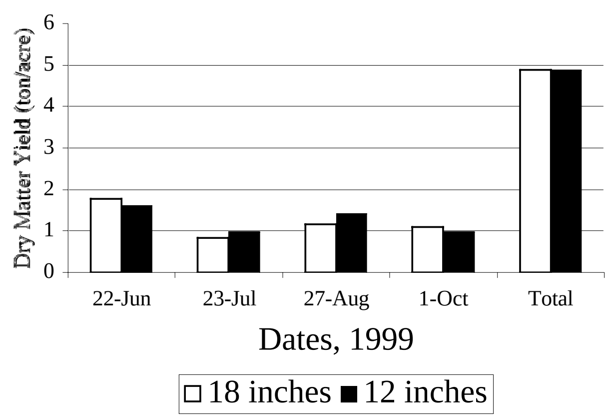


Fig. 2. Dry matter yield as affected by drip tape depth.



depth within a short period (Fig. 4). Irrigation application amount was maintained at the same level for all treatments.

2000

Water applied May 10, 2000 through September 21, 2000: irrigation by SDI -- 21.5 inches (average 0.16 inch/day); sprinkler -- 25 inches (average 0.19 inch/day); rainfall -- 5.51 inches; estimated modified Penman ET -- 41.76 inches (average 0.31inch/day)

Dry matter yields of individual harvests within the season for 2000, including those from the sprinkler-irrigated center pivot field, are presented in Table 2. The highest total yield for the season was a little over 9 ton/acre for the treatment of 40 inches spacing by 12 inches depth of placement. The yield obtained from the center pivot sprinkler treatment was comparable to drip irrigated-treatments in general, although the yield of SDI at 60 inches spacing was slightly lower than the center pivot sprinkler treatment.

Dry matter yield as affected by spacing and placement depth of the drip tapes for the year 2000 are presented in Figures 5 and 6. The results are similar to those from 1999. The drip tape spacing of 40 inches increased the yield by 1.25 tons/acre as compared to drip tape spacing of 60 inches. Depth of placement at 12 inches or 18 inches produced similar yields, although a slight advantage was observed for 18 inches depth of placement (Fig. 6).

A similar pattern of water distribution was observed in the year 2000 as in 1999 (Figs. 7and 8). Distribution was somewhat improved for 60 inches spacing with the increased frequency of irrigation starting in mid July.

The hot and dry summer required an irrigation frequency of three times per week compared to 1.5 times for control and the 1999 season.

Data presented in the figures for soil water status are the readings of the meter. A reading of zero indicates zero available soil water or a depletion of 100 percent. The meter readings are presented for simplicity to show the seasonal changes of soil water content and replenishment from irrigation and rainfall. A conversion chart is given in Table 3 for interpretation of the meter readings in terms of soil water status.

Fig. 3. Gypsum block readings at midpoint for drip tape at 60 inches spacing.

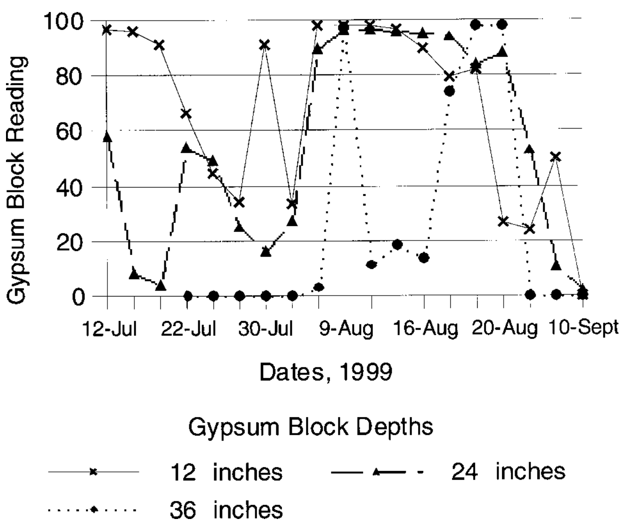


Fig. 4. Gypsum block readings at midpoint for drip tape at 40inches spacing.

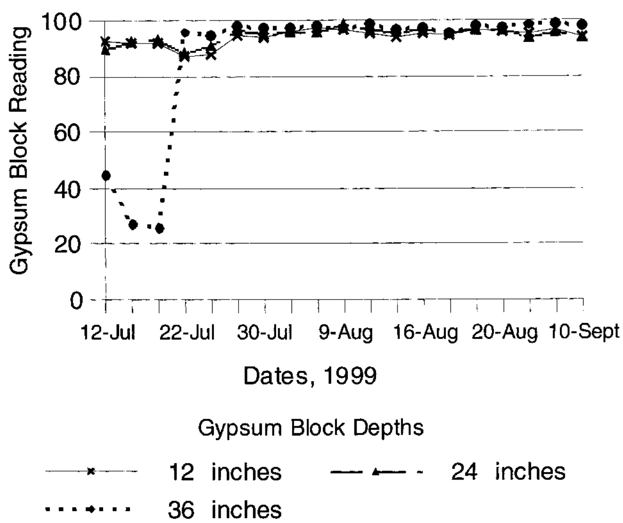


Fig. 5. Dry matter yield as affected by drip tape spacing.

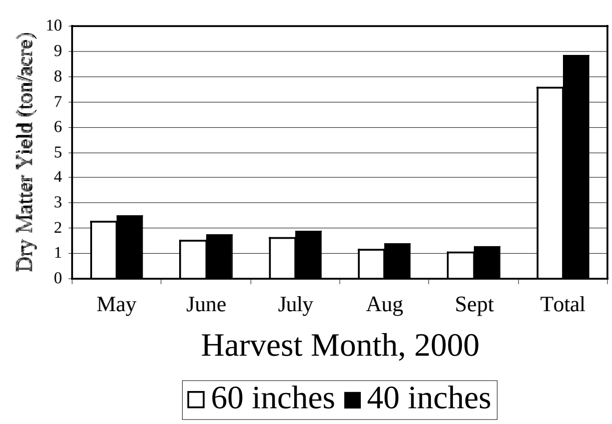


Table 2. Dry matter yield of SDI and sprinkler irrigated alfalfa for 2000.						
	Date of Harvest, Dry Matter ton/acre					
Treatment*	5-22-00	6-23-00	7-28-00	8-25-00	9-26-00	Total
60 (S) x 18 (D)	2.34	1.57	1.83	1.14	1.10	7.98
60 (S) x 12 (D)	2.18	1.45	1.42	1.13	1.00	7.18
40 (S) x 18 (D)	2.40	1.90	1.74	1.40	1.21	8.65
40 (S) x 12 (D)	2.61	1.63	2.05	1.38	1.35	9.02
30 (S) x 18 (D)	2.70	1.61	1.58	1.30	1.27	8.46
Sprinkler (Center Pivot)	1.63	1.99	1.92	1.58	1.26	8.38

*All are in inches; S=Spacing, D=Depth

Fig. 6. Dry matter yield as affected by drip tape placement depth.

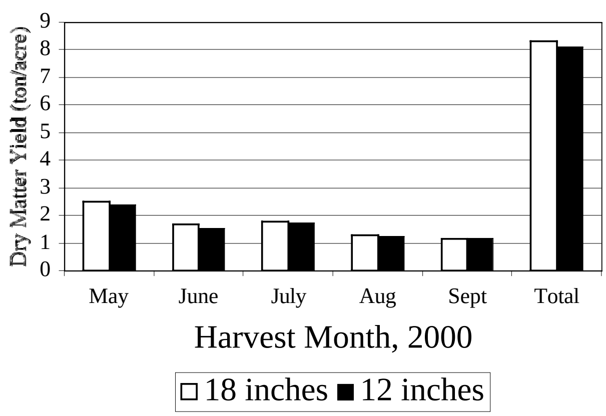


Fig. 8. Gypsum block readings at midpoint drip tape at 40 inches spacing.

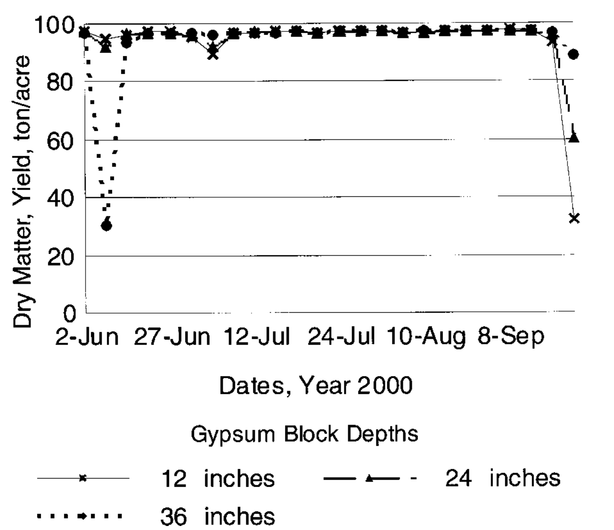
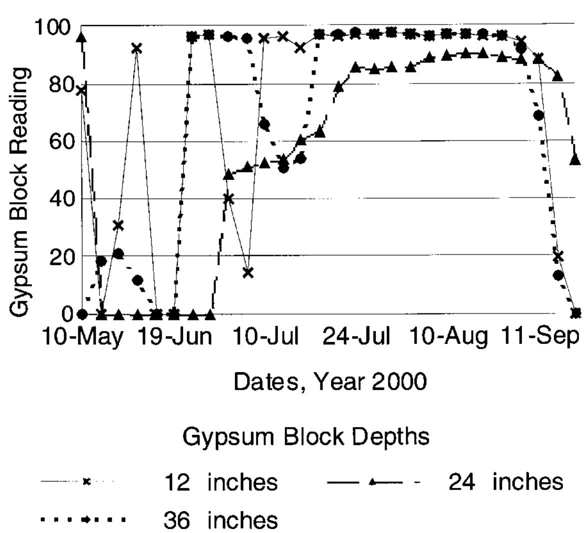


Fig. 7. Gypsum block readings at midpoint for drip tape at 60 inches spacing.



EXTENSION EDUCATION APPLICATION

The demonstration site served as a focal point for educational field tours for area farmers. The results were presented in producer meetings organized by the County Agricultural Extension Agents of the area. Information has been used beneficially by several farmers in the adjoining four counties. There are 250 acres of alfalfa currently on SDI and this happened within a year from the start of the demonstration. Farmers are looking at SDI with great interest, especially those who are experiencing a decline in irrigation well capacity. The information has also been presented at both national and international meetings.

Table 3. Interpretation of meter reading to soil water.

Meter Reading	Available soil water %	Depletion %, Comments
99 to 95	100 to 85	0 to 15% depletion
95 to 85	85 to 70	15 to 30% depletion
85 to 75	70 to 60	30 to 40%, initiate irrigation for light soils
75 to 60	60 to 50	40 to 50%, start irrigation for heavy soils
60 to 40	50 to 40	50 to 60%, caution
40 to 20	40 to 20	60 to 80%, dry
20 to 0	20 to 0	80 to 100% depletion
Negative numbers	None available	Block may lose soil contact

CONCLUSIONS

Alfalfa emergence was affected adversely at a spacing of 60 inches for this site, which has a sandy loam soil. Some striping at emergence was observed in the first year during the establishment period. Yields were reduced slightly for the drip tape spacing of 60 inches. New Mexico State University is conducting research on SDI for alfalfa with a spacing of 30 inches for a clay loam soil, since their experience indicated that 60 inches spacing may not work. In our study, spacing of 30 inches did not show any additional advantage over 40 inches spacing. Depth of placement of drip tapes did not affect the yields, which were similar for depths of 12 and 18 inches. The second year observations showed similar results, although increasing the frequency of irrigation in SDI treatment reduced the striping appearance.

ECONOMIC IMPLICATIONS

An economic study was done at Kansas State University based on 60 inches spacing between laterals for SDI. The closer the spacing, the greater the amount of drip tape used. At a spacing of 40 inches the total length of tape increased by 4,356 ft/acre. The number of fittings required also increased. The calculated cost increased by $250 per acre. The increased yield of 0.5 to 1.25 tons/acre is expected to bring a net return of $40 to $100 per acre per year. This additional investment for the closer spacing could be amortized in 8 years at 7% interest and 10 years at 10 % interest, assuming the lowest yield response. It is expected that an SDI system will last for 15 to 20 years under good management. The SDI system installed at the Experiment Station for corn is 11 years old and functioning without any symptoms of plugging.

FUTURE RESEARCH NEEDS

Long-term replicated and randomized plot studies are needed to fully validate these preliminary results. Root intrusion from a perennial crop like alfalfa is also a possible concern. As such, long-term observations are needed. Use of commercially available Treflan impregnated drip tape may eliminate the occurrence of root intrusion. Root intrusion may also be managed by injecting Treflan through the system. The routine injection of chlorine and acid for the system may also help control root intrusion. Root intrusions were not found to date in this field study, but monitoring will continue.

ACKNOWLEDGMENTS

We thank Steve Stone for providing the land and most of the installation cost. We also thank the following people for their help: Merle Witt, Dennis Tomsicek, Dallas Hensley, A.J. Griffin, Earl Avalon, Phillip Nguyen, Andrew Frey, and Travis Parsons. Partial funding assistance was received from the Southwest Kansas Groundwater Management District No. 3, and material assistance from Gigot, Nelson, Rain Bird, and Western irrigation companies.

IRRIGATION SCHEDULING DEMONSTRATION PROJECT IN WESTERN KANSAS[1]

by
Mahbub Alam, Danny Rogers, and Troy Dumler

SUMMARY

Irrigation-scheduling demonstrations were established in 11counties in southwestern Kansas. Soil-water sensors (gypsum blocks and Watermark sensors) were buried in the field at two locations and placed at three depths. Evapotranspiration (ET) data from the weather station at the Southwest Research and Extension Center (SWREC) were used to calculate water balance. An atmometer (brand name ETgage) was also installed along with a rain gage. ET information from the weather station at SWREC at Garden City was posted in the World Wide Web page. A computer spreadsheet, IRRSCHED, was introduced to the producers for tracking water balance. The spreadsheet was programmed to access the desired data from the web page automatically when wanted. Irrigation scheduling based on ET helped producers take advantage of rainfall to meet the crop's water need. Soil sensors helped in validating soil water status and making irrigation scheduling decisions. Scheduling for better irrigation management is the key to water conservation. A study was done to compare ET data recorded from atmometer (ETgage) with the ET calculated using weather data from the weather station. As a part of irrigation scheduling project, another field study was undertaken to compare the effect of different irrigation closing dates on yield.

INTRODUCTION

Western Kansas is the location of more than two-thirds of the 3 million irrigated acres in Kansas and is dependent on the declining Ogallala aquifer as the primary water source. Production economics and water agency programs have driven a number of changes in irrigated agriculture, including metering of irrigation wells and a conversion to center pivot sprinkler systems. These changes, along with increasingly available electronic database systems and the need for water conservation has resulted in increasing producer interest in ET-based irrigation scheduling. The Western Kansas Irrigation Scheduling Demonstration Project is geared at educating producers on the use of ET-based irrigation scheduling. Demonstrations are established at a cooperator's farm. The purposes of the on-farm sites are to establish a local focal point for data collection and presentation of information through educational tours and meetings. Kansas State University and the local Groundwater Management Districts provide ET-information on the World Wide Web. To build producer confidence in ET-based irrigation scheduling, each site was also equipped with an ET gage and field soil water sensors. An irrigation scheduling spreadsheet, IRRSCHED, was also available to track water balance. Kansas State University has launched an educational program, and County Extension Agricultural Agents have established demonstration sites to work one-on-one with owners/operators. Crop consultants are encouraged to participate in the program.

PROCEDURES

A sample of the spreadsheet 'IRRSCHED', used to track the soil water balance using ET data, rainfall, and soil water status, is shown in Table 1.

The web addresses for the Kansas State University Southwest Research Extension Center weather station at Garden City for 2000 and a sample page are shown in Table 2.

A trial on irrigation cut-off date was achieved by closing progressively a set of six sprinkler nozzles of a center pivot. This was accomplished in a field of a cooperating corn producer in Stevens County.

[1]Project funded by the Kansas Corn Commission from check-off funds.

Table 1. Irrigation scheduling – IRRSCHED (Excerpt from Meyer Farm spreadsheet).							
User Input							
Crop: Corn			Acres Irrigated: 125 acres				
Rooting Depth: 3 ft.			Irrigation Efficiency: 80%				
Soil type: FSL			Allowable Depletion: 50%				
Water Holding Cap: 1.92 in/ft			Initial Depletion: 0 inches				
Well flow Rate: 750 gpm			Root Zone WH Cap: 5.76 inches				
			Allowable Depletion: 2.88 inches				
Date	Effective Rainfall	Gross Irrigation	Etr	Growth Stage	Kc	ETa	Depletions
	Inch	Inch	Inch			Inch	Inch
June 27			0.15		0.80	0.12	0.45
June 28			0.22		0.81	0.19	0.57
June 29	0.75		0.16		0.82	0.13	0.76
June 30			0.07		0.84	0.06	0.14
July 1			0.07		0.85	0.06	0.20
July 2			0.19		0.86	0.16	0.26
July 3			0.26		0.87	0.23	0.42

Table 2. http://www.oznet.ksu.edu/SWAreaOffice/Irrigation/et00.htm.

Date, 2000	DOY	Ref.ET	Wheat	Corn5	Corn24	Sorghum	Soybean	Turf	GDU	Tmax	Tmin
5-23	144	0.36	0.36	0.10	N/A	N/A	N/A	0.29	22.0	99	58
5-24	145	0.21	0.21	0.06	0.04	N/A	N/A	0.17	18.3	82	55
5-25	146	0.23	0.23	0.07	0.05	N/A	0.05	0.18	15.4	80	51
5-26	147	0.20	0.20	0.06	0.04	N/A	0.04	0.16	20.2	83	57
5-27	148	0.33	0.33	0.10	0.07	N/A	0.07	0.26	19.5	82	57
5-28	149	0.47	0.47	0.15	0.09	N/A	0.09	0.38	19.0	96	52
5-29	150	0.45	0.45	0.15	0.09	N/A	0.09	0.36	23.3	100	61
5-30	151	0.42	0.42	0.15	0.08	0.08	0.08	0.34	28.1	97	70

RESULTS AND DISCUSSION

The demonstration fields were utilized as a local point to hold irrigation field tours. Twenty-two irrigation tours were held in 11 sites and 357 individuals attended. The results and experiences from these were shared in educational meetings. Seventeen such meetings were held and 741 persons attended these meetings.

The reference ET data from ETgages and Penman reference ET from the K-State weather station at the Southwest Research and Extension Center (SWREC) are shown in Figure 1. The plot shows data from three ET gages with canvas cover #54 compared to ET data from the weather station. ET gages tended to over-predict especially at the end of August.

A regression analysis of the data was performed and the result presented in Figure 2. The R-squared value was 0.64 and the standard errore 0.04. The data obtained from ET gages may be adjusted by the equation shown in Figure 2.

Soil water monitoring results for the gypsum block at Stalker Farm are presented in Figure 3. The gypsum block readings indicate the water status during the growing season.

The soil water level at Stalker Farm started to fall by the end of July. The rainfall on August 2, 4, and 5, 1999, along with irrigation, helped to restore the soil water back to the total water holding capacity. This illustrates the value of using sensors to check soil water status. This is a good practice even though one may feel confident in using ET based scheduling.

A preliminary result from the first year trial on irrigation cut-off date is presented in Figure 4.

