Kansas State University

Southwest Research-Extension Center

FIELD DAY

2000

REPORT OF PROGRESS
856

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.

Edwin Beason - Assistant Scientist - Tribune. Eddie received his M.S. from the Kansas State University in 1970. He began his work here in March, 2000.

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.

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2000 RESEARCH-EXTENSION CENTER STAFF

Patrick Coyne	Head
Paul Hartman	Area Extension Director
Mahbub Ul Alam	Extension Specialist-Irrigation
Edwin Beason	Assistant Scientist, Tribune
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
Lance Huck	Extension Specialist-Livestock Production
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
Todd Trooien	Agricultural Engineer-Water Management
Merle Witt	Agronomist-Crop Production
Carol Young	Extension Home Economist

2000 SUPPORT PERSONNEL

Jovita Baier, Office Specialist
Marvin Cronin, Jr., Agricultural Technician
Mary Embree, Accountant I
Manuel Garcia, Gen. Maintenance & Repair Tech. II
Daniel Grice, Gen. Maintenance & Repair Tech I
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Gary Miller, Plant Science Technician II
Dale Nolan, Plant Science Technician II - Tribune
Eva Rosas, Keyboard Operator III
David Romero, Jr., Mechanic I
Sharon Schiffelbein, Secretary III
Michele Sells, Agricultural Technician - Tribune
Ramon Servantez, Plant Science Technician II
Monty Spangler, Agricultural Technician
Dennis Tomsicek, Agricultural Technician
John Wooden, Plant Science Technician II
Jennifer Wright, Agricultural Technician

Southwest Research-Extension Center
4500 East Mary, Bldg. 924
Garden City, KS 67846
316-276-8286
Fax No. 316-276-6028

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K-STATE Southwest Research-Extension Center

WEATHER INFORMATION FOR GARDEN CITY

by
Jeff Elliott

1999 was the eleventh consecutive year with above average precipitation. In fact, since records started in 1908, this is the only "wet" period lasting more than 3 consecutive years. Precipitation totaled 21.80 inches compared to 17.91 inches for the 30-year average. We accumulated 18.15 inches growing season precipitation (April – September) compared to 13.90 inches in an average year. June was the wettest month with 4.18 inches, and November was the driest with 0.06 inches. Snowfall measured 19.25 inches, which was slightly above the average of 17.70 inches. Only January, February, and March had measurable snowfall.

July was the warmest month with a mean temperature of 79.0°. January was the coolest with a mean temperature of 32.9°. Monthly mean temperatures were similar to the 30-year averages with the exception of February, November, and December, which were considerably warmer than the norm.

The coldest temperature recorded in 1999 was 0° on January 3. Temperatures of 100° or above were recorded on 6 days in July and 2 days in August. The warmest temperature recorded was 102° on July 26 and July 31.

Three record high temperatures were set or tied in 1999: 72°, 72°, and 74°, respectively on December 28, 29, and 30. Record lows were recorded on March 15 (5°), July 10 (55°), and July 11(50°).

The last spring freeze (32°) of 1999 occurred on April 19. The first freeze in the fall was on October 4. This resulted in a frost-free period of 168 days, similar to the average of 169 days.

Open pan evaporation from April 1 through October 31 totaled 69.41 inches. This is similar to last year and to the 30-year average. Mean wind speed was 4.7 mph. This is also similar to last year and considerably lower than the 5.5 mph average.

The 1999 weather data are summarized in the table below.

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

	Precipitation inches		Temperature (°F)								Wind MPH		Evaporation inches	
			1999 Average		Mean		1999 Extreme							
Month	1999	Avg.	Max.	Min.	1999	Avg.	Max.	Min.			1999	Avg.	1999	Avg.
January	1.18	0.33	47.3	18.5	32.9	27.9	73	0			4.3	4.8		
February	0.15	0.45	58.6	21.6	40.1	32.8	79	10			5.8	5.5		
March	1.74	1.15	53.5	27.4	40.5	41.3	77	2			6.3	7.0		
April	2.22	1.56	65.9	36.1	51.0	52.7	86	23			6.2	7.0	7.15	8.75
May	3.45	3.11	75.6	48.0	61.8	62.2	89	35			5.7	6.4	9.75	10.67
June	4.18	2.87	83.3	57.0	70.1	72.4	93	43			5.7	6.0	11.18	12.89
July	3.50	2.60	92.8	65.1	79.0	77.9	102	50			5.1	5.2	14.75	14.19
August	2.64	2.16	91.4	64.5	77.9	75.4	101	55			3.2	4.5	10.99	11.66
September	2.16	1.59	78.4	52.0	65.2	66.6	96	33			3.7	4.9	7.96	8.84
October	0.43	0.98	72.3	36.8	54.5	55.0	91	25			3.7	4.8	7.63	6.76
November	0.06	0.76	67.4	28.9	48.1	41.1	84	16			3.2	4.8		
December	0.09	0.35	52.6	20.5	36.5	30.7	74	11			3.8	4.5		
Annual	**21.80**	**17.91**	**69.9**	**39.7**	**54.8**	**53.0**					**4.7**	**5.5**	**69.41**	**73.76**

Average latest freeze in spring	April 26	1999:	April 19
Average earliest freeze in fall	Oct. 12	1999	Oct. 4
Average frost-free period	169days	1999:	168 days

All averages are for the period 1961-90.