Fig. 1. ET data from ETgage with canvas cover #54 compared to Penman ETr at SWREC weather station.

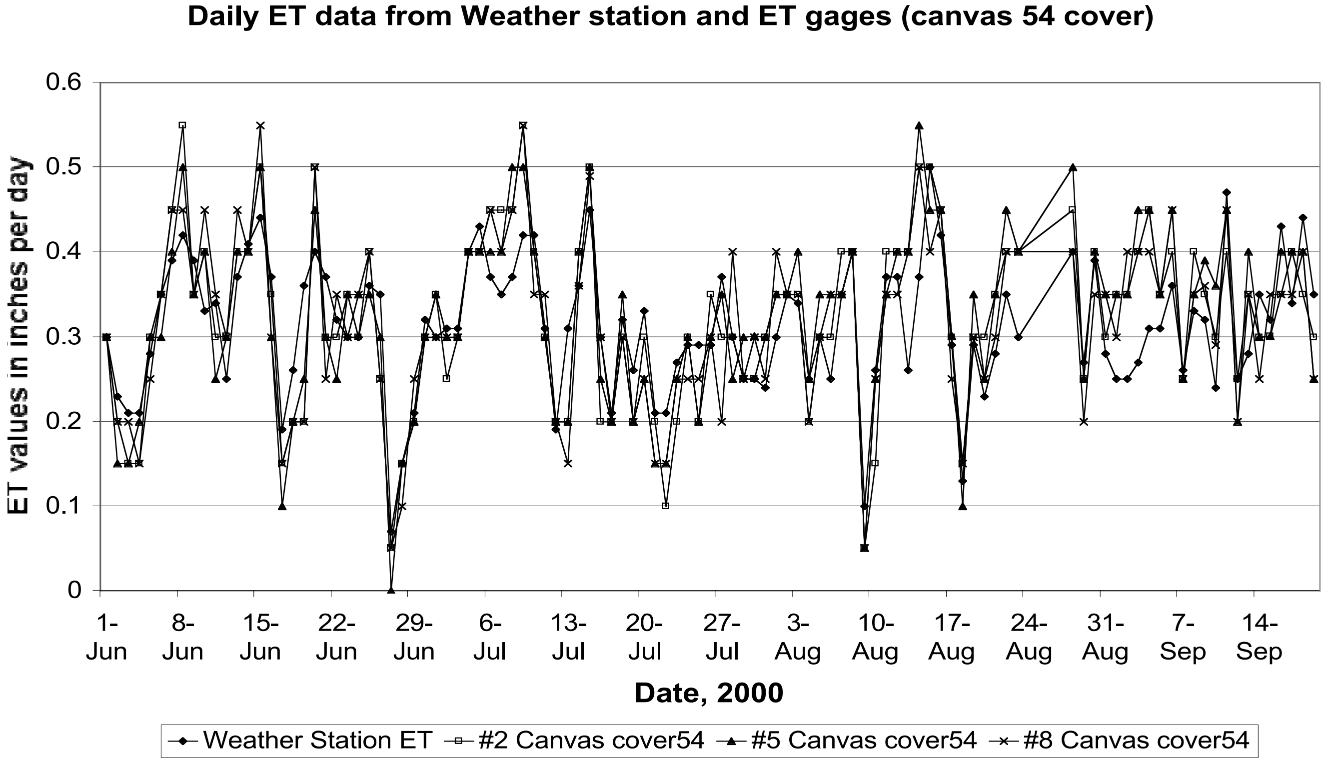


Fig. 2. Graph showing regression data and predicted ET values connected with a line drawn.

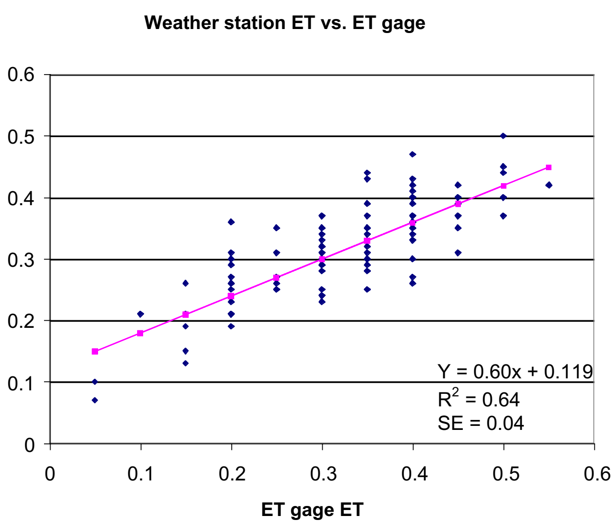


Fig. 3. Soil water status at Stalker Farm as observed from Gypsum block.

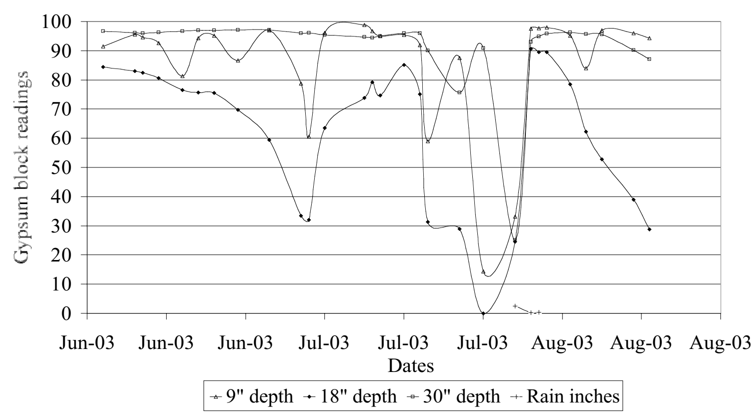


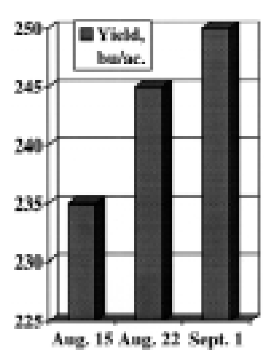
Fig. 4. Corn yield as affected by different irrigation cut-off dates.

Irrigation cut-off dates
August 15, 22, and Sept.1

Aug. 15-22, water use 2.1 in.

Cost $8.40 at $4 per acre-inch
Return $23 for 10 bu at
$2.30 for corn

Aug. 22 - Sept. 1, water use 3 in., cost $12, return $11.50 for 5 bu..



ACKNOWLEDGMENTS

We acknowledge Jeff K. Elliott, Farm Manager, for his untiring help in data collection from ET gages. We thank the participating County Extension Agriculture Agents and the cooperator farmers. We also acknowledge the funding support provided by the Kansas Corn Commission to the demonstration project from check-off funds.

EARLY PREPLANT BURNDOWN WITH BALANCE TANK MIXES

by
Randall Currie

SUMMARY

Most treatments provided some control of all weeds from 3 weeks prior to planting until late into the season. However, control was not commercially acceptable, with the exception of Palmer amaranth. All tankmixes of Balance and 1.5 lbs of atrazine provide good long season control of Palmer amaranth.

INTRODUCTION

Although Balance is an excellent preemergence herbicide, it can cause severe injury to corn when applied postemergence. We hypothesized that it might provide value as an early preplant burndown herbicide prior to corn planting. Although it has good soil persistence, it is unknown how long prior to corn planting these treatments could be applied and still provide adequate in-crop weed control. Therefore, the objectives of this study were to apply several Balance tank mixes 3 weeks prior to planting and evaluate their burndown potential and longevity of control in the corn crop.

PROCEDURES

Weeds were planted to supplement existing natural populations, as described in Table 1. Three weeks prior to corn planting herbicide treatments were applied as described in Table 3. Roundup was applied to all plots but the control, as described in Table 3. Following herbicide applications, corn was planted as described in Table 2. Weed and crop sizes and relative numbers throughout the test are described in Table 4.

RESULTS AND DISCUSSION

Treatments followed by the letter T produced yields not statistically different from the top treatment. These results suggest that a rate of 0.06 lbs/a or more Balance plus 1. 5 lbs/a atrazine, or 0.07 lbs/a Balance plus 0.4 lbs, 2,4-D are better than lower rates of Balance, plus 1.5 lbs atrazine or 0.06 lbs /a Balance alone.

Prior to planting, these treatments provided from 18 to 37%; 7 to 44%; 13 to 59%; and 75 to 100%

Table 1. Weed seeding information, corn herbicide study, Garden City, KS, 2000.

Variety:	Palmer Amaranth, Yellow Foxtail, Crabgrass, Sunflowers, and Shattercane
Planting date:	4-6-00
Planting method:	14 ft Great Plains drill
Carrier:	Cracked corn at 40 lbs/a (used for a mixture of the above weeds, except Shattercane)
Rate, unit:	Palmer Amaranth at 276 grams/a = approx. 700,000 seeds/a, Yellow Foxtail at 1032 grams/a = approx. 344,124 seeds/a, Crabgrass at 5557 grams/a = approx. 9.8 million seeds/a, Sunflowers at 1814 grams/a = approx. 40,000 seeds/a. Shattercane at 5 lbs/a = approx. 119,400 seeds/a planted on 4-10-00.
Depth, unit:	The tubes were pulled off of drill for weed mixture, except Shattercane, and dropped on the soil surface. Shattercane was drilled separately with every 1/3 hole set at 1 inch deep, 2 inches deep, and a tube pulled for seed to be dropped on soil surface.
Row spacing, unit:	10 inches
Soil temperature, unit:	55 F
Soil moisture:	Good

Table 2. Production information for corn herbicide study, Garden City, KS, 2000.	
Variety:	DK 595 BtY
Planting Date:	5-19-00
Planting Method:	John Deere Max Emerge II, 6-row planter
Rate, Unit:	36,900 seeds/a
Depth, Unit:	1.5 inches
Row Spacing, Unit:	30 inches
Soil Temperature, Unit:	65 F
Soil Moisture:	Dry top 1”, moist below
Emergence Date:	5-26-00

Table 3. Application information, corn herbicde study, Garden City, KS, 2000.		
Application date:	5-5-00	5-19-00
Time of day:	3:00 pm	10:15 am
Application method:	Broadcast	Broadcast
Application timing:	Burndown	Post weeds in check
Air temperature, unit:	70 F	57 F
Wind velocity, unit:	15-20 mph SE	0 mph
Dew presence:	None	None
Soil temperature, unit:	68 F	65 F
Soil moisture:	Good	Dry top 1”, moist below
% Relative humidity:	78%	59%
% Cloud cover:	100%	50%
Chemical applied:	Protocol treatments	Roundup at 0.5 qt/a
Application equipment:	Windshield sprayer	Hand-boom
Nozzle type/brand:	Teejet XR	Teejet XR
Nozzle size:	8004 VS	8002 VS
Nozzle spacing, unit:	20 in.	20 in.
Boom length, unit:	10 ft.	5 ft.
Boom height, unit:	18 in.	25 in.
Pressure, unit:	38 psi	40 psi
Ground speed:	3.2 mph	2.8 mph
Application rate:	20 gpa	12 gpa
Incorporation equipment:	None	None
Time to incorporate, unit:	N/A	N/A
Incorporation depth, unit:	N/A	N/A
Spray volume, unit:	3 Liter	3 Liter
Carrier:	H_2O	H_2O
Propellant:	CO_2	CO_2

control of shattercane, sunflowers, crabgrass and Palmer amaranth, respectively. This control was too variable to allow one treatment to be declared superior to any other.

All treatments provided significant levels of sunflower and shattercane control late season (Table 6 and 7). None of the treatments was superior to the other. Further, no treatment provided a level of control that would be commercially acceptable.

All treatments except Balance alone provided good control of crabgrass at two or more rating dates (Table 8). Other research suggests that this level of control may be atypical. Over the last 3 years, this site has produced much greater levels of crabgrass control with Balance tank mixes than others have reported. Naturally occurring levels of crabgrass are low at this site so the primary source of seed was from overseeding. These seeds may be planted much more shallow and at lower levels than other locations. Therefore, these data should not be used alone to make a choice for crabgrass control.

Table 4. Corn and weed stages of growth at various dates, corn herbicide study, Garden City, KS, 2000.

Date	Corn	Weeds
5/5/00	—-	Sunflowers = 2-leaf, 1 inch tall; Shattercane = 2-leaf, 1 inch tall.
5/18/00	—-	Sunflowers = 4-leaf, 2 inches; Shattercane = 2-leaf, 2 inches; Pigweed = 4-leaf, 0.25 inch; Crabgrass = 2-leaf, 0.5 inch.
6/8/00	2-collar	Weed heights are in tables.
6/20/00	5-collar	Weed heights are in tables.
6/30/00	7-collar	Sunflowers = 24 inches; Shattercane = 26 inches; Pigweed = 27 inches; Yellow Foxtail = 15 inches; Crabgrass = 6 inches.
7/13/00	9-collar	Weed heights are in tables.
8/7/00	Tassel	Sunflowers = 43 inches; Shattercane = 53 inches; Pigweed = 53 inches; Yellow Foxtail = 40 inches; Crabgrass = 18 inches.

Table 5. Corn yield in bushels/acre.

Treatment	Rate (lbs ai/a)	Yield bu/a
1 Balance + COC	0.06, 1.25%	55
2 Balance + Atrazine + COC	0.03, 1.5, 1.25%	61
3 Balance + Atrazine + COC	0.04, 1.5, 1.25%	60
4 Balance + Atrazine + COC	0.06, 1.5, 1.25%	72T
5 Balance + Atrazine + COC	0.07, 1.5, 1.25%	94T
6 Balance + Atrazine + 2,4-D + COC	0.07, 1.5, 0.5, 1.25%	71T
7 Balance + 2,4-D + COC	0.07, 0.5, 1.25%	69T
8 Check		18
LSD (0.05)		25

Table 6. Percent reduction of sunflowers.

Treatment	Rate (lbs ai/a)	Appl. Stage	8/7
1 Balance + COC	0.06, 1.25%	Burndown	73T
2 Balance + Atrazine + COC	0.03, 1.5, 1.25%	Burndown	59T
3 Balance + Atrazine + COC	0.04, 1.5, 1.25%	Burndown	64T
4 Balance + Atrazine + COC	0.06, 1.5, 1.25%	Burndown	65T
5 Balance + Atrazine + COC	0.07, 1.5, 1.25%	Burndown	71T
6 Balance + Atrazine + 2,4-D + COC	0.07, 1.5, 0.5, 1.25%	Burndown	73T
7 Balance + 2,4-D + COC	0.07, 0.5, 1.25%	Burndown	65T
8 Check	—-	—-	0
LSD (0.05) =			23

Table 7. Percent reduction of shattercane.			
Treatment	Rate (lbs ai/a)	Appl Stage	8/7
1 Balance + COC	0.06, 1.25%	Burndown	78T
2 Balance + Atrazine + COC	0.03, 1.5, 1.25%	Burndown	54T
3 Balance + Atrazine + COC	0.04, 1.5, 1.25%	Burndown	79T
4 Balance + Atrazine + COC	0.06, 1.5, 1.25%	Burndown	71T
5Balance + Atrazine + COC	0.07, 1.5, 1.25%	Burndown	74T
6 Balance + Atrazine + 2,4-D + COC	0.07, 1.5, 0.5, 1.25%	Burndown	80T
7 Balance + 2,4-D + COC	0.07, 0.5, 1.25%	Burndown	81T
8 Check	—-	—-	0
LSD (0.05) =			33

Table 8. Percent reduction of crabgrass.				
Treatment	Rate (lbs ai/a)	Appl Stage	6/30	8/7
1 Balance + COC	0.06, 1.25%	Burndown	68	88T
2 Balance + Atrazine + COC	0.03, 1.5, 1.25%	Burndown	84T	79T
3 Balance + Atrazine + COC	0.04, 1.5, 1.25%	Burndown	93T	89T
4 Balance + Atrazine + COC	0.06, 1.5, 1.25%	Burndown	94T	95T
5 Balance + Atrazine + COC	0.07, 1.5, 1.25%	Burndown	96T	94T
6 Balance + Atrazine + 2,4-D + COC	0.07, 1.5, 0.5, 1.25%	Burndown	98T	95T
7 Balance + 2,4-D + COC	0.07, 0.5, 1.25%	Burndown	95T	91T
8 Check	—-	—-	0	0
LSD (0.05) =			24	17

All levels of Balance provided excellent long season control of Palmer amaranth when tank mixed with 1.5 lbs of atrazine (Table 9). Balance alone or tank mixed with 2,4-D provided some level of control. Therefore, it seems safe to speculate that it is adding to the level of control provided by atrazine alone.

This should provide an excellent tool to delay the development of atrazine resistance in this species.

Table 9. Percent reduction of Palmer amaranth, early burndown test, Garden City, KS, 2000.				
Treatment	Rate (lbs ai/a)	Appl Stage	7/13	8/7*
1 Balance + COC	0.06, 1.25%	Burndown	57	65
2 Balance + Atrazine + COC	0.03, 1.5, 1.25%	Burndown	100T	96T
3 Balance + Atrazine + COC	0.04, 1.5, 1.25%	Burndown	96T	95T
4 Balance + Atrazine + COC	0.06, 1.5, 1.25%	Burndown	100T	96T
5 Balance + Atrazine + COC	0.07, 1.5, 1.25%	Burndown	100T	99T
6 Balance + Atrazine + 2,4-D + COC	0.07, 1.5, 0.5, 1.25%	Burndown	94	98T
7 Balance + 2,4-D + COC	0.07, 0.5, 1.25%	Burndown	75	78
8 Check	-	—-	0	0
LSD (0.05) =			17	16

COMPARISONS OF 46 HERBICIDE TANK MIXES FOR WEED CONTROL IN LIBERTY AND PURSUIT TOLERANT CORN

by
Randall Currie

SUMMARY

Atrazine has been widely used for more than 35 years, yet it still remains a vital component in herbicide tank mixes for weed control in corn. Only treatments containing more than 1.1 lbs of atrazine/a had top yields and provided good broadleaf weed control.

INTRODUCTION

Corn resistant to the herbicides Liberty and Pursuit has been available for several years. However, corn varieties containing genes for resistance to both herbicides have only recently become available. Therefore, it was the objective of this study to compare a broad range of herbicide tank mixes for weed control in corn varieities containing heribicide resistance to both Liberty and Pursuit.

PROCEDURES

Weeds were planted to supplement existing natural populations, as described in Table 1. Three weeks prior to corn planting, herbicide treatments were applied as described in Table 3. Prior to corn planting, Roundup was applied to all plots but the control, as described in Table 3. Corn was then planted as described in Table 2. Weed and crop sizes and relative numbers throughout the test are described in Table 4.

RESULTS AND DISCUSSION

Treatments followed by the letter T produced yields not statistically different from the top treatment. All of these treatments contained at least 1 lb atrazine. Although atrazine has been widely used for more than 35 years, it still is a vital component in herbicide take mixes for weed control in corn.

Table 1. Weed seeding information corn herbicide study, Garden City, KS, 2000.