WEATHER INFORMATION FOR TRIBUNE

by
Dewayne Bond[1] and Dale Nolan

The yearly total precipitation of 21.38 in. was 5.42 in. above normal; 7 months had above-normal amounts. July was the wettest month, with almost twice the normal. The largest single amount of percipitation was 2.16 in. on July 25. November was the driest month with less than 0.1 in. of precipitation. Snowfall for the year totaled 19.5 in: 3.0 in. in January, 1.0 in. in February, 15.5 in. in March, and 1.0 in. in November, for a total of 9 days of snow cover. The longest consecutive period of snow cover, 4 days, was from March 12 to March 15.

Record high temperatures were set on January 16; February 6 and 15; November 9,12,14,18; and December 29. Record low temperatures were set on July 11 and October 4. The hottest day of the year was September 1 (102°), and the coldest day was January 4 (0°). January was also the coldest month of the year with a mean temperature of 33.0° and an average low of 16.9°. July was the warmest month with a mean temperature of 77.4° and an average high of 92.2°. For half the year, the air temperature was above normal. November had the greatest departure from normal, 6.5° above normal. Days with temperatures of 100° or above (1) and 90° or above (57) were below their 30-year averages. The last day with temperatures of 32° or less in the spring on May 7 was 4 days later than the normal date, and the first day in the fall on September 29 was 4 days earlier than the normal date. This produced a frost-free period of 145 days, 8 days less than the normal of 153 days.

Open pan evaporation for April through September totaled 61.80 in., 9.88 in. below normal. Wind speed for the same period averaged 5.3 mph, 0.4 mph less than normal.

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

	Precipitation inches		Temperature (°F) 1999 Average		Normal		1999 Extreme		Wind MPH		Evaporation inches	
Month	1999	Normal	Max.	Min.	Max.	Min.	Max.	Min.	1999	Avg.	1999	Avg.
January	0.51	0.36	49.1	16.9	43.3	14.2	72	0				
February	0.40	0.40	59.4	20.6	48.7	18.7	77	9				
March	1.48	0.99	55.5	24.3	56.6	25.4	79	5				
April	3.03	1.13	63.4	32.4	67.5	35.1	83	21	6.1	6.6	6.77	8.82
May	3.76	2.69	73.0	42.6	76.0	45.3	88	28	5.8	6.0	9.33	10.95
June	1.93	2.71	83.0	52.7	86.9	55.3	94	40	5.7	5.7	12.14	13.71
July	5.12	2.60	92.2	62.6	92.7	61.3	99	48	5.8	5.5	15.08	15.64
August	1.85	1.98	89.5	60.2	89.9	59.2	97	53	3.8	5.2	10.57	13.01
September	1.62	1.54	77.7	47.1	81.3	49.9	102	29	4.5	5.4	7.91	9.55
October	1.45	0.74	70.8	33.9	70.4	37.3	91	25				
November	0.09	0.49	66.1	26.9	54.7	25.3	83	8				
December	0.14	0.33	52.2	18.5	44.9	16.6	70	6				
Annual	**21.38**	**15.96**	**69.3**	**36.6**	**67.7**	**37.0**	**102**	**0**	**5.3**	**5.7**	**61.80**	**71.67**

Average latest freeze in spring[1]	May 4	1999:	May 6
Average earliest freeze in fall	October 4	1999:	September 28
Average frost-free period	153 days	1999:	145 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

SUMMARY

Short-season and full-season corn hybrids in a wheat-corn-fallow rotation were compared under dryland or limited irrigation for 2 years. Precipitation was above average during most of the growing season in both years; thus, full-season corn yielded more. However, results may differ in drier years.

INTRODUCTION

Fully irrigated corn in western Kansas usually consists of full-season hybrids (115 day or later) grown at populations of 30,000 to 35,000 plants/a. Research has shown no advantages to shorter season corn in terms of yields, 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. Very limited irrigation, meaning once or twice a 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 an alternative to returning acres to dryland.

PROCEDURES

Two corn hybrids having maturities of 104 and 115 days were planted on May 13, 1998 and April 21, 1999 at seeding rates of 18,000 and 33,000 seeds/a. The corn was planted in the stubble remaining from the 1997 and 1998 wheat crops, following about 11 months of fallow. Irrigation was done once at the tassel stage or twice at the 8-leaf and tassel stages. Each irrigation consisted of 6 inches of water applied through gated pipe. A dryland treatment was included. The plots were bordered to prevent runoff.

RESULTS AND DISCUSSION

Results are presented in Table 1. Plant populations were somewhat lower than desired because of crusting in both years, but were considered adequate considering the limited amount of water applied. With one irrigation, yields of both hybrids were increased at both populations in each year. With two irrigations, yields from the low population of either hybrid were not increased further in either year, whereas yields from the high population of both hybrids were increased in 1998, but not 1999. Yields of both hybrids generally increased with population at each irrigation level in both years. The later hybrid yielded more than the earlier hybrid at both population levels when irrigated once or twice, except for one irrigation at either population in 1999. Without irrigation, the later hybrid yielded more than the earlier hybrid at the low population in 1998, but yields of the later hybrid were reduced at the high population in 1999.

The corn was stressed prior to tassel in both years by lack of rainfall. The combination of irrigation and rainfall during the remainder of the growing season resulted in excellent yields, considering that a maximum of only 12 inches of irrigation water was applied. Planting an early hybrid gave no advantage in these conditions, but results may differ in years of less rainfall.

Table 1. Yield of limited-irrigated corn as affected by number of irrigations, hybrid maturity, and plant population. Garden City, KS, 1998, 1999.[1]

	1998				1999			
		Number of Irrigations[2]				Number of Irrigations		
Hybrid	Population	0	1	2	Population	0	1	2
	plants/a	——	bu/a	——	plants/a	——	bu/a	——
NK4640Bt (104)[3]	15,000	119	133	136	18,000	91	113	103
NK4640Bt	25,000	134	156	171	26,000	105	130	130
NK7333Bt (115)	17,000	138	167	168	18,000	82	126	139
NK7333Bt	27,000	129	174	193	27,000	72	148	159

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

[2]Each flood irrigation consisted of 6 inches of water. Irrigation was done at the the tassel stage or at 8-leaf and tassel stages.

[3]Numbers in parentheses indicate days to maturity.

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

EARLY VERSUS LATE PLANTING OF SHORT-SEASON DRYLAND CORN

by
Charles Norwood

SUMMARY

Early corn hybrids were planted in 1998 and 1999 to determine the effects of planting date and plant population on yield. Late planting usually increased yield, but decreased yield of the latest maturing hybrid in 1 of 2 years. Higher populations usually resulted in more grain. Dryland corn can be planted over a wide range of planting dates. The yield from a particular planting depends on the weather conditions during the growing season following that planting.

INTRODUCTION

Management practices for dryland corn need to be developed. Research in southwest Kansas has shown that hybrids having maturities of 100 to 105 days should be planted at populations of about 18,000 plants/a in early May. Hybrids maturing earlier than about 100 days do not use all of the growing season, use less water, and may benefit more from different planting dates and populations than later maturing hybrids. Thus, the objective of the study was to determine the optimum planting dates and plant populations for several early hybrids.

PROCEDURES

Dryland corn was grown at Garden City, KS in a wheat-corn-fallow rotation in 1998 and 1999 to compare early hybrids at two planting dates and three plant populations. Hybrids planted were Pioneer 3984, NK 2555Bt, Pioneer 3860, and Pioneer 3737. These hybrids have maturities of 75, 88, 92, and 98 days, respectively. Planting dates were May 4 and June 1, 1998 and April 30 and May 31, 1999. Planned populations were 18,000; 24,000; and 30,000 plants/a. Because of a combination of differences in emergence between hybrids, crusting, and rodent damage, final plant stands differed somewhat (Table 1). Corn was planted in the stubble remaining from the previous wheat crop (wheat-corn-fallow rotation). The corn in 1998 was no-till, whereas conventional tillage was used in 1999 to destroy a ground squirrel habitat.

RESULTS AND DISCUSSION

Results are given in Table 1. Yields were generally higher from the second planting in 1998. In 1999, the second planting resulted in a substantially higher yield increase from the earliest hybrid; however, yield of the latest hybrid decreased. Planting date had no effect on yield of the two intermediate maturing hybrids in 1999. Poor rainfall distribution in July and August of 1999 probably reduced yield of the latest hybrid, whereas rainfall in 1998 was above average in July and August and below average in June. Higher plant populations increased yield from both planting dates, particularly in 1998. Yield did not increase as much in 1999, but higher populations generally did not cause a yield decrease. The data collected from this and other studies indicate that a wide window exists for planting dryland corn. Data obtained thus far from this study indicate that a very early hybrid will yield more when planted late, whereas a later hybrid will be more dependent on weather conditions following planting. Intermediate hybrids will either increase in yield or be unaffected by planting date.

Table 1. Effects of hybrid, planting date, and plant population on yield of early-season dryland corn. Garden City, KS, 1998, 1999.

	Planting Date						
	5/4/98		6/1/98		4/30/99		5/31/99
Hybrid	Population	Yield	Population	Yield	Population[1]	Yield	Yield
	plants/a	bu/a	plants/a	bu/a	plants/a	bu/a	bu/a
Pioneer 3984 (75)[2]	16,000	53	17,000	78	20,000	44	67
	21,000	66	21,000	88	25,000	48	72
	24,000	68	27,000	98	28,000	50	71
NK 2555Bt (88)	17,000	104	21,000	148	20,000	96	97
	22,000	126	29,000	160	25,000	97	98
	27,000	141	33,000	155	28,000	107	106
Pioneer 3860 (92)	17,000	110	18,000	128	20,000	90	98
	22,000	135	25,000	135	25,000	99	99
	27,000	137	29,000	145	28,000	101	101
Pioneer 3737 (98)	17,000	117	17,000	140	20,000	109	91
	22,000	143	21,000	151	25,000	110	84
	27,000	141	27,000	164	28,000	114	95

[1]Population was the same for both planting dates
[2]Numbers in parentheses are days to maturity

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

YIELD OF NO-TILL DRYLAND CORN AS AFFECTED BY HYBRID, PLANTING DATE, AND PLANT POPULATION

by
Charles Norwood

SUMMARY

Dryland corn was grown in a wheat-corn-fallow rotation from 1996 to 1999 to compare hybrids, planting dates, and plant populations. Later planting produced better yields in all years. Yields generally increased with hybrid maturity, because of favorable weather conditions. Yields from the early planting of all hybrids were low in 1997 because of dry July weather. Late-July rainfall greatly improved yields from the later planting date in 1997, sometimes more than 100%, but was too late to improve yields of the early planting. Except for the first planting date in 1997, higher populations generally improved yields.