Variety:	Palmer Amaranth, Yellow Foxtail, Crabgrass, Sunflowers, and Shattercane
Planting date:	4-19-00
Planting method:	14’ Great Plains drill
Carrier:	Cracked corn at 40 lbs/a (used with a mixture of the above weeds, except Shattercane)
Rate, unit:	Palmer Amaranth at 276 grams/a = approx. 700,000 seeds/a, Yellow Foxtail at 1032 grams/a = approx. 344,124 seeds/a, Crabgrass at 5557 grams/a = approx. 9.8 million seeds/a, Sunflowers at 1814 grams/a = approx. 40,000 seeds/a, Shattercane at 5 lbs/a = approx. 119,400 seeds/a
Depth, unit:	The tubes were pulled off of drill for weed mixture and dropped on the soil surface. Shattercane was drilled separately with every 1/3 hole set at 1 inch deep, 2 inches deep, and a tube pulled for seed to be dropped on soil surface.
Row spacing, unit:	10 inches
Soil temperature, unit:	55 F
Soil moisture:	Good

Table 2. Production information for corn herbicide study, Garden City, KS, 2000.	
Variety:	Garst 8692 LL IT Bt
Planting date:	4-21-00
Planting method:	John Deere Max Emerge II, 6-row planter
Rate, unit:	36,000 seeds/acre
Depth, unit:	1.5 inches
Row spacing, unit:	30 inches
Soil temperature, unit:	60 F
Soil moisture:	Dry top 1/2”, moist below
Emergence date:	4-30-00

Table 3. Application information for general Balance herbicide corn test, Garden City, KS 2000.

Application date:	4-21-00	5-31-00
Time of day:	1:00-6:30 p.m.	9:30 a.m.- 3:30 p.m.
Application method:	Broadcast	Broadcast
Application timing:	PRE	POST
Air temperature, unit:	76 F	94 F
Wind velocity, unit:	18-22 mph S	5-7 mph SW until noon, 25-32 mph S after 12:00 p.m.
Dew presence:	None	None
Soil temperature, unit:	60 F	83 F
Soil moisture:	Dry 1/2”, moist below	Dry top 1”, moist below
% Relative humidity:	23%	24%
% Cloud cover:	30%	0%
Chemical applied:	Pre treatments from protocols	Post & Mpost trt. from protocols
Application equipment:	Windshield sprayer	Windshield sprayer
Nozzle type/brand:	Teejet XR	Teejet XR
Nozzle size:	8004 VS	8004 VS
Nozzle spacing, unit:	20 in.	20 in.
Boom length, unit:	10 ft.	10 ft.
Boom height, Unit:	18 in.	18 in.
Pressure, unit:	38 psi	38 psi
Ground speed:	3.2 mph	3.2 mph
Application rate:	20 gpa	20 gpa
Incorporation equipment:	None	None
Time to incorporate, unit:	N/A	N/A
Incorporation depth, unit:	N/A	N/A
Spray volume, unit:	3 Liter	3 Liter
Carrier:	H_2O	H_2O
Propellant:	CO_2	CO_2

Note: On 5-31-00 treatments 1 through 23 were applied before noon.

Table 4. Corn and weed stages of growth.		
Date	Corn	Weeds
5/17/00	2-collar, approx. 6 inches tall	Sunflowers = 2-4 leaf, 1 inch tall; Shattercane = 2-leaf, 2 inches tall; Pigweed = 4-leaf, 0.5 inch tall; Crabgrass = 1-leaf, 0.5 inch tall.
5/24/00	4-collar, approx. 11 inches tall	Sunflowers = 6-8 leaf; Shattercane = 2-4 leaf; Pigweed = 6-leaf; Yellow Foxtail = 4-leaf; Crabgrass = 2-leaf.
6/15/00	6-collar	Weed heights are in tables.
6/30/00	10-collar	Sunflowers = 25 inches; Shattercane = 34 inches; Pigweed = 31 inches; Yellow Foxtail = 17 inches; Crabgrass = 8 inches.
7/6/00	Tassel	Crabgrass in the furrow = 1/8 – 1 inch tall.
7/12/00	Tassel	Weed heights are in tables.
7/20/00	—-	Crabgrass in the furrow = 2 – 20 inches tall.
7/27/00	—-	Sunflowers = 47 inches; Shattercane = 46 inches; Pigweed = 55 inches; Yellow Foxtail = 22 inches; Crabgrass = 19 inches.
8/8/00	—-	Sunflowers = 52 inches; Shattercane = 51 inches; Pigweed = 63 inches; Yellow Foxtail = 25 inches; Crabgrass = 23 inches.
8/22/00	—-	Sunflowers = 37 inches; Shattercane = 55 inches; Pigweed = 71 inches; Yellow Foxtail = 34 inches; Crabgrass = 33 inches.

All treatments provided some level of sunflower control (Table 6). Treatments followed by the letter T produced sunflower control not statistically different from the top treatment. All of these top treatments contained greater than 1.1 lb/a atrazine.

Most treatments produced excellent shattercane control (Table 7). Treatments followed by the letter T produced control not statistically different from the top treatment. It must be noted that the control provided by Bicep, Frontier, Fulltime, TopNotch, and Dual II, although not unprecedented, should not be considered typical.

Most treatments produced excellent control of Palmer amaranth (Table 8). Treatments followed by the letter T produced control not statistically different from the top treatment. Treatments containing more than 1.1 lb of atrazine most often produced the best control.

Most treatments provided excellent control of crabgrass in the early season (Table 9). Treatments followed by the letter T produced control not statistically different from the top treatment. However, many of these same treatments failed to maintain this level of control all season long.

Most treatments produced good control of foxtail throughout the length of the season (Table 10). Treatments followed by the letter T produced control not statistically different from the top treatment. The natural level of foxtail at this site was low so the bulk of plants were produced by over seeding. The process used to plant the foxtail places the seeds shallow. Therefore, control seen at this site is probably a bit higher than would be seen in natural plant populations.

Table 5. Harvest data in bushels/acre.

Treatment	Rate (lbs ai/a)	Appl. Stage	Yield bu/a
1 Bicep II Magnum	2.9	Pre	76
2 Atrazine / Liberty + Atrazine + AMS	1.0 / 0.3, 0.5, 3.0	Pre/Post	86T
3 Balance Pro / Liberty + Atrazine + AMS	0.03 / 0.3, 0.75, 3.0	Pre/Post	99T
4 Dual II / Liberty + Atrazine + AMS	0.98 / 0.3, 0.5, 3.0	Pre/Post	70
5 Liberty ATZ + AMS	1.36, 3.0	Mpost	51
6 Accent Gold + Clarity + COC + 28%UAN	0.15, 0.06, 1.0%, 2.5%	Mpost	63
7 Leadoff / Basis Gold + COC + 28%UAN	0.7 / 0.79, 1.0%, 2.5%	Pre/Post	71
8 Bicep II Magnum / Northstar + Spirit + Exceed + COC + 28%UAN	2.9 / 0.14, 0.036, 0.036, 1.0%, 2.5%	Pre/Post	87T
9 Frontier / Distinct + NIS + 28%UAN	1.17 / 0.13, 0.25%, 2.5%	Pre/Post	72
10 FulTime / Hornet + COC + 28%UAN	3.0 / 0.13, 1.0%, 2.5%	Pre/Post	81T
11 AE F130360-01 + MSO + 28%UAN	0.055, 0.94%, 2.5%	Mpost	43
12 AE F130360-02 + MSO + 28%UAN	0.048, 0.94%, 2.5%	Mpost	48
13 Balance Pro + Atrazine / AE F130360-01 + MSO + 28%UAN	0.04, 1.0 / 0.055, 0.94%, 2.5%	Pre/Post	92T
14 Balance Pro / AE F130360-02 + MSO + 28%UAN	0.04 / 0.048, 0.94%, 2.5%	Pre/Post	76
15 AE F130360-01 + Atrazine + MSO + 28%UAN	0.055, 0.34, 0.94%, 2.5%	Mpost	61
16 AE F130360-02 + Atrazine + MSO + 28%UAN	0.048, 0.34, 0.94%, 2.5	Mpost	63
17 Prowl + Atrazine / Lightning + Clarity + MSO + 28%UAN	0.99, 1.0 / 0.056, 0.12, 1.0 %, 2.5%Pre/Post		81T
18 Lightning + Clarity + MSO + 28%UAN	0.056, 0.12, 1.0%, 2.5%	Post	76
19 Lightning + Distinct + NIS + 28%UAN	0.056, 0.19, 0.25%, 2.5	Post	70
20 Lightning + Atrazine + MSO + 28%UAN	0.056, 1.0, 1.0%, 2.5%	Post	72
21 Pursuit Plus + Atrazine	0.94, 1.0	Pre	94T
22 Lightning + Liberty + NIS + AMS	0.056, 0.36, 0.25%, 2.5	Post	53
23 FulTime	3.0	Pre	69
24 FulTime / ZA1296 + COC	2.5 / 0.094, 1.0%	Pre/Post	61
25 TopNotch / ZA1296 + COC	1.92 / 0.094, 1.0%	Pre/Post	76
26 Dual II / Aim + Atrazine + NIS	1.95 / 0.008, 0.75, 0.25%	Pre/Post	57
27 Dual II / Aim + Clarity + NIS	1.95 / 0.008, 0.25, 0.25%	Pre/Post	44
28 Aim + Basis Gold + COC + 28%UAN	0.008, 0.78, 1.0%, 5.0%	Post	53
29 Dual II / Aim + Balance + NIS	1.95 / 0.008, 0.02, 0.25%	Pre/Post	58
30 Axiom AT	1.88	Pre	87T
31 Axiom AT + Balance	1.13, 0.047	Pre	86T
32 Axiom + Balance + Atrazine	0.38, 0.047, 1.0	Pre	92T
33 EPIC + Atrazine	0.36, 1.0	Pre	93T
34 EPIC + Atrazine	0.29, 1.0	Pre	95T
35 USA 2001	0.58	Pre	80
36 USA 2001 + Atrazine	0.58, 1.0	Pre	91T
37 Flufenacet + EPIC + Atrazine (USA 3001)	0.23, 0.27, 1.0	Pre	101T
38 USA 2001 / Basis Gold + Banvel + NIS	0.29, 0.79, 0.13, 0.25%	Pre/Post	78
39 Axiom AT / Basis Gold + Banvel + NIS	0.75 / 0.79, 0.13, 0.25%	Pre/Post	91T
40 Leadoff / Basis Gold + Banvel + COC + 28%UAN	0.94 / 0.79, 0.13, 1.0% 2.5%	Pre/Post	101T
41 Leadoff + Balance / Basis Gold + Banvel + COC + 28%UAN	0.94, 0.02 / 0.79, 0.13, 1.0%, 2.5%	Pre/Post	96T

continued

Table 5. Harvest data in bushels/acre, continued.

Treatment	Rate (lbs ai/a)	Appl. Stage	Yield bu/a
42 Leadoff + Balance / Basis Gold + Banvel + COC + 28%UAN	0.94, 0.05 / 0.79, 0.13, 1.0%, 2.5%	Pre/Post	103T
43 Basis Gold + Banvel + COC + 28%UAN	0.79, 0.13, 1.0%, 2.5%	Post	75
44 Basis Gold + Aim + Banvel + COC + 28%UAN	0.79, .008, .06, 1%, 2.5	Post	69
45 Basis + Marksman + COC + 28%UAN	0.015, 0.4, 1.0%, 2.5%	Post	62
46 Atrazine / Basis + NIS	1.0 / 0.02, 0.25%	Pre/Post	94T
47 Check	—-	—-	27
LSD (0.05) =			24

Table 6. Percent reduction of sunflowers.

Treatment	Rate (lbs ai/a)	Appl. Stage	6/30*	8/22*
1 Bicep II Magnum	2.9	Pre	99T	100T
2 Atrazine / Liberty + Atrazine + AMS	1.0 / 0.3, 0.5, 3.0	Pre/Post	100T	100T
3 Balance Pro / Liberty + Atrazine + AMS	0.03 / 0.3, 0.75, 3.0	Pre/Post	100T	100T
4 Dual II / Liberty + Atrazine + AMS	0.98 / 0.3, 0.5, 3.0	Pre/Post	99T	99T
5 Liberty ATZ + AMS	1.36, 3.0	Mpost	99T	98T
6 Accent Gold + Clarity + COC + 28%UAN	0.15, 0.06, 1.0%, 2.5%	Mpost	98T	100T
7 Leadoff / Basis Gold + COC + 28%UAN	0.7 / 0.79, 1.0%, 2.5%	Pre/Post	95T	88
8 Bicep II Magnum / Northstar + Spirit + Exceed + COC + 28%UAN	2.9 / 0.14, 0.036, 0.036, 1.0%, 2.5%	Pre/Post	100T	100T
9 Frontier / Distinct + NIS + 28%UAN	1.17 / 0.13, 0.25%, 2.5%	Pre/Post	93T	95T
10 FulTime / Hornet + COC + 28%UAN	3.0 / 0.13, 1.0%, 2.5%	Pre/Post	100T	100T
11 AE F130360-01 + MSO + 28%UAN	0.055, 0.94%, 2.5%	Mpost	98T	99T
12 AE F130360-02 + MSO + 28%UAN	0.048, 0.94%, 2.5%	Mpost	98T	100T
13 Balance Pro + Atrazine / AE F130360-01 + MSO + 28%UAN	0.04, 1.0 / 0.055, 0.94%, 2.5%	Pre/Post	100T	100T
14 Balance Pro / AE F130360-02 + MSO + 28%UAN	0.04 / 0.048, 0.94%, 2.5%	Pre/Post	100T	100T
15 AE F130360-01 + Atrazine + MSO + 28%UAN	0.055, 0.34, 0.94%, 2.5%	Mpost	85T	99T
16 AE F130360-02 + Atrazine + MSO + 28%UAN	0.048, 0.34, 0.94%, 2.5%	Mpost	98T	99T
17 Prowl + Atrazine / Lightning + Clarity + MSO + 28%UAN	0.99, 1.0 / 0.056, 0.12, 1.0 %, 2.5%	Pre/Post	99T	100T
18 Lightning + Clarity + MSO + 28%UAN	0.056, 0.12, 1.0%, 2.5%	Post	93T	100T
19 Lightning + Distinct + NIS + 28%UAN	0.056, 0.19, 0.25%, 2.5%	Post	98T	100T
20 Lightning + Atrazine + MSO + 28%UAN	0.056, 1.0, 1.0%, 2.5%	Post	78	90
21 Pursuit Plus + Atrazine	0.94, 1.0	Pre	100T	100T
22 Lightning + Liberty + NIS + AMS	0.056, 0.36, 0.25%, 2.5%	Post	70	80
23 FulTime	3.0	Pre	91T	91T
24 FulTime / ZA1296 + COC	2.5 / 0.094, 1.0%	Pre/Post	95T	97T
25 TopNotch / ZA1296 + COC	1.92 / 0.094, 1.0%	Pre/Post	99T	98T
26 Dual II / Aim + Atrazine + NIS	1.95 / 0.008, 0.75, 0.25%	Pre/Post	48	71
27 Dual II / Aim + Clarity + NIS	1.95 / 0.008, 0.25, 0.25%	Pre/Post	88T	98T
28 Aim + Basis Gold + COC + 28%UAN	0.008, 0.78, 1.0%, 5.0%	Post	51	83
29 Dual II / Aim + Balance + NIS	1.95 / 0.008, 0.02, 0.25%	Pre/Post	48	86

continued

Table 6. Percent reduction of sunflowers, continued.

Treatment	Rate (lbs ai/a)	Appl. Stage	6/30*	8/22*
30 Axiom AT	1.88	Pre	94T	100T
31 Axiom AT + Balance	1.13, 0.047	Pre	100T	100T
32 Axiom + Balance + Atrazine	0.38, 0.047, 1.0	Pre	100T	100T
33 EPIC + Atrazine	0.36, 1.0	Pre	100T	100T
34 EPIC + Atrazine	0.29, 1.0	Pre	100T	100T
35 USA 2001	0.58	Pre	100T	100T
36 USA 2001 + Atrazine	0.58, 1.0	Pre	100T	100T
37 Flufenacet + EPIC + Atrazine (USA 3001)	0.23, 0.27, 1.0	Pre	99T	99T
38 USA 2001 / Basis Gold + Banvel + NIS	0.29, 0.79, 0.13, 0.25%	Pre/Post	99T	100T
39 Axiom AT / Basis Gold + Banvel + NIS	0.75 / 0.79, 0.13, 0.25%	Pre/Post	99T	100T
40 Leadoff / Basis Gold + Banvel + COC + 28%UAN	0.94 / 0.79, 0.13, 1.0% 2.5%	Pre/Post	98T	98T
41 Leadoff + Balance / Basis Gold + Banvel + COC + 28%UAN	0.94, 0.02 / 0.79, 0.13, 1.0%, 2.5%	Pre/Post	100T	100T
42 Leadoff + Balance / Basis Gold + Banvel + COC + 28%UAN	0.94, 0.05 / 0.79, 0.13, 1.0%, 2.5%	Pre/Post	99T	100T
43 Basis Gold + Banvel + COC + 28%UAN	0.79, 0.13, 1.0%, 2.5%	Post	95T	99T
44 Basis Gold + Aim + Banvel + COC + 28%UAN	0.79, 0.008, 0.06, 1%, 2.5%	Post	96T	100T
45 Basis + Marksman + COC + 28%UAN	0.015, 0.4, 1.0%, 2.5%	Post	83	98T
46 Atrazine / Basis + NIS	1.0 / 0.02, 0.25%	Pre/Post	100T	100T
47 Check	---	---	0	0
LSD (0.05) =			15	9

Table 7. Percent reduction of shattercane, corn herbicide study, Garden City, KS, 2000.