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. Corn traditionally is thought to lack sufficient tolerance to heat and drought for dryland production in southwest Kansas. However, research at Garden City indicates that dryland corn may be feasible, if attention is given to hybrid, planting date, and plant population. No-till has proven to be essential for adequate yields in dry years and has increased yields substantially in wet years. This no-till dryland corn study compares hybrids of five different maturities planted on two dates at three populations. The objectives of this study are to determine the corn maturity class, planting date, and plant population, or, more likely, a combination of these factors, that will allow successful dryland corn production in southwest Kansas.

PROCEDURES

Dryland corn was grown at Garden City, KS in a wheat-corn-fallow rotation in 1996 through 1999 to compare different maturing hybrids at different planting dates and plant populations. Five Pioneer hybrids having days to maturity of 75, 92, 98, 106, and 110 were planted in mid-April and early May each year. The two earliest hybrids were not planted in 1996. Populations were 12,000; 18,000; and 24,000 plants/a. The hybrids were no-till planted into the stubble remaining from the previous wheat crop.

RESULTS AND DISCUSSION

Results are given in Table 1. Yields of hybrids in 1996 increased with plant population. The 110-day hybrid produced the most yield, particularly at the highest population. Yields were improved by later planting, probably because of more favorable weather conditions. Yields were improved drastically by later planting in 1997, sometimes more than 100%. Hybrids planted on the second date were able to take advantage of rainfall that came too late for the earlier planting. The 110-day hybrid again produced the most grain, but yields were reduced at the high population. Results from the first and second planting dates in 1998 were similar to those of 1996, with corn planted on the second date yielding more. Yields from 1999 were lower than those in 1998, because of lower rainfall (although still above average). The 75-day hybrid was the lowest yielding on both dates in all years; this hybrid apparently did not have enough yield potential to utilize the more favorable weather conditions following the later planting date.

Early planting is thought to increase irrigated corn yield and dryland yield, when stress is lacking. Under dryland conditions in western Kansas, however, yield is determined by weather conditions, and rainfall distribution is most important. The best yield will result from the planting date followed by the best rainfall distribution. Stress also can be caused by early planting, because the soil is cold and germination and early growth are slower. In this study, the later of the two dates produced the most yield in all years, but this could change if good rainfall distribution follows the first date, and poor distribution follows the second date. However, the results of this study show no advantage to earlier planting in years of adequate rainfall. Yields also increased with increased maturity and higher plant populations because of above-average rainfall. Higher populations use more soil water, or, at least, water is depleted faster than at a lower population. The results of dryland corn research done so far support a population of 18,000 plants/a, with the qualification that yields may be reduced in dry years compared with those of lower populations. The results of this and other studies also indicate that the yield reduction from a population too high in dry years is less than the yield reduction resulting from a population too low in wet years.

Based on this research, a farmer should plant two or more hybrids in early May at populations not exceeding 18,000 plants/a. However, more than one planting date is recommended to lessen the effects of low rainfall during critical growth stages.

Table 1. Effects of hybrid, planting date, and plant population on yield of dryland corn (wheat-corn-fallow rotation), Garden City, KS, 1996-1999.

		Planting Date														
		1996			1997			1998			1999			1997-1999		
Hybrid	Population	4/16	5/8	Avg Yield	4/17	5/6	Avg Yield	4/15	5/12	Avg Yield	4/21	5/6	Avg Yield	4/18	5/8	Avg Yield
	plants/a	bu/a														
3984 (75)[1]	12,000	—	—	—	37	43	40	34	48	41	35	38	36	35	43	39
	18,000	—	—	—	36	58	47	44	65	54	43	45	44	41	56	48
	24,000	—	—	—	35	64	50	44	75	59	51	51	51	43	63	53
	Avg	—	—	—	36	55		41	63	51	43	44		40	54	
3860 (92)	12,000	—	—	—	51	88	70	85	99	92	63	75	69	66	87	77
	18,000	—	—	—	45	108	77	100	130	115	78	94	86	74	111	93
	24,000	—	—	—	46	99	73	106	137	122	84	101	93	79	112	96
	Avg	—	—	—	47	98		97	122	110	75	90		73	103	
3737 (98)	12,000	78	112	95	42	65	54	100	110	105	77	93	85	73	89	81
	18,000	100	139	120	38	87	63	123	135	129	85	101	93	82	108	95
	24,000	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)	12,000	99	84	92	69	92	81	106	118	112	83	98	91	86	103	95
	18,000	106	133	120	39	84	62	125	137	131	93	108	101	86	110	98
	24,000	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	

continued

Table 1. Effects of hybrid, planting date, and plant population on yield of dryland corn (wheat-corn-fallow rotation), Garden City, KS, 1996-1999, continued.

		Planting date														
		1996			1997			1998			1999			1997-1999		
Hybrid	Population	4/16	5/8	Avg Yield	4/17	5/6	Avg Yield	4/15	5/12	Avg Yield	4/21	5/6	Avg Yield	4/18	5/8	Avg Yield
	plants/a	bu/a														
3394 (110)	12,000	102	117	110	64	106	85	122	133	127	93	103	98	93	114	103
	18,000	126	161	144	40	130	85	140	160	150	110	115	113	97	135	116
	24,000	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	
Hybrid avg	12,000	93	104		53	79		89	102		70	81		71	87	
	18,000	111	144		40	93		107	125		82	93		76	104	
	24,000	138	157		41	93		109	132		89	99		80	108	

[1] Numbers in parentheses are days to maturity

	1996	1997	1998	1999
LSD (0.10) Date within hybrid (averaged across populations)	7	19	—	4
Hybrid within date (averaged across populations)	8	17	—	5
Date within population (averaged across hybrids)	9	14	7	—
Population within date (averaged across hybrids)	9	11	4	—
Hybrid within population (averaged across dates)	—	16	—	5
Population within hybrid (averaged across dates)	—	14	—	5
Hybrid averaged across populations and dates	—	—	5	—

WINTER WHEAT YIELDS IN WHEAT-SUMMER CROP-FALLOW ROTATIONS

by
Alan Schlegel and Curtis Thompson

SUMMARY

The previous crop often affects wheat yields in a wheat-summer crop-fallow rotation. In 3 out of 5 years, wheat yields were less following sunflower than following corn or grain sorghum. In the other 2 years, no differences occurred in wheat yields in any of the 3-yr rotations. Averaged across the 5-yr period, wheat yields were 33 bu/a following sunflower compared to 39 bu/a following corn and 42 bu/acre following grain sorghum. Wheat yields in a wheat-fallow rotation were similar to those in wheat-sorghum-fallow in 4 of the 5 years; however, the 5-yr average yield in wheat-fallow was 4 bu/a greater than that in any of the 3-yr rotations.

INTRODUCTION

In the past few years, acreage of dryland summer crops has increased in western Kansas. In areas that received timely summer rains, crop yields have been very good. In many cases, winter wheat is grown following a summer crop after a fallow period. The purpose of this study was to determine the effect of summer crops on wheat yields in a wheat-summer crop-fallow rotation.

PROCEDURES

Winter wheat was grown in wheat-summer crop-fallow and wheat-fallow rotations from 1995 to 1999 at the Tribune Unit, Southwest Research-Extension Center. They were corn, grain sorghum, and sunflower. They were no-till planted into standing wheat stubble, whereas a sweep plow was used for weed control during the fallow period prior to wheat planting in all rotations.

RESULTS AND DISCUSSION

Wheat yields varied considerably over the 5-yr period (Table 1). They were very low in 1996 (7 to 26 bu/a) because of spring freeze damage, but yields were above 50 bu/a for all rotations in 1998 and 1999. In 2 of the 5 years, yields were similar for wheat following each of the summer crops. However, in the other 3 years, wheat yields were lower following sunflower than following corn or sorghum. Wheat yields following sunflower averaged 33 bu/a compared to 39 bu/a following corn and 42 bu/a following sorghum. Little difference occurred in yield of wheat following corn or sorghum except for 1999, when yields were significantly greater in a wheat-sorghum-fallow rotation than in a wheat-corn-fallow rotation.

Wheat yields in a wheat-fallow rotation were generally no better than those in a wheat-sorghum-fallow rotation, except for 1996. This was the lowest yielding year, and yields in wheat-fallow were significantly greater than those in any of the wheat-summer crop-fallow rotations. Averaged across the 5 years, wheat yields in a wheat-fallow rotation were 4 bu/a greater than those following sorghum, 7 bu/a greater than those following corn, and 13 bu/a greater than those following sunflower.

Table 1. Effect of crop rotation on wheat yields, Tribune, KS, 1995-1999.

Rotation	1995	1996	1997	1998	1999	Average
			bu/a			
Wheat-Fallow	34	26	47	55	69	46
Wheat-Sorghum-Fallow	31	15	42	53	68	42
Wheat-Corn-Fallow	30	18	38	51	58	39
Wheat-Sunflower-Fallow	27	7	28	51	52	33
$LSD_{0.05}$	4	7	9	5	5	4

SPARTAN FOR WEED CONTROL IN NO-TILL SUNFLOWER ON HIGH PH SOILS

by
Curtis Thompson and Alan Schlegel

SUMMARY

The full registration of Spartan could greatly enhance broadleaf weed control in sunflower and is anticipated for 2001. Spartan gives excellent control of kochia, Russian thistle, and pigweed species. Control of puncturevine and crabgrass will not be adequate if infestations are heavy. Producers need to be aware that the some crop injury can be expected especially on high pH and calcareous soils. Special precautions need be taken on light-textured soils, especially if soil organic matter is low. Spartan should be evaluated further on sunflowers planted in a sandy or sandy loam soil type. A section 18 label was attained for sunflower in several states during1999 and 2000.

INTRODUCTION

Herbicides registered for weed control in reduced- or no-till sunflower are very limited. With the current herbicides registered, incorporation into the soil is required and not all broadleaf weeds are controlled. In drier areas of the country, like western Kansas, several research experiments have shown that planting a summer crop, like sunflower, no-till into crop stubble is more productive, more profitable, and less risky than planting into conventionally tilled crop stubble. No-till enhances efficiency of moisture storage by increasing snow capture and reducing run-off and evaporation from the soil. Moisture is the key to production; thus, good weed control is essential to optimize production and profits. No-till sunflower provides additional challenges, because herbicides can not be incorporated into the soil. This eliminates several of the herbicides that are currently registered for weed control in sunflower.

This experiment evaluated preemergence surface applied Spartan and Prowl for weed control in no-till conditions and sunflower tolerance to these herbicides. This study further evaluated the effects of rate and timing of Spartan application on weed control and sunflower tolerance.