Treatment	Rate (lbs ai/a)	Appl. Stage	6/30	8/8
1 Bicep II Magnum	2.9	Pre	84T	60
2 Atrazine / Liberty + Atrazine + AMS	1.0 / 0.3, 0.5, 3.0	Pre/Post	94T	90T
3 Balance Pro / Liberty + Atrazine + AMS	0.03 / 0.3, 0.75, 3.0	Pre/Post	99T	97T
4 Dual II / Liberty + Atrazine + AMS	0.98 / 0.3, 0.5, 3.0	Pre/Post	91T	83
5 Liberty ATZ + AMS	1.36, 3.0	Mpost	93T	83
6 Accent Gold + Clarity + COC + 28%UAN	0.15, 0.06, 1.0%, 2.5%	Mpost	99T	99T
7 Leadoff / Basis Gold + COC + 28%UAN	0.7 / 0.79, 1.0%, 2.5%	Pre/Post	100T	100T
8 Bicep II Magnum / Northstar + Spirit + Exceed + COC + 28%UAN	2.9 / 0.14, 0.036, 0.036, 1.0%, 2.5%	Pre/Post	100T	100T
9 Frontier / Distinct + NIS + 28%UAN	1.17 / 0.13, 0.25%, 2.5%	Pre/Post	71	70
10 FulTime / Hornet + COC + 28%UAN	3.0 / 0.13, 1.0%, 2.5%	Pre/Post	95T	85T
11 AE F130360-01 + MSO + 28%UAN	0.055, 0.94%, 2.5%	Mpost	99T	97T
12 AE F130360-02 + MSO + 28%UAN	0.048, 0.94%, 2.5%	Mpost	100T	100T
13 Balance Pro + Atrazine / AE F130360-01 + MSO + 28%UAN	0.04, 1.0 / 0.055, 0.94%, 2.5%	Pre/Post	100T	100T
14 Balance Pro / AE F130360-02 + MSO + 28%UAN	0.04 / 0.048, 0.94%, 2.5%	Pre/Post	99T	100T
15 AE F130360-01 + Atrazine + MSO + 28%UAN	0.055, 0.34, 0.94%, 2.5%	Mpost	98T	96T
16 AE F130360-02 + Atrazine + MSO + 28%UAN	0.048, 0.34, 0.94%, 2.5%	Mpost	100T	99T
17 Prowl + Atrazine / Lightning + Clarity + MSO + 28%UAN	0.99, 1.0 / 0.056, 0.12, 1.0 %, 2.5%	Pre/Post	100T	100T
18 Lightning + Clarity + MSO + 28%UAN	0.056, 0.12, 1.0%, 2.5%	Post	98T	100T
19 Lightning + Distinct + NIS + 28%UAN	0.056, 0.19, 0.25%, 2.5%	Post	74	84
20 Lightning + Atrazine + MSO + 28%UAN	0.056, 1.0, 1.0%, 2.5%	Post	100T	98T
21 Pursuit Plus + Atrazine	0.94, 1.0	Pre	100T	100T
22 Lightning + Liberty + NIS + AMS	0.056, 0.36, 0.25%, 2.5%	Post	99T	88T
23 FulTime	3.0	Pre	95T	90T
24 FulTime / ZA1296 + COC	2.5 / 0.094, 1.0%	Pre/Post	69	40
25 TopNotch / ZA1296 + COC	1.92 / 0.094, 1.0%	Pre/Post	95T	86T
26 Dual II / Aim + Atrazine + NIS	1.95 / 0.008, 0.75, 0.25%	Pre/Post	25	44
27 Dual II / Aim + Clarity + NIS	1.95 / 0.008, 0.25, 0.25%	Pre/Post	49	40
28 Aim + Basis Gold + COC + 28%UAN	0.008, 0.78, 1.0%, 5.0%	Post	99T	99T
29 Dual II / Aim + Balance + NIS	1.95 / 0.008, 0.02, 0.25%	Pre/Post	25	36
30 Axiom AT	1.88	Pre	94T	93T
31 Axiom AT + Balance	1.13, 0.047	Pre	99T	99T
32 Axiom + Balance + Atrazine	0.38, 0.047, 1.0	Pre	99T	98T
33 EPIC + Atrazine	0.36, 1.0	Pre	100T	97T
34 EPIC + Atrazine	0.29, 1.0	Pre	100T	98T
35 USA 2001	0.58	Pre	100T	99T
36 USA 2001 + Atrazine	0.58, 1.0	Pre	100T	99T
37 Flufenacet + EPIC + Atrazine (USA 3001)	0.23, 0.27, 1.0	Pre	100T	100T
38 USA 2001 / Basis Gold + Banvel + NIS	0.29, 0.79, 0.13, 0.25%	Pre/Post	99T	100T
39 Axiom AT / Basis Gold + Banvel + NIS	0.75 / 0.79, 0.13, 0.25%	Pre/Post	100T	98T
40 Leadoff / Basis Gold + Banvel + COC + 28%UAN	0.94 / 0.79, 0.13, 1.0% 2.5%	Pre/Post	100T	98T
41 Leadoff + Balance / Basis Gold + Banvel + COC + 28%UAN	0.94, 0.02 / 0.79, 0.13, 1.0%, 2.5%	Pre/Post	100T	100T

continued

Table 7. Percent reduction of shattercane, corn herbicide study, Garden City, KS, 2000, continued.				
Treatment	Rate (lbs ai/a)	Appl. Stage	6/30	8/8
42 Leadoff + Balance / Basis Gold + Banvel + COC + 28%UAN	0.94, 0.05 / 0.79, 0.13, 1.0%, 2.5%	Pre/Post	99T	100T
43 Basis Gold + Banvel + COC + 28%UAN	0.79, 0.13, 1.0%, 2.5%	Post	99T	100T
44 Basis Gold + Aim + Banvel + COC + 28%UAN	0.79, 0.008, 0.06, 1%, 2.5%	Post	96T	99T
45 Basis + Marksman + COC + 28%UAN	0.015, 0.4, 1.0%, 2.5%	Post	96T	90T
46 Atrazine / Basis + NIS	1.0 / 0.02, 0.25%	Pre/Post	99T	100T
47 Check	—-		0	0
LSD (0.05) =			18	16

Table 8. Percent reduction of Palmer amaranth.

Treatment	Rate (lbs ai/a)	Appl. Stage	6/30*	8/8*
1 Bicep II Magnum	2.9	Pre	100T	100T
2 Atrazine / Liberty + Atrazine + AMS	1.0 / 0.3, 0.5, 3.0	Pre/Post	100T	100T
3 Balance Pro / Liberty + Atrazine + AMS	0.03 / 0.3, 0.75, 3.0	Pre/Post	100T	97T
4 Dual II / Liberty + Atrazine + AMS	0.98 / 0.3, 0.5, 3.0	Pre/Post	100T	97T
5 Liberty ATZ + AMS	1.36, 3.0	Mpost	86T	55
6 Accent Gold + Clarity + COC + 28%UAN	0.15, 0.06, 1.0%, 2.5%	Mpost	91T	85T
7 Leadoff / Basis Gold + COC + 28%UAN	0.7 / 0.79, 1.0%, 2.5%	Pre/Post	100T	100T
8 Bicep II Magnum / Northstar + Spirit + Exceed + COC + 28%UAN	2.9 / 0.14, 0.036, 0.036, 1.0%, 2.5%	Pre/Post	100T	100T
9 Frontier / Distinct + NIS + 28%UAN	1.17 / 0.13, 0.25%, 2.5%	Pre/Post	100T	98T
10 FulTime / Hornet + COC + 28%UAN	3.0 / 0.13, 1.0%, 2.5%	Pre/Post	100T	100T
11 AE F130360-01 + MSO + 28%UAN	0.055, 0.94%, 2.5%	Mpost	64	34
12 AE F130360-02 + MSO + 28%UAN	0.048, 0.94%, 2.5%	Mpost	65	31
13 Balance Pro + Atrazine / AE F130360-01 + MSO + 28%UAN	0.04, 1.0 / 0.055, 0.94%, 2.5%	Pre/Post	100T	100T
14 Balance Pro / AE F130360-02 + MSO + 28%UAN	0.04 / 0.048, 0.94%, 2.5%	Pre/Post	84	69
15 AE F130360-01 + Atrazine + MSO + 28%UAN	0.055, 0.34, 0.94%, 2.5%	Mpost	91T	70
16 AE F130360-02 + Atrazine + MSO + 28%UAN	0.048, 0.34, 0.94%, 2.5%	Mpost	99T	88T
17 Prowl + Atrazine / Lightning + Clarity + MSO + 28%UAN	0.99, 1.0 / 0.056, 0.12, 1.0 %, 2.5%	Pre/Post	99T	99T
18 Lightning + Clarity + MSO + 28%UAN	0.056, 0.12, 1.0%, 2.5%	Post	99T	86T
19 Lightning + Distinct + NIS + 28%UAN	0.056, 0.19, 0.25%, 2.5%	Post	99T	100T
20 Lightning + Atrazine + MSO + 28%UAN	0.056, 1.0, 1.0%, 2.5%	Post	74	76
21 Pursuit Plus + Atrazine	0.94, 1.0	Pre	100T	99T
22 Lightning + Liberty + NIS + AMS	0.056, 0.36, 0.25%, 2.5%	Post	93T	83T
23 FulTime	3.0	Pre	100T	100T
24 FulTime / ZA1296 + COC	2.5 / 0.094, 1.0%	Pre/Post	100T	99T
25 TopNotch / ZA1296 + COC	1.92 / 0.094, 1.0%	Pre/Post	100T	99T
26 Dual II / Aim + Atrazine + NIS	1.95 / 0.008, 0.75, 0.25%	Pre/Post	99T	99T
27 Dual II / Aim + Clarity + NIS	1.95 / 0.008, 0.25, 0.25%	Pre/Post	100T	100T
28 Aim + Basis Gold + COC + 28%UAN	0.008, 0.78, 1.0%, 5.0%	Post	76	56
29 Dual II / Aim + Balance + NIS	1.95 / 0.008, 0.02, 0.25%	Pre/Post	99T	94T
30 Axiom AT	1.88	Pre	100T	99T
31 Axiom AT + Balance	1.13, 0.047	Pre	100T	100T
32 Axiom + Balance + Atrazine	0.38, 0.047, 1.0	Pre	100T	100T
33EPIC + Atrazine	0.36, 1.0	Pre	100T	100T
34 EPIC + Atrazine	0.29, 1.0	Pre	100T	100T
35 USA 2001	0.58	Pre	100T	100T
36 USA 2001 + Atrazine	0.58, 1.0	Pre	100T	100T
37 Flufenacet + EPIC + Atrazine (USA 3001)	0.23, 0.27, 1.0	Pre	99T	98T
38 USA 2001 / Basis Gold + Banvel + NIS	0.29, 0.79, 0.13, 0.25%	Pre/Post	99T	98T
39 Axiom AT / Basis Gold + Banvel + NIS	0.75 / 0.79, 0.13, 0.25%	Pre/Post	100T	100.0
40 Leadoff / Basis Gold + Banvel + COC + 28%UAN	0.94 / 0.79, 0.13, 1.0% 2.5%	Pre/Post	100T	100T
41 Leadoff + Balance / Basis Gold + Banvel + COC + 28%UAN	0.94, 0.02 / 0.79, 0.13, 1.0%, 2.5%	Pre/Post	100T	100T

continued

Table 8. Percent reduction of Palmer amaranth, continued.

Treatment	Rate (lbs ai/a)	Appl. Stage	6/30*	8/8*
42 Leadoff + Balance / Basis Gold + Banvel + COC + 28%UAN	0.94, 0.05 / 0.79, 0.13, 1.0%, 2.5%	Pre/Post	100T	98T
43 Basis Gold + Banvel + COC + 28%UAN	0.79, 0.13, 1.0%, 2.5%	Post	96T	85T
44 Basis Gold + Aim + Banvel + COC + 28%UAN	0.79, 0.008, 0.06, 1%, 2.5%	Post	86T	86T
45 Basis + Marksman + COC + 28%UAN	0.015, 0.4, 1.0%, 2.5%	Post	81T	78
46 Atrazine / Basis + NIS	1.0 / 0.02, 0.25%	Pre/Post	100T	100T
47 Check			0	0
LSD (0.05) =			16	22

Table 9. Percent reduction of crabgrass.

Treatment	Rate (lbs ai/a)	Appl. Stage	6/30*	8/8*
1 Bicep II Magnum	2.9	Pre	99T	83T
2 Atrazine / Liberty + Atrazine + AMS	1.0 / 0.3, 0.5, 3.0	Pre/Post	99T	78
3 Balance Pro / Liberty + Atrazine + AMS	0.03 / 0.3, 0.75, 3.0	Pre/Post	99T	83T
4 Dual II / Liberty + Atrazine + AMS	0.98 / 0.3, 0.5, 3.0	Pre/Post	100T	85T
5 Liberty ATZ + AMS	1.36, 3.0	Mpost	86T	49
6 Accent Gold + Clarity + COC + 28%UAN	0.15, 0.06, 1.0%, 2.5%	Mpost	59	46
7 Leadoff / Basis Gold + COC + 28%UAN	0.7 / 0.79, 1.0%, 2.5%	Pre/Post	96T	65
8 Bicep II Magnum / Northstar + Spirit + Exceed + COC + 28%UAN	2.9 / 0.14, 0.036, 0.036, 1.0%, 2.5%	Pre/Post	100T	88T
9 Frontier / Distinct + NIS + 28%UAN	1.17 / 0.13, 0.25%, 2.5%	Pre/Post	100T	71
10 FulTime / Hornet + COC + 28%UAN	3.0 / 0.13, 1.0%, 2.5%	Pre/Post	100T	81T
11 AE F130360-01 + MSO + 28%UAN	0.055, 0.94%, 2.5%	Mpost	91T	41
12 AE F130360-02 + MSO + 28%UAN	0.048, 0.94%, 2.5%	Mpost	91T	44
13 Balance Pro + Atrazine / AE F130360-01 + MSO + 28%UAN	0.04, 1.0 / 0.055, 0.94%, 2.5%	Pre/Post	100T	85T
14 Balance Pro / AE F130360-02 + MSO + 28%UAN	0.04 / 0.048, 0.94%, 2.5%	Pre/Post	100T	74
15 AE F130360-01 + Atrazine + MSO + 28%UAN	0.055, 0.34, 0.94%, 2.5%	Mpost	70	43
16 AE F130360-02 + Atrazine + MSO + 28%UAN	0.048, 0.34, 0.94%, 2.5%	Mpost	63	19
17 Prowl + Atrazine / Lightning + Clarity + MSO + 28%UAN	0.99, 1.0 / 0.056, 0.12, 1.0 %, 2.5%	Pre/Post	93T	80
18 Lightning + Clarity + MSO + 28%UAN	0.056, 0.12, 1.0%, 2.5%	Post	93T	48
19 Lightning + Distinct + NIS + 28%UAN	0.056, 0.19, 0.25%, 2.5%	Post	78	63
20 Lightning + Atrazine + MSO + 28%UAN	0.056, 1.0, 1.0%, 2.5%	Post	53	48
21 Pursuit Plus + Atrazine	0.94, 1.0	Pre	100T	90T
22 Lightning + Liberty + NIS + AMS	0.056, 0.36, 0.25%, 2.5%	Post	90T	64
23 FulTime	3.0	Pre	100T	83T
24 FulTime / ZA1296 + COC	2.5 / 0.094, 1.0%	Pre/Post	100T	71
25 TopNotch / ZA1296 + COC	1.92 / 0.094, 1.0%	Pre/Post	100T	90T
26 Dual II / Aim + Atrazine + NIS	1.95 / 0.008, 0.75, 0.25%	Pre/Post	100T	97T
27 Dual II / Aim + Clarity + NIS	1.95 / 0.008, 0.25, 0.25%	Pre/Post	100T	81T
28 Aim + Basis Gold + COC + 28%UAN	0.008, 0.78, 1.0%, 5.0%	Post	71	25
29 Dual II / Aim + Balance + NIS	1.95 / 0.008, 0.02, 0.25%	Pre/Post	88	89T
30 Axiom AT	1.88	Pre	100T	87T
31 Axiom AT + Balance	1.13, 0.047	Pre	100T	85T
32 Axiom + Balance + Atrazine	0.38, 0.047, 1.0	Pre	100T	90T
33 EPIC + Atrazine	0.36, 1.0	Pre	100T	88T
34 EPIC + Atrazine	0.29, 1.0	Pre	100T	87T
35 USA 2001	0.58	Pre	100T	92T
36 USA 2001 + Atrazine	0.58, 1.0	Pre	100T	96T
37 Flufenacet + EPIC + Atrazine (USA 3001)	0.23, 0.27, 1.0	Pre	100T	88T
38 USA 2001 / Basis Gold + Banvel + NIS	0.29, 0.79, 0.13, 0.25%	Pre/Post	100T	92T
39 Axiom AT / Basis Gold + Banvel + NIS	0.75 / 0.79, 0.13, 0.25%	Pre/Post	99T	83T
40 Leadoff / Basis Gold + Banvel + COC + 28%UAN	0.94 / 0.79, 0.13, 1.0% 2.5%	Pre/Post	73	49
41 Leadoff + Balance / Basis Gold + Banvel + COC + 28%UAN	0.94, 0.02 / 0.79, 0.13, 1.0%, 2.5%	Pre/Post	99T	80

continued

Table 9. Percent reduction of crabgrass, continued.				
Treatment	Rate (lbs ai/a)	Appl. Stage	6/30*	8/8*
42 Leadoff + Balance / Basis Gold + Banvel + COC + 28%UAN	0.94, 0.05 / 0.79, 0.13, 1.0%, 2.5%	Pre/Post	98T	79
43 Basis Gold + Banvel + COC + 28%UAN	0.79, 0.13, 1.0%, 2.5%	Post	63	35
44 Basis Gold + Aim + Banvel + COC + 28%UAN	0.79, 0.008, 0.06, 1%, 2.5%	Post	83T	58
45 Basis + Marksman + COC + 28%UAN	0.015, 0.4, 1.0%, 2.5%	Post	26	8
46 Atrazine / Basis + NIS	1.0 / 0.02, 0.25%	Pre/Post	99T	83T
47 Check	—-	—-	0	0
LSD (0.05) =			24	20

Table 10. Percent reduction of yellow foxtail.

Treatment	Rate (lbs ai/a)	Appl . Stage	6/30*	8/8*
1 Bicep II Magnum	2.9	Pre	99T	100T
2 Atrazine / Liberty + Atrazine + AMS	1.0 / 0.3, 0.5, 3.0	Pre/Post	100T	100T
3 Balance Pro / Liberty + Atrazine + AMS	0.03 / 0.3, 0.75, 3.0	Pre/Post	99T	100T
4 Dual II / Liberty + Atrazine + AMS	0.98 / 0.3, 0.5, 3.0	Pre/Post	100T	99T
5 Liberty ATZ + AMS	1.36, 3.0	Mpost	95T	89T
6 Accent Gold + Clarity + COC + 28%UAN	0.15, 0.06, 1.0%, 2.5%	Mpost	96T	96T
7 Leadoff / Basis Gold + COC + 28%UAN	0.7 / 0.79, 1.0%, 2.5%	Pre/Post	99T	100T
8 Bicep II Magnum / Northstar + Spirit + Exceed + COC + 28%UAN	2.9 / 0.14, 0.036, 0.036, 1.0%, 2.5%	Pre/Post	100T	100T
9 Frontier / Distinct + NIS + 28%UAN	1.17 / 0.13, 0.25%, 2.5%	Pre/Post	99T	93T
10 FulTime / Hornet + COC + 28%UAN	3.0 / 0.13, 1.0%, 2.5%	Pre/Post	100T	100T
11 AE F130360-01 + MSO + 28%UAN	0.055, 0.94%, 2.5%	Mpost	98T	93T
12 AE F130360-02 + MSO + 28%UAN	0.048, 0.94%, 2.5%	Mpost	96T	95T
13 Balance Pro + Atrazine / AE F130360-01 + MSO + 28%UAN	0.04, 1.0 / 0.055, 0.94%, 2.5%	Pre/Post	100T	100T
14 Balance Pro / AE F130360-02 + MSO + 28%UAN	0.04 / 0.048, 0.94%, 2.5%	Pre/Post	96T	98T
15 AE F130360-01 + Atrazine + MSO + 28%UAN	0.055, 0.34, 0.94%, 2.5%	Mpost	94T	86
16 AE F130360-02 + Atrazine + MSO + 28%UAN	0.048, 0.34, 0.94%, 2.5%	Mpost	95T	83
17 Prowl + Atrazine / Lightning + Clarity + MSO + 28%UAN	0.99, 1.0 / 0.056, 0.12, 1.0 %, 2.5%	Pre/Post	100T	100T
18 Lightning + Clarity + MSO + 28%UAN	0.056, 0.12, 1.0%, 2.5%	Post	99T	99T
19 Lightning + Distinct + NIS + 28%UAN	0.056, 0.19, 0.25%, 2.5%	Post	98T	95T
20 Lightning + Atrazine + MSO + 28%UAN	0.056, 1.0, 1.0%, 2.5%	Post	96T	94T
21 Pursuit Plus + Atrazine	0.94, 1.0	Pre	100T	100T
22 Lightning + Liberty + NIS + AMS	0.056, 0.36, 0.25%, 2.5%	Post	100T	95T
23 FulTime	3.0	Pre	99T	100T
24 FulTime / ZA1296 + COC	2.5 / 0.094, 1.0%	Pre/Post	99T	96T
26 TopNotch / ZA1296 + COC	1.92 / 0.094, 1.0%	Pre/Post	99T	98T
26 Dual II / Aim + Atrazine + NIS	1.95 / 0.008, 0.75, 0.25%	Pre/Post	100T	98T
27 Dual II / Aim + Clarity + NIS	1.95 / 0.008, 0.25, 0.25%	Pre/Post	98T	99T
28 Aim + Basis Gold + COC + 28%UAN	0.008, 0.78, 1.0%, 5.0%	Post	98T	84
29 Dual II / Aim + Balance + NIS	1.95 / 0.008, 0.02, 0.25%	Pre/Post	99T	98T
30 Axiom AT	1.88	Pre	100T	99T
31 Axiom AT + Balance	1.13, 0.047	Pre	100T	100T
32 Axiom + Balance + Atrazine	0.38, 0.047, 1.0	Pre	100T	100T
33 EPIC + Atrazine	0.36, 1.0	Pre	100T	100T
34 EPIC + Atrazine	0.29, 1.0	Pre	100T	100T
35 USA 2001	0.58	Pre	100T	100T
36 USA 2001 + Atrazine	0.58, 1.0	Pre	100T	100T
37 Flufenacet + EPIC + Atrazine (USA 3001)	0.23, 0.27, 1.0	Pre	100T	100T
38 USA 2001 / Basis Gold + Banvel + NIS	0.29, 0.79, 0.13, 0.25%	Pre/Post	100T	100T
39 Axiom AT / Basis Gold + Banvel + NIS	0.75 / 0.79, 0.13, 0.25%	Pre/Post	99T	100T
40 Leadoff / Basis Gold + Banvel + COC + 28%UAN	0.94 / 0.79, 0.13, 1.0% 2.5%	Pre/Post	95T	100T
41 Leadoff + Balance / Basis Gold + Banvel + COC + 28%UAN	0.94, 0.02 / 0.79, 0.13, 1.0%, 2.5%	Pre/Post	98T	100T

continued

Table 10. Percent reduction of yellow foxtail, continued.

Treatment	Rate (lbs ai/a)	Appl. Stage	6/30*	8/8*
42 Leadoff + Balance / Basis Gold + Banvel + COC + 28%UAN	0.94, 0.05 / 0.79, 0.13, 1.0%, 2.5%	Pre/Post	100T	98T
43 Basis Gold + Banvel + COC + 28%UAN	0.79, 0.13, 1.0%, 2.5%	Post	95T	93T
44 Basis Gold + Aim + Banvel + COC + 28%UAN	0.79, 0.008, 0.06, 1%, 2.5%	Post	99T	98T
45 Basis + Marksman + COC + 28%UAN	0.015, 0.4, 1.0%, 2.5%	Post	64	68
46 Atrazine / Basis + NIS	1.0 / 0.02, 0.25%	Pre/Post	100T	100T
47 Check	—-	—-	0	0
LSD (0.05) =			5	12

IMPACT OF A WHEAT COVER CROP ON REDUCED ATRAZINE RATES FOR PALMER AMARANTH CONTROL IN IRRIGATED CORN

by
Randall Currie

SUMMARY

The opportunity cost of water for growing a wheat cover crop ranged from 3.9 to 4.5 inches, on the average. The cover crop provided significant levels of weed control in plots with no atrazine treatment. This effect, however, was masked by atrazine treatment. Cover crop increased yield across all rates of atrazine used but was only statistically significant in plots without atrazine. This increase in yield was achieved in spite of the significant soil water handicap at planting produced by growth of the cover crop.

INTRODUCTION

It has long been known that winter wheat or rye killed at boot stage improves weed control in vegetable production. It seems logical that a cover crop should improve weed control provided by a herbicide. Therefore, it was the objective of this experiment to measure the effect of full and reduced rates of atrazine for weed control in irrigated corn, with and without a wheat cover crop.

PROCEDURES

The study was established in a 2 by 3 factorial arrangement of cover crop (with and without) and atrazine rate (0, 0.75 and 1.5 lb/a). Plots with a cover crop were planted to winter wheat in October. Soil moisture was measured gravimetrically to 5 ft at the two-leaf stage in the wheat. Wheat was allowed to grow until May 1, when it was killed by an application of 2.2 kg/ha of glyphosate. Soil water was then measured to determine opportunity cost of water used to grow the wheat. The corn hybrid DK592SR was then planted no-till in all plots, followed immediately by application of atrazine treatments. Palmer amaranth was the only weed consistently present in all replications. The experiment was repeated at two separate locations in 1999 and 2000, and it was further replicated by reimposing the treatments on the same plots in three successive years. There will be a total of nine location-year combinations. To date, six of the combinations are completed and are reported here.

RESULTS AND DISCUSSION

Water costs ranged from 4 to 6 inches (Table 1), although in some location-year combinations, water used to grow the wheat cover crop was to 2.5 inches or less. Average losses over six location-year combinations ranged from 3.9 to 4.5 inches and did not vary with previous treatment.

Palmer amaranth numbers varied from location to location and year-to-year (Table 2). However, when expressed as a percent reduction of untreated control the trend was very similar across location-years (Table 3). Although the cover crop alone provided dramatic levels of control compared to no treatment, even the lowest level of atrazine masked this effect, providing improved control. To measure the effect of stunting of Palmer amaranth an index of total bio mass of weeds was calculated by multiplying the number of weeds by their height (Table 4). This index does not show as great an effect of cover crop. However, it shows a similar trend, albiet not as striking.

Cover crop improved corn yield by 16.2, 9.9, and 12.5 bu/a, with applications of 0, 0.75, and 1.5 lbs/a of atrazine, respectively. Due to a complex interaction of water use with weed pressure within location-years, the improvements in atrazine-treated plots were not statistically significant. In all cases, these increases in yield were produced despite a significant deficit in soil water in the cover crop plots. Therefore, a complex interaction of water use with weed pressure seems to be involved.

Table 1. Total amount of water used by wheat in 6 feet of soil profile from fall to spring.

Treatment	Rate*	Appl. Stage	Amount of available H_2O used: Loc.1 1997-98	Loc.1 1998-99	Loc.2 1998-99	Loc.1 1999-00	Loc.2 1999-00	Loc.3 1999-00	Loc. Avg.
1 No Atrazine + No Cover	—-	—-	7.0	4.1	5.5	2.6	3.8	8.2	5.4
2 No Atrazine + Cover	—-	—-	11.6	10.6	10.4	6.7	8.2	10.9	10.0
3 Atrazine + No Cover	0.75	Pre	7.8	4.0	5.3	1.3	5.5	7.6	5.5
4 Atrazine + Cover	0.75	Pre	11.8	9.5	11.2	6.0	8.1	9.9	9.7
5 Atrazine + No Cover	1.5	Pre	7.5	4.5	5.6	1.1	6.0	7.5	5.6
6 Atrazine + Cover	1.5	Pre	11.6	9.5	10.4	5.8	6.9	11.3	9.5
LSD (0.05)			1.7	1.7	1.8	2.1	2.4	2.6	0.7

Table 2. Average number of Palmer amaranth in 8.2 square feet in early June.

Treatment	Rate*	Appl. Stage	Loc.1 6/5/98	Loc.1 6/8/99	Loc.2 6/8/99	Loc.1 6/7/00	Loc.2 6/6/00	Loc.3 6/6/00	Avg. Loc.
1 No Atrazine + No Cover	—-	—-	14.8	353.5	14.7	13.0	3.17	0.15	66.6
2 No Atrazine + Cover	—-	—-	9.0	278.8	6.4	0.8	0.43	0.01	49.3
3 Atrazine + No Cover	0.75	Pre	1.6	18.2	0.3	0.4	0.04	0.00	3.4
4 Atrazine + Cover	0.75	Pre	0.0	7.5	2.6	0.0	0.01	0.00	1.7
5 Atrazine + No Cover	1.5	Pre	0.0	3.1	0.1	0.2	0.01	0.00	0.6
6 Atrazine + Cover	1.5	Pre	0.0	16.5	0.1	0.0	0.04	0.00	2.8
LSD (0.05)			9.0	100.7	6.7	9.2	0.9	0.03	16.7

Table 3. Percent reduction of Palmer amaranth height times number in early June.

Treatment	Rate*	Appl. Stage	Loc.1 6/5/98	Loc.1 6/8/99	Loc.2 6/8/99	Loc.1 6/7/00	Loc.2 6/6/00	Loc.3 6/6/00	Avg. Loc.
1 No Atrazine + No Cover	—-	—-	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 No Atrazine + Cover	—-	—-	77.3	52.7	62.7	75.3	73.4	83.3	70.1
3 Atrazine + No Cover	0.75	Pre	97.7	88.4	99.8	99.0	98.4	100.0	97.2
4 Atrazine + Cover	0.75	Pre	100.0	89.2	74.7	99.9	99.9	100.0	94.0
5 Atrazine + No Cover	1.5	Pre	100.0	89.5	99.2	99.3	99.9	100.0	98.0
6 Atrazine + Cover	1.5	Pre	100.0	88.4	99.9	100.0	99.2	100.0	97.9
LSD (0.05)			23.8	18.6	27.1	22.8	22.6	20.1	9.48

Table 4. Percent reduction of Palmer amaranth height times number in mid-June.

Treatment	Rate*	Appl. Stage	Loc.1 6/15/98	Loc.1 6/17/99	Loc.2 6/17/99	Loc.1 6/19/00	Loc.2 6/19/00	Loc.3 6/19/00	Avg. Loc.
1 No Atrazine + No Cover	—-	—-	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 No Atrazine + Cover	—-	—-	82.0	68.4	49.6	52.9	63.8	28.0	57.4
3 Atrazine + No Cover	0.75	Pre	82.5	86.9	95.6	99.2	98.8	95.6	93.1
4 Atrazine + Cover	0.75	Pre	98.8	89.7	73.3	98.7	96.0	85.0	90.3
5 Atrazine + No Cover	1.5	Pre	100.0	89.4	94.7	98.6	99.8	100.0	97.1
6 Atrazine + Cover	1.5	Pre	100.0	89.2	99.4	99.6	79.8	100.0	94.7
LSD (0.05)			15.2	13.4	19.0	26.5	27.6	28.8	13.1

Table 5. Average bushels/acre.										
Treatment	Rate*	Appl. Stage	Loc.1 9/29/98	Loc.1** 10/14/99	Loc.2 10/15/99	Loc.1 9/21/00	Loc.2 9/22/00	Loc.3 9/22/00	Loc. Avg.
1 No Atrazine + No Cover	—-	—-	45.7	74.8	75.7	46.0	45.5	96.7	64.1
2 No Atrazine + Cover	—-	—-	84.8	112.9	91.4	57.9	48.0	86.9	80.3
3 Atrazine + No Cover	0.75	Pre	112.9	95.3	84.9	68.5	44.4	95.7	84.6
4 Atrazine + Cover	0.75	Pre	129.7	117.3	100.0	71.6	60.2	94.2	94.5
5 Atrazine + No Cover	1.5	Pre	130.2	106.1	77.8	65.1	46.2	96.3	87.0
6 Atrazine + Cover	1.5	Pre	129.2	130.3	109.0	75.9	61.1	99.8	99.5
LSD (0.05)			17.2	21.4	25.3	20.0	22.5	16.6	13.6

COMPARISONS OF 36 HERBICIDE TANK MIXES FOR WEED CONTROL IN CORN WITH CONVENTIONAL HERBICIDE RESISTANCE

by
Randall Currie

SUMMARY

All treatments provided excellent control of two or more weed species present. Shattercane control seemed to have been the best predictor of top yield.

INTRODUCTION

A substantial portion of soybean acres in the United States are planted to varieties containing herbicide resistance genes. In contrast, with corn this technology has not been as popular. Therefore, it was the objective of this study to compare herbicides that do not require special herbicide resistance genes to be present in the corn variety used.

PROCEDURES

Weeds were planted to supplement existing natural populations, as described in Table 1. Corn was then planted as described in Table 2. Herbicide treatments were applied as described in Table 3. Weed and crop sizes and relative numbers throughout the test are described in Table 4.

RESULTS AND DISCUSSION

All treatments provided excellent control of two or more weed species present. Treatments followed by the letter T produced control not statistically different from the top treatment (Tables 5, 6, 7, 8, and 9). Treatments followed by the letter T produced yields not different from the top treatment (Table 10). With one exception, treatment 8, shattercane control seemed to have been the best predictor of top yield. Although treatment 8 produced a yield not different from top yielding plot, it provided modest shattercane control. It did, however, provide good control of all other weed species, which seems to have compensated for this weakness.

Table 1. Weed seeding information, corn herbicide study, Garden City, KS, 2000.

Variety:	Palmer Amaranth, Yellow Foxtail, Crabgrass, Sunflowers, and Shattercane
Planting date:	5-15-00
Planting method:	14-ft Great Plains drill
Carrier:	Cracked corn at 40 lbs/a (used for a mixture of the above weeds, except Shattercane)
Rate, unit:	Palmer Amaranth at 276 grams/a = approx. 700,000 seeds/a, Yellow Foxtail at 1032 grams/a = approx. 344,124 seeds/a, Crabgrass at 5557 grams/a = approx. 9.8 million seeds/a, Sunflowers at 1814 grams/a = approx. 40,000 seeds/a. Shattercane at 5 lbs/a = approx. 119,400 seeds/a.
Depth, unit:	The tubes were pulled off of drill for weed mixture, except Shattercane, and dropped on the soil surface. Shattercane was drilled separately with every 1/3 hole set at 1 inch deep, 2 inches deep, and a tube pulled for seed to be dropped on soil surface.
Row spacing, unit:	10 inches
Soil temperature, unit:	71 F
Soil moisture:	Dry top 0.25 inches, moist below

Table 2. Crop information for corn herbicide study, Garden City, KS, 2000.	
Variety:	DK 595 BtY
Planting date:	5-15-00
Planting method:	John Deere Max Emerge II, 6-row planter
Rate, unit:	36,000 seeds/acre
Depth, unit:	1.5 inches
Row spacing, unit:	30 inches
Soil temperature, unit:	71 F
Soil moisture:	Dry top 1.5 inches, moist below
Emergence date:	5-21-00 and 5-30-00

Note: Due to lack of moisture the corn emerged at two different dates. The 5-30-00 emergence came up after a rain.

Table 3. Application information for herbicide corn study, Garden City, KS 2000.

Application date:	5-15-00	5-15-00	5-19-00	5-24-00	6-12-00
Time of day:	9:00 a.m.	1:30 p.m. - 5:30 p.m.	11:30 a.m.	11:00 a.m.	9:30 a.m.
Application method:	Broadcast	Broadcast	Broadcast	Broadcast	Broadcast
Application timing:	Post weeds	PRE	Pre-Spike	Spike-3 inch corn	Post
Air Temperature, unit:	88 F	88 F	57 F	74 F	87 F
Wind Velocity, unit:	0 mph	0-5 mph S	0 mph	10-15 mph E	18-24 mph S
Dew presence:	None	None	None	None	None
Soil temperature, unit:	71 F	71 F	69 F	75 F	89 F
Soil moisture:	Dry top 0.25” moist below	Dry top 0.25” moist below	Dry top 1” moist below	Dry top 1.5” moist below	Dry top 0.5” moist below
% Relative humidity:	53%	52%	59%	69%	48%
% Cloud cover:	35%	15%	50%	100%	0%
Chemical applied:	Roundup Ultra at 1.5 pt/a	Pre treatments from protocols from protocols	Outlook & Marksman, treatment 32	Marksman & Clarity, treatments 6, 7, & 33	Post treatments
Application equipment:	Farm sprayer	Windshield sprayer	Windshield sprayer	Windshield sprayer	Windshield sprayer
Nozzle type/brand:	Greenleaf	Teejet XR	Teejet XR	Teejet XR	Teejet XR
Nozzle size:	TDVC-03/-06	8004 VS	8004 VS	8004 VS	8004 VS
Nozzle spacing, unit:	30 in.	20 in.	20 in.	20 in.	20 in.
Boom length, unit:	30 ft.	10 ft.	10 ft.	10 ft.	10 ft.
Boom height, unit:	23 in.	18 in.	18 in.	18 in.	18 in.
Pressure, unit:	40 psi	38 psi	38 psi	38 psi	38 psi
Groundspeed:	6.5 mph	3.2 mph	3.2 mph	3.2 mph	3.2 mph
Application rate:	10 gpa	20 gpa	20 gpa	20 gpa	20 gpa
Incorporation equipment:	None	None	None	None	None
Time to incorporate, unit:	N/A	N/A	N/A	N/A	N/A
Incorporation depth, unit:	N/A	N/A	N/A	N/A	N/A
Spray volume, unit:	20 gal	3 Liter	3 Liter	3 Liter	3 Liter
Carrier:	H_2O	H_2O	H_2O	H_2O	H_2O
Propellant:	Hydraulic pump	CO_2	CO_2	CO_2	CO_2

Table 4. Corn and weed stages of growth at various dates, corn study, Garden City, KS, 2000.		
Date	Corn	Weeds
6/2/00	Between 2-collar	Sunflowers = 2-leaf, 1 inch tall; Shattercane= 2-leaf, 2 inches tall; Pigweed = 2-8 leaf, 0.5-1.5 inches tall.
6/8/00	2-4 collar	Weed heights are in tables.
6/20/00	4-6 collar	Weed heights are in tables.
7/3/00	6-7 collar	Sunflowers = 15 inches; Shattercane = 30 inches; Pigweed = 13 inches; Yellow Foxtail = 0.5 inch; Crabgrass = 0.25 inch.
7/6/00	8-collar	Crabgrass in the furrow = 0.5 – 1 inch tall.
7/14/00	8-11 collar	Weed heights are in tables.
7/26/00	10-collar and Tassel	Sunflowers = 48 inches; Shattercane = 50 inches; Pigweed = 45 inches; Yellow Foxtail = 5 inches; Crabgrass = 10 inches.
8/8/00	Tassel	Sunflowers = 53 inches; Shattercane = 57 inches; Pigweed = 67 inches; Yellow Foxtail = 21 inches; Crabgrass = 18 inches.
8/21/00	—-	Sunflowers = 48 inches; Shattercane = 56 inches; Pigweed = 68 inches; Yellow Foxtail = 29 inches; Crabgrass = 32 inches.