PROCEDURES

An experiment was established in west central Kansas near Tribune in no-till soybean and pea stubble to evaluate weed control with Spartan and Prowl applied early preplant (EPP) and postplant preemergence (PRE). The Richfield silt loam soil had a pH of 7.9 and organic matter content of 1.4%. Roundup Ultra at 16 fl oz/a was broadcast applied after planting as a substitute for tillage. Sunflower Pioneer 64M01 was planted at 20,000 seeds/a in 30-in. rows with a four-row Model 7300 John Deere planter on May 20, 1999.

All treatments were applied with a back-pack sprayer delivering 20 gpa at 30 psi. The EPP treatments were applied on May 7, and the PRE treatments were applied to the soil surface without incorporation on May 20.

Weed control and crop injury from both treatments were evaluated visually on June 15 and August 11. Plants in the two center rows of four-row plots were harvested for yield on September 23. Treatments were arranged as a factorial in a randomized complete block design with four replicates.

RESULTS AND DISCUSSION

All Spartan treatments injured sunflower (Table 1). Sunflowers were injured more with PRE treatments than EPP treatments; however, the increase in injury did not reduce yield. Sunflower yields ranged from 682 to 1592 lb/a in this experiment. They were reduced by Spartan at 0.25 lb ai/a or 0.2 lb/a tank mixed with Prowl at 1.0 lb ai/a. Injury and yield reductions by Spartan were greater during 1999 than previously observed (data not shown). The high pH (8.0 or more) and high Ca concentration (>5000 ppm) of the soil may have increased the risk of Spartan injury to sunflower, and, in some instances, this injury may be unacceptable.

Sunflower stand was not reduced by any herbicide treatment (Table 2). Spartan alone at 0.188 lb/a or more and all Spartan rates tank mixed with Prowl tended to reduce sunflower test weight compared to the untreated sunflowers. Seed moisture was not affected by any of the herbicide treatments.

Spartan at all rates applied alone or tank mixed with Prowl controlled kochia, Russian thistle, and pigweed species, tumble and redroot pigweed, 95% or more (Tables 3 and 4). Spartan had good activity on puncturevine; however, control was more variable than for other broadleaf weeds evaluated. Prowl applied alone generally gave inadequate control of broadleaf weeds regardless of rate or application timing.

A low infestation of large crabgrass was controlled with Spartan or Prowl at all rates and combinations (Table 5).

Table 1. Effects of Spartan and Prowl on sunflower yield and injury, Tribune, KS, 1999.

Treatment	Rate	Yield at 10% H_2O EPP[1]	PRE[1]	Mean	Injury 6-15-99 EPP[1]	PRE[1]	Mean	Injury 8-11-99 EPP	PRE[1]	Mean
	lb ai/a		lb/a				%			
Untreated		1391	1592	1491						
Spartan	0.125	1247	1405	1326	23	23	23	13	1	7
Spartan	0.15	1100	1054	1078	14	28	21	6	5	5
Spartan	0.188	1115	1030	1072	33	43	38	13	13	13
Spartan	0.2	1050	1106	1078	35	40	38	9	12	10
Spartan	0.25	940	682	811	49	57	53	21	36	28
Spartan + Prowl	0.125+1.0	1124	826	975	30	24	27	4	12	8
Spartan + Prowl	0.15+1.0	1165	1058	1112	33	52	42	14	14	14
Spartan + Prowl	0.188+1.0	843	1025	934	33	44	38	10	22	16
Spartan + Prowl	0.2+1.0	749	855	802	40	54	47	8	25	17
Prowl	1.0	1041	1196	1118	0	6	3	0	1	1
Prowl	1.5	1182	1576	1379	1	0	0	1	0	0
Mean		1079	1117		26	34		9	13	
LSD (0.05)	Timing		NS			7			NS	
	Herbicide		436			16			13	
	Timing x Herbicide		NS			NS			NS	

[1] application timing EPP = early preplant PRE = postplant preemergence

Table 2. Effects of Spartan and Prowl on sunflower test weight, seed moisture, and stand, Tribune, KS, 1999.

Treatment	Rate	Test Weight EPP[1]	Test Weight PRE[1]	Test Weight Mean	Seed Moisture EPP[1]	Seed Moisture PRE[1]	Seed Moisture Mean	Stand EPP[1]	Stand PRE[1]	Stand Mean
	— lb ai/a —	—— lb/bu ——			—— % ——			— 1000 plants/a —		
Untreated		26.1	26.4	26.2	6.2	8.5	7.4	18.6	17.8	18.2
Spartan	0.125	25.8	25.4	25.6	7.9	5.7	6.8	12.9	18.0	15.4
Spartan	0.15	25.0	25.5	25.2	6.5	7.2	6.8	19.0	15.7	17.4
Spartan	0.188	23.3	24.2	23.8	9.0	7.6	8.3	17.6	15.9	16.7
Spartan	0.2	23.3	24.2	23.7	7.1	8.6	7.9	16.2	16.3	16.3
Spartan	0.25	24.2	24.8	24.5	8.8	7.7	8.2	16.1	14.8	15.4
Spartan + Prowl	0.125+1.0	24.3	23.5	23.9	7.2	5.2	6.2	17.4	17.4	17.4
Spartan + Prowl	0.15+1.0	25.7	24.2	24.9	6.5	9.0	7.7	18.5	15.9	17.1
Spartan + Prowl	0.188+1.0	24.3	24.5	24.4	8.1	6.6	7.4	16.4	15.8	16.1
Spartan + Prowl	0.2+1.0	24.9	23.3	24.1	7.4	8.5	8.0	17.2	16.1	16.6
Prowl	1.0	25.9	26.7	26.3	6.7	7.4	7.1	17.5	17.8	17.7
Prowl	1.5	25.7	25.6	25.7	5.6	7.1	6.3	15.8	19.0	17.4
	Mean	24.9	24.8		7.3	7.4		16.9	16.7	
LSD (0.05)	Timing		NS			NS			NS	
	Herbicide		1.5			NS			NS	
	Timing x Herbicide		NS			NS			NS	

[1] application timing EPP = early preplant PRE = postplant preemergence

Table 3. Control of kochia and Russian thistle in no-till sunflower, Tribune, KS, 1999.