Table 5. Percent reduction of sunflowers, in corn herbicide test, Garden City, KS 2000.				
Treatment	Rate (lbs ai/a)	Appl. Stage	7/3*	8/21*
1 Check	—-	—-	0	0
2 Dual II Magnum / Northstar + NIS + AMS	1.27 / .15, .25%, 2.5	Pre/Epost	100T	100T
3 Dual II Magnum / Spirit + COC + AMS	1.27 / .04, 1.25%, 2.5	Pre/Epost	100T	100T
4 Bicep Lite II Magnum / Northstar + NIS + AMS	2.25 / .15, .25%, 2.5	Pre/Epost	100T	100T
5 Bicep Lite II Magnum / Spirit + COC + AMS	2.25 / .04, 1.25%, 2.5	Pre/Epost	100T	100T
6 Frontier / Clarity + AMS	1.2 / .25, 2.5	Pre/Spike-3”	95T	94T
7 Frontier / Marksman + AMS	1.2 / 1.2, 2.5	Pre/Spike-3”	100T	98T
8 Frontier / Distinct + NIS + AMS	1.2 / .26, .25%, 1.0	Pre/Epost	100T	100T
9 TopNotch / Hornet + NIS + AMS	1.6 / .13, .25%, 2.5	Pre/Epost	100T	100T
10 Harness Xtra / Permit + COC + AMS	2.7 / .05, 1.25%, 2.5	Pre/Epost	100T	100T
11 Leadoff / Accent Gold + NIS + AMS	1.25 / .15, .25% 2.5	Pre/Epost	99T	100T
12 Leadoff / Basis Gold + COC + AMS	1.25 / .79, 1.25%, 2.5	Pre/Epost	100T	98T
13 Degree / Permit + COC + AMS	1.54 / .05, 1.25%, 2.5	Pre/Epost	100T	100T
14 Northstar + Accent + NIS	0.15, .02, .25%	Epost	99T	100T
15 Dual II Magnum + Northstar + Accent + NIS	1.27, .15, .02, .25%	Epost	100T	100T
16 Dual II Magnum + Atrazine / Northstar + Accent + NIS	1.27, .75 / .15, .02, .25%	Epost	100T	100T
17 Spirit + Accent + NIS	0.036, .02, .25%	Epost	100T	100T
18 Dual II Magnum + Spirit + Accent + NIS	1.27, 0.036, 0.02, .25%	Epost	100T	100T
19 Bicep Lite II Magnum / Northstar + NIS	2.25 / .15, .25%	Epost	99T	100T
20 Bicep Lite II Magnum / Spirit + NIS	2.25 / .036, .25%	Epost	100T	100T
21 Celebrity + NIS + AMS	0.29, .25%, 1.0	Epost	97T	100T
22 Celebrity Plus + NIS + AMS	0.21, .25%, 1.0	Epost	97T	100T
23 Accent Gold + NIS	0.15, .25%	Epost	98T	100T
24 Basis Gold + NIS	0.79, .25%	Epost	89T	83
25 Spirit + Accent + Clarity + NIS	0.036, .02, .06, .25%	Epost	100T	100T
26 Hornet + Accent + NIS	0.13, .03, .25%	Epost	100T	100T
27 Guardsman	2.5	Pre	48	68
28 EPIC	0.29	Pre	53	86
29 Guardsman + Balance	2.5, 0.035	Pre	90T	92T
30 Guardsman + Clarity	2.5, 0.25	Pre	90T	93T
31 Outlook + Marksman	0.72, 0.8	Pre-Spike	89T	92T
32 Outlook / Marksman + AMS	0.72 / 0.8, 2.5	Pre/Spike-3”	74	99T
33 Guardsman / Distinct + NIS + AMS	2.5 / 0.175, .25%, 1.0	Pre/Epost	100T	100T
34 Outlook / Distinct + Atrazine + NIS + AMS	0.72 / 0.175, .5, .25%, 1.0	Pre/Epost	99T	100T
35 Atrazine / Celebrity Plus + Atrazine	1.0 / 0.21, 0.5, .25%, 1.0	Pre/Epost	100T	100T
LSD (0.05) =			20	13

Table 6. Percent reduction of shattercane.				
Treatment	Rate (lbs ai/a)	Appl. Stage	7/3*	8/8*
1 Check	—-	—-	0	0
2 Dual II Magnum / Northstar + NIS + AMS	1.27 / .15, .25%, 2.5	Pre/Epost	93T	85T
3 Dual II Magnum / Spirit + COC + AMS	1.27 / .04, 1.25%, 2.5	Pre/Epost	99T	91T
4 Bicep Lite II Magnum / Northstar + NIS + AMS	2.25 / .15, .25%, 2.5	Pre/Epost	93T	80T
5 Bicep Lite II Magnum / Spirit + COC + AMS	2.25 / .04, 1.25%, 2.5	Pre/Epost	99T	99T
6 Frontier / Clarity + AMS	1.2 / .25, 2.5	Pre/Spike-3”	56	40
7 Frontier / Marksman + AMS	1.2 / 1.2, 2.5	Pre/Spike-3”	15	14
8 Frontier / Distinct + NIS + AMS	1.2 / .26, .25%, 1.0	Pre/Epost	64	60
9 TopNotch / Hornet + NIS + AMS	1.6 / .13, .25%, 2.5	Pre/Epost	68	55
10 Harness Xtra / Permit + COC + AMS	2.7 / .05, 1.25%, 2.5	Pre/Epost	30	19
11 Leadoff / Accent Gold + NIS + AMS	1.25 / .15, .25% 2.5	Pre/Epost	90T	69
12 Leadoff / Basis Gold + COC + AMS	1.25 / .79, 1.25%, 2.5	Pre/Epost	100T	99T
13 Degree / Permit + COC + AMS	1.54 / .05, 1.25%, 2.5	Pre/Epost	5	18
14 Northstar + Accent + NIS	0.15, .02, .25%	Epost	96T	93T
15 Dual II Magnum + Northstar + Accent + NIS	1.27, .15, .02, .25%	Epost	100T	99T
16 Dual II Magnum + Atrazine / Northstar + Accent + NIS	1.27, .75 / .15, .02, .25%	Epost	97T	98T
17 Spirit + Accent + NIS	0.036, .02, .25%	Epost	97T	99T
18 Dual II Magnum + Spirit + Accent + NIS	1.27, 0.036, 0.02, .25%	Epost	98T	99T
19 Bicep Lite II Magnum / Northstar + NIS	2.25 / .15, .25%	Epost	96T	89T
20 Bicep Lite II Magnum / Spirit + NIS	2.25 / .036, .25%	Epost	96T	98T
21 Celebrity + NIS + AMS	0.29, .25%, 1.0	Epost	95T	94T
22 Celebrity Plus + NIS + AMS	0.21, .25%, 1.0	Epost	96T	88T
23 Accent Gold + NIS	0.15, .25%	Epost	98T	97T
24 Basis Gold + NIS	0.79, .25%	Epost	96T	88T
25 Spirit + Accent + Clarity + NIS	0.036, .02, .06, .25%	Epost	97T	96T
26 Hornet + Accent + NIS	0.13, .03, .25%	Epost	97T	93T
27 Guardsman	2.5	Pre	35	25
28 EPIC	0.29	Pre	45	49
29 Guardsman + Balance	2.5, 0.035	Pre	71	53
30 Guardsman + Clarity	2.5, 0.25	Pre	34	35
31 Outlook + Marksman	0.72, 0.8	Pre-Spike	38	21
32 Outlook / Marksman + AMS	0.72 / 0.8, 2.5	Pre/Spike-3”	19	31
33 Guardsman / Distinct + NIS + AMS	2.5 / 0.175, .25%, 1.0	Pre/Epost	64	78
34 Outlook / Distinct + Atrazine + NIS + AMS	0.72 / 0.175, .5, .25%, 1.0	Pre/Epost	43	60
35 Atrazine / Celebrity Plus + Atrazine	1.0 / 0.21, 0.5, .25%, 1.0	Pre/Epost	96T	89T
LSD (0.05) =			25	21

Table 7. Percent reduction of Palmer amaranth.

Treatment	Rate (lbs ai/a)	Appl. Stage	7/14	8/8*
1 Check	—-	—-	0	0
2 Dual II Magnum / Northstar + NIS + AMS	1.27 / .15, .25%, 2.5	Pre/Epost	100T	100T
3 Dual II Magnum / Spirit + COC + AMS	1.27 / .04, 1.25%, 2.5	Pre/Epost	100T	97T
4 Bicep Lite II Magnum / Northstar + NIS + AMS	2.25 / .15, .25%, 2.5	Pre/Epost	100T	100T
5 Bicep Lite II Magnum / Spirit + COC + AMS	2.25 / .04, 1.25%, 2.5	Pre/Epost	98T	93T
6 Frontier / Clarity + AMS	1.2 / .25, 2.5	Pre/Spike-3"	100T	95T
7 Frontier / Marksman + AMS	1.2 / 1.2, 2.5	Pre/Spike-3"	100T	100T
8 Frontier / Distinct + NIS + AMS	1.2 / .26, .25%, 1.0	Pre/Epost	100T	99T
9 TopNotch / Hornet + NIS + AMS	1.6 / .13, .25%, 2.5	Pre/Epost	100T	98T
10 Harness Xtra / Permit + COC + AMS	2.7 / .05, 1.25%, 2.5	Pre/Epost	94T	98T
11 Leadoff / Accent Gold + NIS + AMS	1.25 / .15, .25% 2.5	Pre/Epost	100T	100T
12 Leadoff / Basis Gold + COC + AMS	1.25 / .79, 1.25%, 2.5	Pre/Epost	100T	100T
13 Degree / Permit + COC + AMS	1.54 / .05, 1.25%, 2.5	Pre/Epost	100T	100T
14 Northstar + Accent + NIS	0.15, .02, .25%	Epost	98T	97T
15 Dual II Magnum + Northstar + Accent + NIS	1.27, .15, .02, .25%	Epost	97T	99T
16 Dual II Magnum + Atrazine / Northstar + Accent + NIS	1.27, .75 / .15, .02, .25%	Epost	100T	100T
17 Spirit + Accent + NIS	0.036, .02, .25%	Epost	56	78
18 Dual II Magnum + Spirit + Accent + NIS	1.27, 0.036, 0.02, .25%	Epost	44	88T
19 Bicep Lite II Magnum / Northstar + NIS	2.25 / .15, .25%	Epost	100T	100T
20 Bicep Lite II Magnum / Spirit + NIS	2.25 / .036, .25%	Epost	100T	100T
21 Celebrity + NIS + AMS	0.29, .25%, 1.0	Epost	81T	92T
22 Celebrity Plus + NIS + AMS	0.21, .25%, 1.0	Epost	88T	96T
23 Accent Gold + NIS	0.15, .25%	Epost	80	83
24 Basis Gold + NIS	0.79, .25%	Epost	88T	90T
25 Spirit + Accent + Clarity + NIS	0.036, .02, .06, .25%	Epost	80	78
26 Hornet + Accent + NIS	0.13, .03, .25%	Epost	75	76
27 Guardsman	2.5	Pre	100T	98T
28 EPIC	0.29	Pre	100T	100T
29 Guardsman + Balance	2.5, 0.035	Pre	100T	100T
30 Guardsman + Clarity	2.5, 0.25	Pre	100T	100T
31 Outlook + Marksman	0.72, 0.8	Pre-Spike	100T	100T
32 Outlook / Marksman + AMS	0.72 / 0.8, 2.5	Pre/Spike-3"	100T	100T
33 Guardsman / Distinct + NIS + AMS	2.5 / 0.175, .25%, 1.0	Pre/Epost	100T	100T
34 Outlook / Distinct + Atrazine + NIS + AMS	0.72 / 0.175, .5, .25%, 1.0	Pre/Epost	100T	100T
35 Atrazine / Celebrity Plus + Atrazine	1.0 / 0.21, 0.5, .25%, 1.0	Pre/Epost	100T	100T
LSD (0.05) =			20	14

Table 8. Percent reduction of yellow foxtail.

Treatment	Rate (lbs ai/ a)	Appl. Stage	7/14	8/8*
1 Check	—-	—-	0	0
2 Dual II Magnum / Northstar + NIS + AMS	1.27 / .15, .25%, 2.5	Pre/Epost	100T	100T
3 Dual II Magnum / Spirit + COC + AMS	1.27 / .04, 1.25%, 2.5	Pre/Epost	100T	100T
4 Bicep Lite II Magnum / Northstar + NIS + AMS	2.25 / .15, .25%, 2.5	Pre/Epost	100T	98T
5 Bicep Lite II Magnum / Spirit + COC + AMS	2.25 / .04, 1.25%, 2.5	Pre/Epost	93T	100T
6 Frontier / Clarity + AMS	1.2 / .25, 2.5	Pre/Spike-3”	100T	100T
7 Frontier / Marksman + AMS	1.2 / 1.2, 2.5	Pre/Spike-3”	100T	100T
8 Frontier / Distinct + NIS + AMS	1.2 / .26, .25%, 1.0	Pre/Epost	100T	100T
9 TopNotch / Hornet + NIS + AMS	1.6 / .13, .25%, 2.5	Pre/Epost	100T	100T
10 Harness Xtra / Permit + COC + AMS	2.7 / .05, 1.25%, 2.5	Pre/Epost	100T	100T
11 Leadoff / Accent Gold + NIS + AMS	1.25 / .15, .25% 2.5	Pre/Epost	93T	99T
12 Leadoff / Basis Gold + COC + AMS	1.25 / .79, 1.25%, 2.5	Pre/Epost	100T	100T
13 Degree / Permit + COC + AMS	1.54 / .05, 1.25%, 2.5	Pre/Epost	100T	100T
14 Northstar + Accent + NIS	0.15, .02, .25%	Epost	100T	99T
15 Dual II Magnum + Northstar + Accent + NIS	1.27, .15, .02, .25%	Epost	88T	100T
16 Dual II Magnum + Atrazine / Northstar + Accent + NIS	1.27, .75 / .15, .02, .25%	Epost	88T	97T
17 Spirit + Accent + NIS	0.036, .02, .25%	Epost	100T	100T
18 Dual II Magnum + Spirit + Accent + NIS	1.27, 0.036, 0.02, .25%	Epost	90T	99T
19 Bicep Lite II Magnum / Northstar + NIS	2.25 / .15, .25%	Epost	100T	100T
20 Bicep Lite II Magnum / Spirit + NIS	2.25 / .036, .25%	Epost	100T	100T
21 Celebrity + NIS + AMS	0.29, .25%, 1.0	Epost	77	96
22 Celebrity Plus + NIS + AMS	0.21, .25%, 1.0	Epost	100T	97T
23 Accent Gold + NIS	0.15, .25%	Epost	100T	96
24 Basis Gold + NIS	0.79, .25%	Epost	89T	100T
25 Spirit + Accent + Clarity + NIS	0.036, .02, .06, .25%	Epost	88T	100T
26 Hornet + Accent + NIS	0.13, .03, .25%	Epost	80	81
27 Guardsman	2.5	Pre	100T	99T
28 EPIC	0.29	Pre	100T	100T
29 Guardsman + Balance	2.5, 0.035	Pre	100T	100T
30 Guardsman + Clarity	2.5, 0.25	Pre	100T	100T
31 Outlook + Marksman	0.72, 0.8	Pre-Spike	100T	100T
32 Outlook / Marksman + AMS	0.72 / 0.8, 2.5	Pre/Spike-3”	100T	100T
33 Guardsman / Distinct + NIS + AMS	2.5 / 0.175, .25%, 1.0	Pre/Epost	100T	100T
34 Outlook / Distinct + Atrazine + NIS + AMS	0.72 / 0.175, .5, .25%, 1.0	Pre/Epost	100T	100T
35 Atrazine / Celebrity Plus + Atrazine	1.0 / 0.21, 0.5, .25%, 1.0	Pre/Epost	93T	100T
LSD (0.05) =			18	4

Table 9. Percent reduction of crabgrass.

Treatment	Rate (lbs ai/a)	App. Stage	7/14	7/14**	8/8*
1 Check	—-	—-	0	0	0
2 Dual II Magnum / Northstar + NIS + AMS	1.27 / .15, .25%, 2.5	Pre/Epost	94T	86T	85T
3 Dual II Magnum / Spirit + COC + AMS	1.27 / .04, 1.25%, 2.5	Pre/Epost	100T	60T	86T
4 Bicep Lite II Magnum / Northstar + NIS + AMS	2.25 / .15, .25%, 2.5	Pre/Epost	97T	63T	85T
5 Bicep Lite II Magnum / Spirit + COC + AMS	2.25 / .04, 1.25%, 2.5	Pre/Epost	98T	54	88T
6 Frontier / Clarity + AMS	1.2 / .25, 2.5	Pre/Spike-3”	93T	63T	88T
7 Frontier / Marksman + AMS	1.2 / 1.2, 2.5	Pre/Spike-3”	100T	53	91T
8 Frontier / Distinct + NIS + AMS	1.2 / .26, .25%, 1.0	Pre/Epost	96T	97T	83T
9 TopNotch / Hornet + NIS + AMS	1.6 / .13, .25%, 2.5	Pre/Epost	100T	54	84T
10 Harness Xtra / Permit + COC + AMS	2.7 / .05, 1.25%, 2.5	Pre/Epost	96T	29	83T
11 Leadoff / Accent Gold + NIS + AMS	1.25 / .15, .25% 2.5	Pre/Epost	100T	35	73
12 Leadoff / Basis Gold + COC + AMS	1.25 / .79, 1.25%, 2.5	Pre/Epost	99T	23	80T
13 Degree / Permit + COC + AMS	1.54 / .05, 1.25%, 2.5	Pre/Epost	99T	88T	93T
14 Northstar + Accent + NIS	0.15, .02, .25%	Epost	87T	41	60
15 Dual II Magnum + Northstar + Accent + NIS	1.27, .15, .02, .25%	Epost	93T	47	78T
16 Dual II Magnum + Atrazine / Northstar + Accent + NIS	1.27, .75 / .15, .02, .25%	Epost	96T	50	71
17 Spirit + Accent + NIS	0.036, .02, .25%	Epost	71	14	61
18 Dual II Magnum + Spirit + Accent + NIS	1.27, 0.036, 0.02, .25%	Epost	86T	53	83T
19 Bicep Lite II Magnum / Northstar + NIS	2.25 / .15, .25%	Epost	100T	58T	86T
20 Bicep Lite II Magnum / Spirit + NIS	2.25 / .036, .25%	Epost	99T	44	89T
21 Celebrity + NIS + AMS	0.29, .25%, 1.0	Epost	53	11	51
22 Celebrity Plus + NIS + AMS	0.21, .25%, 1.0	Epost	72	11	54
23 Accent Gold + NIS	0.15, .25%	Epost	89T	33	70
24 Basis Gold + NIS	0.79, .25%	Epost	86T	51	71
25 Spirit + Accent + Clarity + NIS	0.036, .02, .06, .25%	Epost	73	30	53
26 Hornet + Accent + NIS	0.13, .03, .25%	Epost	81	19	60
27 Guardsman	2.5	Pre	88T	87T	65
28 EPIC	0.29	Pre	100T	53	90T
39 Guardsman + Balance	2.5, 0.035	Pre	100.0	36	89T
30 Guardsman + Clarity	2.5, 0.25	Pre	91T	58T	66
31 Outlook + Marksman	0.72, 0.8	Pre-Spike	100T	48	74
32 Outlook / Marksman + AMS	0.72 / 0.8, 2.5	Pre/Spike-3”	100T	73T	73
33 Guardsman / Distinct + NIS + AMS	2.5 / 0.175, .25%, 1.0	Pre/Epost	100T	29	84T
34Outlook / Distinct + Atrazine + NIS + AMS	0.72 / 0.175, .5, .25%, 1.0	Pre/Epost	100T	30	86T
35Atrazine / Celebrity Plus + Atrazine	1.0 / 0.21, 0.5, .25%, 1.0	Pre/Epost	90T	39	71
LSD (0.05) =			18	44	18

Table 10. Harvest data from corn in bushels per acre, Garden City, KS 2000.

Treatment	Rate (lbs ai/a)	Appl. Stage	Bu/A
1 Check	—-	—-	57
2 Dual II Magnum / Northstar + NIS + AMS	1.27 / .15, .25%, 2.5	Pre/Epost	90T
3 Dual II Magnum / Spirit + COC + AMS	1.27 / .04, 1.25%, 2.5	Pre/Epost	93T
4 Bicep Lite II Magnum / Northstar + NIS + AMS	2.25 / .15, .25%, 2.5	Pre/Epost	97T
5 Bicep Lite II Magnum / Spirit + COC + AMS	2.25 / .04, 1.25%, 2.5	Pre/Epost	106T
6 Frontier / Clarity + AMS	1.2 / .25, 2.5	Pre/Spike-3”	73
7 Frontier / Marksman + AMS	1.2 / 1.2, 2.5	Pre/Spike-3”	55
8 Frontier / Distinct + NIS + AMS	1.2 / .26, .25%, 1.0	Pre/Epost	88T
9 TopNotch / Hornet + NIS + AMS	1.6 / .13, .25%, 2.5	Pre/Epost	81
10 Harness Xtra / Permit + COC + AMS	2.7 / .05, 1.25%, 2.5	Pre/Epost	73
11 Leadoff / Accent Gold + NIS + AMS	1.25 / .15, .25% 2.5	Pre/Epost	89T
12 Leadoff / Basis Gold + COC + AMS	1.25 / .79, 1.25%, 2.5	Pre/Epost	92T
13 Degree / Permit + COC + AMS	1.54 / .05, 1.25%, 2.5	Pre/Epost	73
14 Northstar + Accent + NIS	0.15, .02, .25%	Epost	102T
15 Dual II Magnum + Northstar + Accent + NIS	1.27, .15, .02, .25%	Epost	97T
16 Dual II Magnum + Atrazine / Northstar + Accent + NIS	1.27, .75 / .15, .02, .25%	Epost	101T
17 Spirit + Accent + NIS	0.036, .02, .25%	Epost	85T
18 Dual II Magnum + Spirit + Accent + NIS	1.27, 0.036, 0.02, .25%	Epost	100T
19 Bicep Lite II Magnum / Northstar + NIS	2.25 / .15, .25%	Epost	98T
20 Bicep Lite II Magnum / Spirit + NIS	2.25 / .036, .25%	Epost	105T
21 Celebrity + NIS + AMS	0.29, .25%, 1.0	Epost	98T
22 Celebrity Plus + NIS + AMS	0.21, .25%, 1.0	Epost	97T
23 Accent Gold + NIS	0.15, .25%	Epost	92T
24 Basis Gold + NIS	0.79, .25%	Epost	92T
25 Spirit + Accent + Clarity + NIS	0.036, .02, .06, .25%	Epost	91T
26 Hornet + Accent + NIS	0.13, .03, .25%	Epost	88T
27 Guardsman	2.5	Pre	65
28 EPIC	0.29	Pre	79
29 Guardsman + Balance	2.5, 0.035	Pre	78
30 Guardsman + Clarity	2.5, 0.25	Pre	69
31 Outlook + Marksman	0.72, 0.8	Pre-Spike	57
32 Outlook / Marksman + AMS	0.72 / 0.8, 2.5	Pre/Spike-3”	65
33 Guardsman / Distinct + NIS + AMS	2.5 / 0.175, .25%, 1.0	Pre/Epost	81
34 Outlook / Distinct + Atrazine + NIS + AMS	0.72 / 0.175, .5, .25%, 1.0	Pre/Epost	82
35 Atrazine / Celebrity Plus + Atrazine	1.0 / 0.21, 0.5, .25%, 1.0	Pre/Epost	85T
LSD (0.05) =			23

EFFICACY OF CRY1F CORN FOR THE CONTROL OF SOUTHWESTERN CORN BORER AND CORN EARWORM

by
Larry Buschman, Phil Sloderbeck and Merle Witt

SUMMARY

This trial evaluated the efficacy of corn containing the cry1F gene for controlling southwestern corn borer, (SWCB) *Diatraea grandiosella* Dyar, and corn earworm *Helicoverpa zea* (Bobbie). Three corn hybrids were evaluated: an experimental hybrid with Bt event TC1507 expressing cry1F, a non-Bt isoline, and a commercial Bt corn hybrid with event MON810 expressing Cry1Ab. The seed was supplied by Mycogen Seeds/Dow AgroSciences. The efficacy of the Cry1F experimental hybrid against SWCB was outstanding and appeared to be equal to that of a current commercial Cry1Ab Bt corn hybrid. In addition, both transgenic hybrids appeared to suppress kernel damage at the ear tip by the corn earworm.

PROCEDURES

The plots were machine-planted on 17 May at the Southwest Research-Extension Center near Garden City, KS, using seed supplied by Mycogen Seeds/ Dow AgroSciences. Three corn hybrids were evaluated: an experimental hybrid Mycogen 2395+ with Bt event TC1507 expressing cry1F, a non-Bt isoline hybrid Mycogen 2395- and a commercial Bt corn hybrid, Pioneer 33A14 with event MON810 expressing cry1Ab. The plots were four rows wide (10 ft), 20 ft long and separated by two additional border rows of Bt corn and 10-ft wide alleys. The plot design was a randomized block design with four replicates. Four to eight rows of Bt corn were planted around the experimental plots as a border/windbreak. Emergence was recorded for plants in the two center rows on 31 May. The two south rows of each plot were infested with a total of 40 southwestern corn borer neonates on 28 and 30 June, when the plants were in the 8 to 10 leaf growth stage. First generation infestation was evaluated using modified Guthrie ratings (0-9 scale) on 10 infested plants per plot on 20 July. In addition, five infested plants were dissected to record the number of larvae and tunnels and the total tunneling per plant on 27 July. The second generation SWCB infestation came from free-flying feral moths and moths emerging from the manually infested first generation. Five ears per plot were examined on 14 August to record numbers of corn earworm, the number of damaged kernels and the percent ear tip and ear base damage. Ten plants from the two north rows were dissected on 23 September to make observations on the number of corn borer larvae per plant, plus the number and length of tunnels in the ear shanks and stalks.

RESULTS

Corn emergence was similar for the three hybrids (Table 1). The pollen shed and silking observations indicate that the M2395 hybrids (treatments 1 & 2) reached pollen shed and silking at about the same time, but that the MON810 hybrid reached that stage significantly later (Table 1).

The artificial infestation of first generation SWCB was successful, producing modified Guthrie ratings of 7.8 on a scale of 1 to 9 in the infested non-Bt hybrid plants, while only a few feeding scars were found on the two transgenic hybrids (Table 1, Fig. 1). Plant dissections revealed 100 percent infested plants and a mean of 2.7 first generation SWCB larvae per plant in the non-Bt hybrid, but no larvae were found in the Cry1F hybrid and only two infested plants were found in the Cry1Ab hybrid (Fig.2). No European corn borer larvae were recorded. There was an average of 3.2 tunnels and 7.6 inches of tunneling per plant in the infested non-Bt hybrid plants, while the transgenic hybrids with events TC1507 and MON810 reduced SWCB tunneling to almost nothing (Fig. 3).

Observations made on ears sampled 14 August recorded 90 percent of ears infested in the non-Bt hybrid (Table 2). A mean of 1.4 CEW larvae per ear with an average of 25.4 damaged kernels was recorded

Table 1. Early season observations on the efficacy of Cry1F corn on southwestern corn borer (SWCB). SWREC Garden City, Finney Co., Kansas.

Trt No	Hybrid Code	Bt-Event	Emerged 31 May	Pollen 20 July	Silking 20 July	Guthrie Rating 0-9 scale	Guthrie Rating % Plts. 3+	1st Gen. SWCB /Plant	1st Gen. Tunnels /Plant	1st Gen. Inches /Plant	1st Gen. %Plant Infested
1	M2395+	TC1507	75	50 ab	46	0.5 b	0 b	0.0 b	0.0 b	0.0 b	0
2	M2395	Non-Bt	78	90 a	55	7.8 a	100 a	2.7 a	3.2 a	7.6 a	100
3	P33A14	MON810	72	13 b	13	0.5 b	0 b	0.1 b	0.2 b	0.1 b	10
	P-value		0.6442	0.0221	0.0995	<0.0001	<0.0001	0.0027	0.0019	0.0037	—
	LSD		16.48	48.34	41	0.542	0.499	0.478	1.36	3.68	—

Table 2. Late season observations and the efficacy of Cry1F corn on corn earworm (CEW) and southwestern corn borer (SWCB). SWREC Garden City, Finney Co., Kansas.

Trt No.	Hybrid Code	Bt-Event	CEW Larvae Per ear	CEW Mean Instar	CEW Damaged Kernels/ear	% Ear Tips Infested	Bases Infested
1	M2395+	TC1507	0.9 ab	4.1	10.3 b	90	23
2	M2395	Non-Bt	1.4 a	4.3	25.4 a	97	49
3	P33A14	MON810	0.6 b	3.5	2.9 b	80	10
	P-value		0.0171	0.1566	0.0053	0.1064	0.0694
	LSD		0.472	0.878	10.547	16.42	33.23

in these ears (Fig. 4). The Bt hybrids reduced the number of CEW larvae and significantly reduced kernel damage, but the percent of ears with damage ears remained above 80. There was an average of 25.4 damaged kernels in the non-Bt hybrid ears, and the Bt hybrids significantly reduced kernel damage (Fig. 5). Reduction in damage was greatest for the MON810 hybrid, but was not significantly different from the TC1507 hybrid. Nearly all of the damage to the ear tips would have been done by the corn earworm. The transgenic hybrids also appeared to reduce kernel damage at the ear base; however, the differences were not statistically significant. The damage at the ear "base" included damage caused by early stages of the southwestern corn borer, which should have been susceptible to the toxins expressed in the Bt corn hybrids.

The second generation SWCB population averaged 1.1 larvae per plant in the non-Bt hybrid in September, but the Bt hybrids reduced the number of larvae to undetectable levels (Table 3, Fig. 6). One European corn borer larva was recorded in the 120 plants dissected, therefore, most of the stalk tunneling was done by the SWCB. There was an average of 2.6 stalk tunnels and 0.7 shank tunnels per plant with an average of 13.4 inches of total tunneling per plant in the infested non-Bt hybrids. Tunneling was undected in the Bt hybrids (Fig. 7).

The efficacy of the Cry1F experimental hybrid against SWCB was outstanding and appeared to be equal to that of a current commercial Cry 1Ab Bt corn hybrid. In addition, both transgenic hybrids appeared to suppress kernel damage at the ear tip by the corn earworm.

Fig. 1. First generation SWCB leaf-damage in three corn hybrids

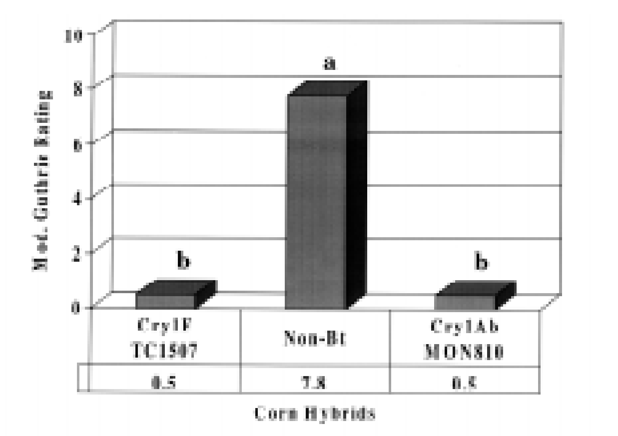


Fig.3. First generation SWCB tunneling in three corn hybrids

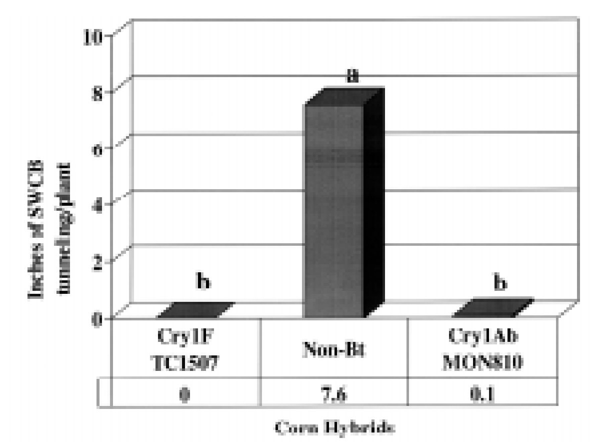


Fig. 2. First generation SWCB larvae in three corn hybrids

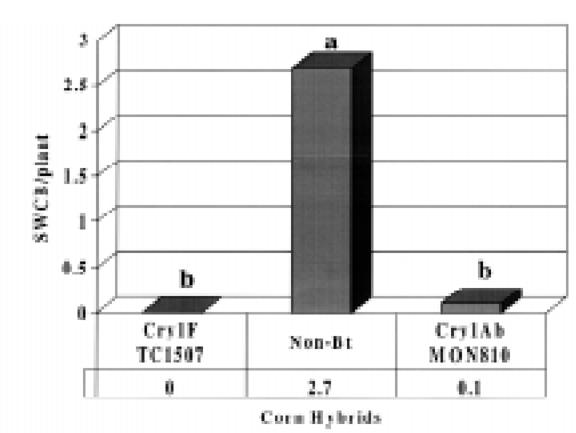


Fig. 4. Corn earworms in the ears of three corn hybrids

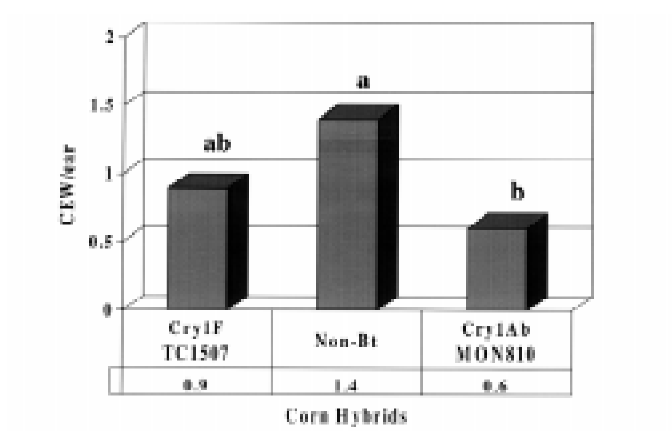


Table 3. Late season observations on the efficacy of Cry1F corn on southwestern corn borer (SWCB). SWREC Garden City, Finney Co., Kansas.										
Trt No	Hybrid Code	Bt-Event	SWCB /plant	Stalk Tun No./plt	Shank Tun No./plt	Stalk Tun Inches/plt	Shank Tun Inches/plt	Total Tun Inches/plt	Plants CB Infest
1	M2395+	TC1507	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b	0
2	M2395	Non-Bt	1.1 a	2.6 a	0.7 a	12.2 a	1.1 a	13.4 a	100
3	P33A14	MON810	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b	0
	P-value		<0.0001	<0.0001	0.0008	<0.0001	<0.009	<0.0001	—
	LSD		0.126	0.129	0.238	2.283	0.674	2.859	—

Fig. 5. Corn earworm kernel damage in ears of three corn hybrids

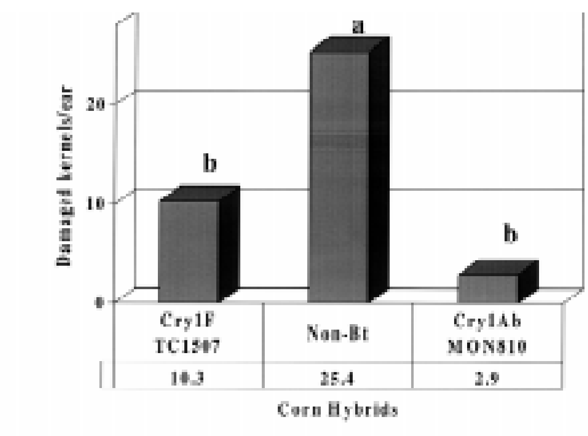


Fig. 6. Second generation SWCB larvae in three corn hybrids

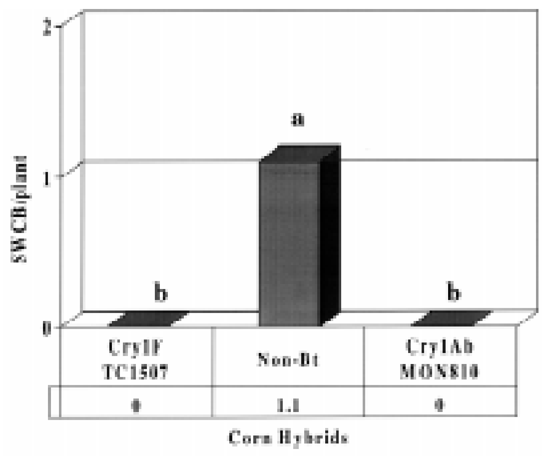
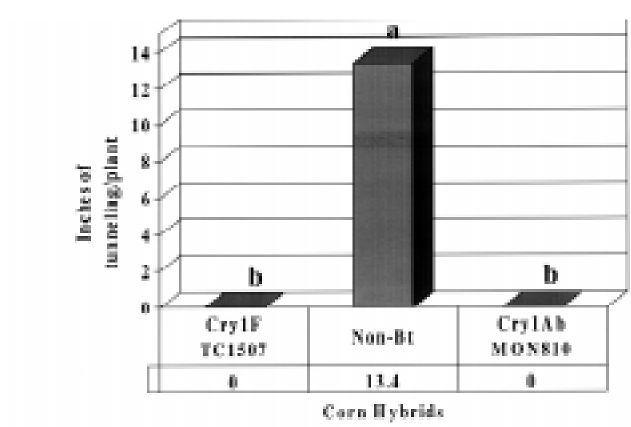


Fig. 7. Second generation SWCB Tunneling in three corn hybrids



EFFICACY OF REGENT AND COUNTER ON CORN ROOTWORM AND SOUTHWESTERN CORN BORER LARVAE

by
Larry Buschman, Phil Sloderbeck and Randall Currie

SUMMARY

This trial was conducted to evaluate planting time applications of Regent 80WG and Counter 20CR against corn rootworm and southwestern corn borer larvae. Both insecticides provided significant protection against corn rootworm injury. The Regent plots had significantly less southwestern corn borer infestation than did the Counter plots. In addition, the Regent plots had significantly less fallen corn as a result of lodging caused by second generation southwestern corn borer injury than did either the untreated or the Counter treatments. Thus, there is evidence that the Regent treatment reduced damage significantly from corn rootworms, as well as first and second generation southwestern corn borer. Total yield for the Regent and Counter plots was similar and both were significantly greater than yield of the untreated plots.

PROCEDURES

These plots were machine planted 10 May 2000 at the Southwest Research-Extension Center near Garden City, KS using Pioneer 3162IR corn seed. The plots were 6 rows wide (15 ft) and 50 ft long with 10-ft alleys. The plot design was a randomized block design with 4 replicates. Counter 15G was applied with planter-mounted granular applicator boxes at 6 oz per 1000 ft. A 7-inch bander was mounted before the press-wheel to apply the insecticide in a “T-Band." Regent 80WG was mixed with water and applied at 3 gal of solution per acre at 14 psi through a microtube directed into the seed furrow.

There were strong dry winds on 19 June (during an extended dry period) that caused some plants to lean from lack of root support and show serious wilting. The leaning and wilting appeared to be associated with loss of roots from corn rootworm damage. The plots were rated for leaning using a 1-3 scale, where 1 was no leaning and 3 was extensive leaning. The plants were rated for wilting using a 1 to 5 rating scale, where a 1 was no wilting and a 5 was severe wilting. On 7 July 4 corn plants were dug from each plot and rated for rootworm damage using the Iowa 1 to 6 root damage scale.