Treatment	Rate	Kochia 6-15-99 EPP[1]	Kochia 6-15-99 PRE[1]	Kochia 6-15-99 Mean	Kochia 8-11-99 EPP[1]	Kochia 8-11-99 PR[1]	Kochia 8-11-99 Mean	Russian Thistle 6-15-99 EPP[1]	Russian Thistle 6-15-99 PRE[1]	Russian Thistle 6-15-99 Mean	Russian Thistle 8-11-99 EPP[1]	Russian Thistle 8-11-99 PRE[1]	Russian Thistle 8-11-99 Mean
	lb ai /a	—— % ——											
Spartan	0.125	100	100	100	98	98	98	100	100	100	100	100	100
Spartan	0.15	100	100	100	99	98	98	100	100	100	100	100	100
Spartan	0.188	100	98	99	95	100	98	100	97	99	95	99	97
Spartan	0.2	100	100	100	99	100	99	100	99	100	100	100	100
Spartan	0.25	98	97	97	100	100	100	96	94	95	99	98	99
Spartan+Prowl	0.125+1.0	100	100	100	98	100	99	100	100	100	100	100	100
Spartan+Prowl	0.15+1.0	96	97	97	100	100	100	93	95	94	98	99	98
Spartan+Prowl	0.188+1.0	100	100	100	99	99	99	100	100	100	100	100	100
Spartan+Prowl	0.2+1.0	96	100	98	100	100	100	92	100	96	97	100	99
Prowl	1.0	56	65	61	50	85	67	39	52	45	30	58	44
Prowl	1.5	61	70	66	57	89	73	42	52	48	28	61	44
	Mean	92	93		90	97		87	90		86	92	
LSD (0.05)	Timing		NS			NS			NS			NS	
	Herbicide		10			14			16			9	
	Timing x Herbicide		NS			NS			NS			NS	

[1] application timing EPP = early preplant PRE = postplant preemergence

Table 4. Control of pigweeds and puncturevine in no-till sunflower, Tribune, KS, 1999.

		Pigweed Control[3]						Puncturevine Control					
		6-15-99			8-11-99			6-15-99			8-11-99		
Treatment[1]	Rate	EPP[1]	PRE[1]	Mean	EPP[1]	PRE[1]	Mean	EPP[1]	PRE[1]	Mean	EPP[1]	PRE[1]	Mean
	lb ai/a	%											
Spartan	0.125	100	100	100	99	100	99	95	93	94	80	97	89
Spartan	0.15	100	100	100	100	99	99	89	88	88	82	69	76
Spartan	0.188	100	100	100	100	100	100	100	90	95	90	84	87
Spartan	0.2	100	100	100	100	100	100	98	97	97	88	84	86
Spartan	0.25	97	98	97	100	100	100	100	100	100	94	94	94
Spartan+Prowl	0.125+1.0	100	100	100	100	100	100	100	75	87	92	62	77
Spartan+Prowl	0.15+1.0	98	97	97	100	100	100	96	100	98	93	100	97
Spartan+Prowl	0.188+1.0	99	100	100	100	100	100	99	98	98	100	91	90
Spartan+Prowl	0.2+1.0	98	99	98	100	100	100	90	100	96	96	100	98
Prowl	1.0	71	81	76	74	85	79	13	46	29	44	46	45
Prowl	1.5	77	92	85	84	93	88	62	84	73	73	73	73
	Mean	95	97		96	98		85	88		85	81	
LSD (0.05)	Timing		NS			NS			NS			NS	
	Herbicide		8			7			15			19	
	Timing x Herbicide		NS			NS			NS			NS	

[1] application timing EPP = early preplant PRE = postplant preemergence
[2] Redroot pigweed and tumble pigweed

Table 5. Control of large crabgrass in no-till sunflower, Tribune, KS, 1999.

		Large Crabgrass Control					
		6-15-99			8-11-99		
Treatment[1]	Rate	EPP[1]	PRE[1]	Mean	EPP[1]	PRE[1]	Mean
	lb ai/a	%					
Spartan	0.125	100	99	100	92	97	95
Spartan	0.15	100	100	100	97	82	90
Spartan	0.188	100	100	100	94	100	97
Spartan	0.2	100	100	100	98	100	99
Spartan	0.25	98	99	98	96	100	98
Spartan + Prowl	0.125+1.0	100	100	100	100	100	100
Spartan + Prowl	0.15+1.0	98	98	98	100	100	100
Spartan + Prowl	0.188+1.0	100	100	100	100	100	100
Spartan + Prowl	0.2+1.0	99	99	99	100	100	100
Prowl	1.0	77	93	85	95	100	97
Prowl	1.5	92	96	94	100	99	99
	Mean	97	99		98	98	
LSD (0.05)	Timing		NS			NS	
	Herbicide		7			NS	
	Timing x Herbicide			NS			NS