Ten plants in each plot (reps 1-3) were infested with an average of 2 SWCB neonate larvae per plant on 22 June. First generation infestation was evaluated on 13 July using a modified Guthrie rating (0-9 scale) on 10 infested plants per plot. The plants were then dissected to record the number of larvae, the length of tunneling and percent plants infested. Two rows of each plot were harvested in early October by hand harvesting the SWCB lodged corn and then machine harvesting the standing corn. Grain yield (adjusted to 15.5% moisture) was calculated per acre for standing corn, fallen grain, and for total grain. Data were analyzed by ANOVA and means separated using LSD (P=0.05).

RESULTS AND DISCUSSION

Corn rootworm pressure in the plots was high enough that some plants in the untreated plots died from desiccation during the dry winds of 19 June. The wilting index was significantly lower for the two insecticide-treated plots relative to the untreated plots (Table 1). Corn rootworm pressure averaged 4.9 on the Iowa 1 to 6 root damage scale, and both Regent and Counter treatments had significantly lower corn rootworm injury than the untreated check (Table 1). The root rating for Counter was significantly lower than that of Regent.

The artificial infestation of first generation SWCB was remarkable with only 2 neonates per plant. The modified Guthrie ratings averaged 2.9 to 3.4 on the 0 to 9 scale with 34 to 62 percent of the plants infested (Table 1). There were 0.3 to 0.8 larvae per plant and 0.9 to 2.0 inches of tunneling per plant. The southwestern corn borer infestation was higher in the Counter-treated plots than in the control plots. This was unexpected, since these two treatments should not have affected the corn borers. Apparently, the desiccation stress from corn rootworm damage reduced corn borer survival in the control plots. Therefore, the meaningful comparison should be between the Counter- and the Regent-treated plots. The Regent-treated plots had a significantly lower southwestern corn borer infestation relative to the Counter-treated plots.

Total yield for the Regent and Counter plots was similar and both were significantly higher than that of the untreated plots. The Regent plots had significantly less fallen corn as a result of lodging caused by second generation southwestern corn borer injury than did either the untreated or the Counter treatments. Thus, there is evidence that Regent reduced damage significantly from second-generation southwestern corn borer, as well as first-generation southwestern corn borer and corn rootworms.

Table 1. Efficacy of Regent and Counter for controlling western corn rootworm on corn in SW Kansas, Garden City, KS, 2000.

		Corn Rootworm Damage			
Treatment	Rate	Leaning Plants 1-3 scale	Wilting Plants 1-5 scale	Root Rating 1-6 scale	Plants Rated 3.5+
Untreated	--	2.9 a	3.4 a	4.9 a	3.5 a
Regent 80WG	0.13 lb ai/a	1.6 b	1.8 b	3.6 b	2.8 a
Counter 20CR	1.3 lb ai/a	1.3 b	1.7 b	3.1 c	1.4 B
F-Test Prob.		0.007	0.004	0.0002	0.0463
LSD value at p=0.05		0.8728	0.793	0.453	1.612

Means within a column followed by the same letter do not differ significantly (LSD, P=0.05)

Table 2. Efficacy of Regent and Counter for controlling southwestern corn borer larvae plus associated grain yields. Garden City, KS, 2000.

		First Generation Southwestern Corn Borer Larval Injury				Grain Yield		
Treatment	Rate	Modified Guthrie Rating 0-9	% Plants Infested	SWCB Per plant	Tunneling Inches per Plant	Standing Bu/a	Fallen Bu/a	Total Bu/aA
Untreated	—	2.9	47 ab	0.4 b	1.4 ab	88.1 b	14.7 a	102.7 b
Regent 80WG	0.13 lb ai/a	3.0	34 b	0.3 b	0.9 b	128.2 a	4.8 b	132.9 a
Counter 20CR	1.3 lb ai/a	3.4	62 a	0.8 a	2.0 a	125.2 a	17.9 a	143.1 a
F-Test Prob.		<0.50	0.056	0.011	0.029	0.045	0.006	0.031
LSD value at p=0.05		0.807	2.51	0.374	0.89	33.2	6.4	28.5

Means within a column followed by the same letter do not differ significantly (LSD, P=0.05).

Fig. 1. Plant wilting associated with plants treated or untreated with soil insecticides

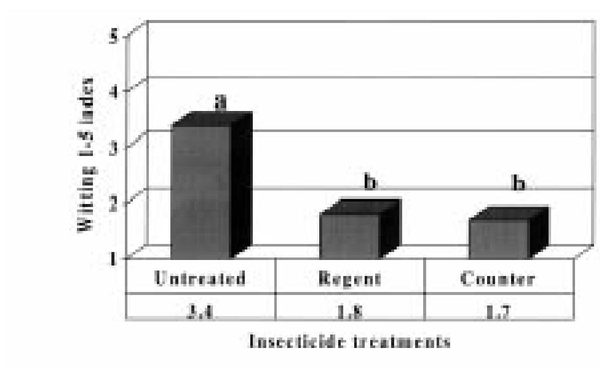


Fig. 2. Corn rootworm damage to roots treated or untreated with soil insecticides

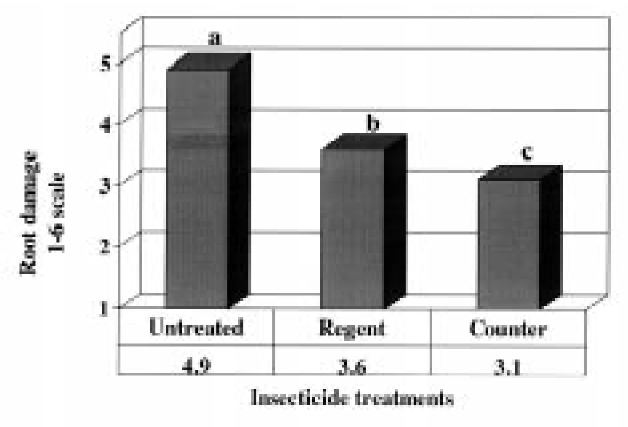


Fig. 3. First generation SWCB in plants treated or untreated with soil insecticides

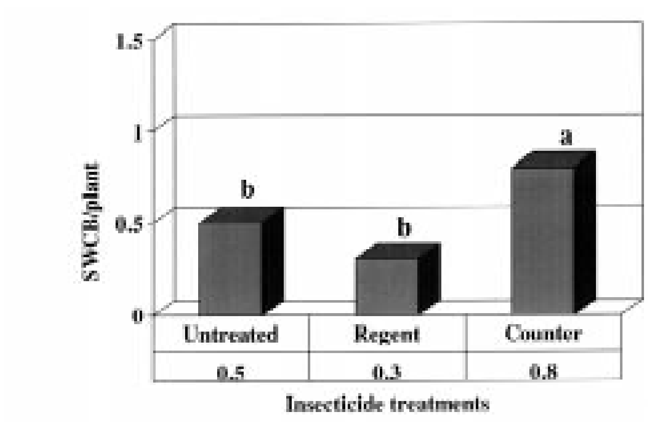


Fig. 4. First generation SWCB in plants treated or untreated with soil insecticides

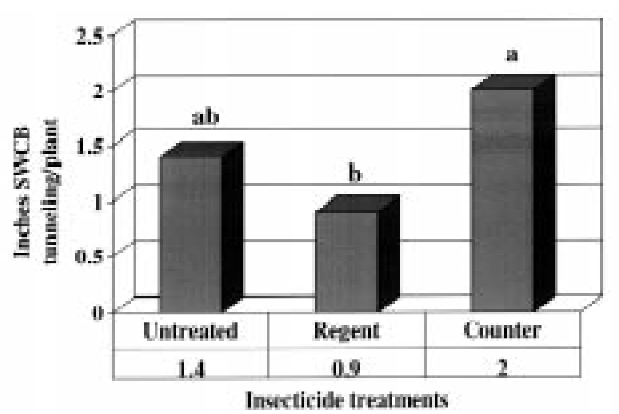


Fig. 5. Grain yield lost to SWCB girdling in plots treated or untreated with soil insecticides

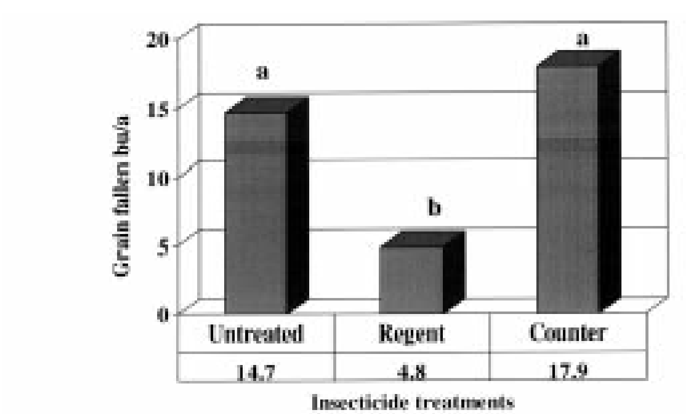
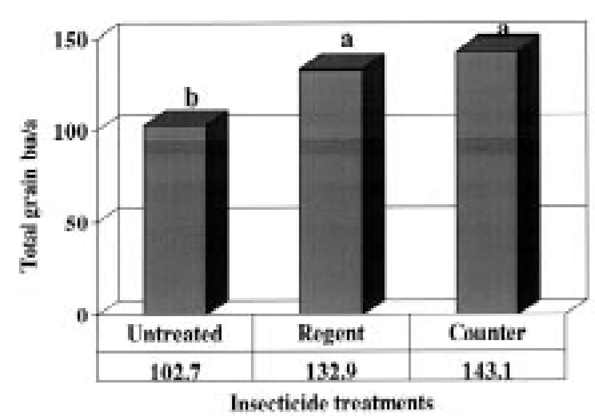


Fig. 6. Total grain yield in plots treated or untreated with soil insecticides



WINTER CEREALS FOR FORAGE OR FOR GRAIN

by
Merle Witt

SUMMARY

In this dryland small grains trial, wheat, rye, and triticale as spring forage only (in April), or as a grain crop only (in June) were compared. Kitaro triticale produced the highest forage yields (10,439 lbs/a) and the highest grain yield (50.4 bu/a) of the 3 crops and varieties compared.

INTRODUCTION

When grain prices are low, producers often consider wheat and other small grain cereal crops for livestock forage. This trial was conducted to compare the relative spring forage yields of wheat, rye, and triticale versus leaving these crops for grain harvest.

PROCEDURES

In this dryland small grains comparison, replicated plots were split so that both forage yields and grain yields of several small grain cereal crops could be measured. Forage yields were taken by clipping the foliage in each sub-plot 1 inch above the soil on 24 April 2000. Another area of each plot was harvested for grain in late June.

RESULTS AND DISCUSSION

Resulting forage dry matter yields of several varieties of wheat, rye, and triticale are shown in Table 1. As shown, the highest forage yield was produced by Kitaro triticale, with 10,439 lbs of dry forage/a. The highest grain yield was also produced by Kitaro triticale, with 50.4 bu/a.

Table 1. Forage yield vs. grain yields of dryland winter cerals at Garden City, KS in 2000.

		Forage Plots	Grain Plots			
Crop		Forage Lb/acre April 24	Mature Height Inches	Test Weight	Lb/acre	Bu/acre*
Rye						
	Amilo	8,060	42	52.2	1782	31.8
	Warko	7,292	42	50.6	1703	30.4
Triticale						
	DED 496	6,371	33	49.6	1426	28.5
	Kitaro	10,439	40	50.2	2518	50.4
	Lamberto	7,753	37	50.4	2017	40.3
	Presto	9,787	41	51.2	2280	45.6
Wheat						
	TAM 107	6,371	32	57.7	2070	34.5
	Mean	8,010	38.1	51.7	1971	
	c.v.%	4.4	3.9	0.7	8.9	
	L.S.D. 5%	831	3.7	0.9	428.7	

* Rye = 56 lb/bu
Triticale = 50 lb/bu
Wheat = 60 lb/bu

ALLELOPATHIC INFLUENCE OF ALFALFA ON THE SUCCEEDING WHEAT CROP

by
Merle Witt

SUMMARY

We evaluated 33 alfalfa varieties for possible differences in their toxic effect on the following wheat crop. We did not identify any alfalfa varieties with an unusually large, undesirable allelopathic influence on wheat.

INTRODUCTION

Several field crops, tree species, and weeds have been shown to exert a toxic, or allelopathic, influence on the succeeding crop, thus adversely affecting it's germination and growth.[1] Among local crops, alfalfa has sometimes been observed to cause a replanting problem where toxicity from root exudates restricts emergence of the succeeding crop. The roots of alfalfa have been reported to produce differing amounts of saponin, medicarpin, and phenolics, all water-soluble materials potentially toxic to the next crop.

PROCEDURES

On 20 October 1999, TAM 107 winter wheat was cross drilled at 100 pounds seed per acre into a 3-year-old stand. The stand contained 4 replicated plots of 33 alfalfa varieties each. Emerged wheat stands in each plot were counted and wheat in each plot was harvested for grain yield comparisons in late June 2000.

RESULTS AND DISCUSSION

Alfalfa stands averaged 3.4 plants/ft^2. Wheat emergence among the plots of alfalfa stubble did not differ significantly, regardless of the alfalfa variety, and averaged 11.8 plants/ft^2.

Harvested wheat grain yields in June 2000, averaged 33.0 bushels/acre with no significant variation caused by any of the 33 alfalfa varieties that preceeded the wheat. Therefore, we did not identify any alfalfa varieties to avoid due to an unusually high toxic influence on the succeeding wheat crop.

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[1]Kohli, R.K., D. Batish, & H. P.Singh. Allelopathy and It's Implications in Agroecosystems. 1998. Journal of Crop Production. Vol. 1, No. 1, pp 169-202.

Table 1. Influence of alfalfa varieties on the succeeding wheat crop in 2000.

Brand	Variety	No. Wheat Plants/ft^2	Yield bu/a
Allied	Asset	11.8	37.0
Allied	Excalibur II	12.0	34.6
Allied	Spur	12.3	31.7
Allied	Stamina	12.4	32.4
Cal/West	C/W 4429 Exp	12.3	31.4
Cal/West	C/W 4598 Exp	12.6	33.7
Cal/West	C/W 5406	12.8	35.7
Cal/West	C/W 5440	10.9	34.2
Cargill	Big Horn	11.4	33.7
Casterline	Pro Gro 424	11.4	33.4
DeKalb	DK 127	11.3	32.6
DeKalb	DK 133	11.2	32.5
Drussel	DSS 5106X Exp	11.7	33.0
Drussel	DSS 5211 Exp	11.6	32.0
Drussel	Enhancer	12.6	33.7
Golden Harvest	GH 766	12.8	32.9
Golden Harvest	GH 755	11.7	34.9
Jerry Weaver Seeds	Magnum III	10.8	30.8
Mycogen	TMF Multiplier II	12.4	31.6
Sharp	Alfaleaf II	11.6	32.9
Sharp	Shamrock	12.1	31.5
Sharp	Sure	11.9	37.1
Star	A-100	12.3	34.5
W-L Research	Ace	11.9	36.3
W-L Research	WL 323	11.6	34.6
W-L Research	WL 324	11.2	33.5
W-L Research	WL 325 HQ	11.4	32.1
W-L Research	WL 414	10.6	31.5
	Kanza	12.8	30.7
	Riley	11.3	30.8
	Perry	11.6	28.8
ICI	630	11.1	30.2
ICI	645	12.2	33.0
Mean		11.8	33.0
Coefficient of variation		11.0	10.3
Least significant difference (0.5%)		n.s.	n.s.

DRYLAND SOYBEAN MATURITY GROUP BY PLANTING DATE STUDY

by

Merle Witt

SUMMARY

In this study. three maturity groups of soybeans (MG II, MG III, and MG IV) were seeded on four planting dates (15 April, 1 May, 15 May, and 1 June). The longest season (MG IV) soybeans were the highest yielding among the four maturity groups and these were favored by the earliest planting date (15 April). The MG IV soybeans planted early produced a yield of 25.4 bu/a.

INTRODUCTION

A previous dryland soybean study (1989-91) at this location produced an average yield of 22 bu/a for four Maturity Groups (MG I, MG II, MG III, and MG IV). Highest yields in that study resulted from a MG IV soybean variety. The present study further evaluated additional varieties at several planting dates.

PROCEDURE

Soybeans were seeded at 40 lbs/a and grown on a previously fallowed Keith Silt Loam soil using Pursuit Plus herbicide applied at 2.5 pt/a.

RESULTS AND DISCUSSION

Yields of dryland soybeans in 2000 ranged from 14 to 25 bu/a (Table 1). A full profile of stored subsoil moisture at planting time allowed reasonably good yields in spite of the fact that late summer was very dry. Yields increased with increasing maturity length of the soybeans and produced the highest yields using a MG IV soybean planted 15 April.

Table 1. Dryland soybean maturity group (MG) x planting date study at Garden City, KS in 2000.

Date	# Days To Emerge	# Days To Bloom	Height	Test Wt	Bu/A	G/100 Seeds
			MGII (Turner)			
April 15	21	77	13	56.5	14.2	14.7
May 1	10	65	15	56.6	15.7	14.2
May 15	5	56	16	57.4	18.9	13.3
June 1	5	46	17	57.4	20.9	12.8
			MG III (Macon)			
April 15	21	83	18	55.7	18.6	11.4
May 1	10	71	20	55.9	19.0	11.1
May 15	5	63	21	56.2	20.1	10.6
June 1	5	51	22	57.0	20.7	9.8
			MG IV (KS4694)			
April 15	21	87	20	57.7	25.4	9.7
May 1	10	79	25	58.6	22.7	9.5
May 15	5	69	26	57.8	20.7	9.1
June 1	5	55	26	56.8	17.3	9.5

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W-L Research

Alan Schlegel—Agronomist-in-Charge, Tribune. Alan received his M.S. and Ph.D. degrees at Purdue University. He joined the staff in 1986. His research involves fertilizer and water management in reduced tillage systems.

Curtis Thompson—Extension Agronomist. Curtis received his M.S. from North Dakota State University and his Ph.D. from the University of Idaho. He joined the staff in 1993. His extension responsibilities include all aspects of soils and field crop production.

Tom Willson—Environmental Scientist. Tom received a B.A. in Biology and Environmental Studies from the University of California, Santa Cruz and studied Soil Science at Colorado State University before receiving his PhD in Soil Ecology and Sustainable Agriculture from Michigan State University. Tom's current research activities include several field experiments integrating manure and irrigation water management in grain and forage production, water quality projects, including a study of the sources of fecal coliform contamination in the Upper Arkansas River; and resource conserving /odor reducing technologies such as biogas production from animal waste in fully enclosed lagoons (anaerobic digesters). He joined the staff in October 2000.

Phil Sloderbeck—Extension Entomologist. Phil received his M.S. from Purdue University and his Ph.D. from the University of Kentucky. He joined the staff in 1981. His extension emphasis is on insect pests of field crops.

Carol Young—Extension Home Economist and Program Specialist. Carol received her M.Ed. from Wichita State University in educational administration. She joined the staff in 1982 with Extension agent experience in Edwards, Sumner, and Osage counties. Carol promotes programs that benefit families and communities and teaches planning, leadership, and citizen involvement skills.

Merle Witt—Agronomist –Crop Specialist. Merle received his M.S. at Kansas State University and joined the staff in 1969. He received his Ph.D. from the University of Nebraska in 1981. Merle's research has included varietal and cultural testing of established crops and potential crops for southwest Kansas.

Kansas State University Agricultural Experiment Station and Cooperative Extension Service, Manhattan 66506

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