[1] application timing EPP = early preplant PRE = postplant preemergence

WEED CONTROL IN NO-TILL SUNFLOWER ON SILT LOAM AND SANDY SOILS

by
Curtis Thompson, Alan Schlegel, and Gary Gold[1]

SUMMARY

Spartan is a very effective herbicide for weed control in sunflower. However, significant injury can occur on certain soil types with pH near 8.0 or more. This experiment showed that low rates of Spartan alone or tank mixed with Prowl can be very effective on a sandy soil with minimal crop injury. Early preplant (EPP) applications will be safer than preemergence applications. The organic matter of the sandy soil was 1.6%; however, more sunflower injury would be expected at lower concentrations of organic matter. Magnum Dual II (not registered) shows good promise as a tank mix partner with Spartan on silt loam soil. In these experiments, Valor was not as effective as Spartan for weed control in sunflower and reduced sunflower stand with the EPP applications. A continued investigation of new herbicides is needed for weed control in sunflower. Consult the herbicide label for proper utilization, because some of these herbicides are not registered in sunflower. A section 18 label for Spartan was attained for no-till sunflower in several states during 1999 and 2000. Full registration is planned for 2001.

INTRODUCTION

A limited number of herbicides is registered for weed control in reduced- or no-till sunflower. In western Kansas, reduced tillage helps to conserve moisture, which enhances summer crop yields and protects soil from wind erosion. With the current herbicides registered, incorporation into the soil is required and not all broadleaf weeds are controlled. Further evaluation of new herbicides for weed control in sunflower is critical.

These experiments evaluated preemergence and postemergence applied herbicides for broadleaf and grass weed control in no-till sunflowers and evaluated sunflower tolerance to these herbicides. One of the experiments further evaluated Spartan and other herbicides on an irrigated sandy soil.

PROCEDURES

An experiment was established in west central Kansas near Tribune in no-till soybean and pea stubble to evaluate weed control with soil-active herbicides applied early preplant (EPP) or preemergence after planting (PRE) and postemergence (POST) grass herbicides. The Richfield silt loam had a pH of 7.9 and organic matter of 1.4%. Roundup Ultra at 16 fl oz/a was broadcast applied after planting as a substitute for tillage. Sunflower Pioneer 64M01 was planted at 20,000 seeds/a in 30-inch rows with a four-row Model 7300 John Deere planter on May 20, 1999.

All soil-applied treatments were applied with a back-pack sprayer delivering 20 gpa at 30 psi. The EPP and PRE treatments were applied to the soil surface without incorporation on May 7 and May 20, respectively. The POST treatments were applied to 4- to 5-leaf sunflower and 0.5- to 1-in large crabgrass on June 18.

Weed control and crop injury from EPP and PRE treatments were evaluated visually on June 15 and August 11. Plants in the two center rows of four-row plots were harvested for yield on September 23, 1999. Treatments were arranged as a factorial in a randomized complete block design with four replicates.

A second experiment was established in Stevens County, KS on an irrigated sandy soil with 1.6% organic matter, 7.7 pH, 90% sand, 6% silt, and 4% clay. All treatments were applied EPP with a backpack sprayer delivering 20 gpa at 30 psi to the soil surface on July 1, 1999. Sunflower were planted into oat

[1]Stevens County Extension Agricultural Agent, Kansas State University, Hugoton.

stubble in 30-inch rows on July 16. Herbicides were incorporated with two passes of sprinkler irrigation delivering 0.5 in water per pass. Roundup at 20 fl oz/a was applied on July 1, 1999. Visual evaluations of weed control and sunflower injury were made on July 29 and September 2. Two rows 17.5 feet long were hand harvested for seed yield on October 20.

RESULTS AND DISCUSSION

Magnum Dual II tank mixed with Spartan or Spartan alone applied PRE caused significant sunflower injury in the experiment near Tribune (Table 1). In addition, Valor applied EPP caused severe sunflower stand reductions, which are reflected in the injury ratings. Despite the crop injury from certain treatments, no significant yield reductions occurred when compared to the untreated sunflower. The untreated sunflowers yielded 912 to 1208 lb/a. The highest sunflower yield was 2068 lb/a from the PRE Valor treatment followed by Select applied postemergence.

All treatments except Prowl gave excellent control of redroot and tumble pigweeds and a low infestation of kochia (Table 2). Puncturevine was the most difficult broadleaf weed to control; however, 85% control or more was obtained with Magnum Dual II tank mixed with Spartan, Spartan applied alone PRE, or Valor applied PRE. A low infestation of large crabgrass was controlled with all treatments except Prowl. It may not have had sufficient moisture for proper activation; thus, weed control rating were lower.

Sunflower injury from Spartan on a sandy soil ranged from 6 to 25% at the July evaluation and 0 to 16% at the September evaluation (Table 3). This was lower than had been expected based on sunflower response to Spartan in previous work. Valor also injured sunflower with a rate response similar to Spartan's. Prowl alone did not injure sunflower. Despite the sunflower injury that was observed, sunflower yields were not reduced.

Herbicide treatments, with the exception of Prowl, increased yield compared to the untreated sunflower (Table 3). This was due to the heavy Palmer amaranth infestations, 20 to 30/sq ft. Sunflowers treated with Spartan at 0.125 lb ai/a tank mixed with Prowl at 1.0 lb ai/a had the highest yield. Spartan tended to give better Palmer amaranth control than did Valor. Spartan at 0.125 lb/a applied alone was not adequate for the heavy Palmar amaranth infestation. All treatments containing Prowl provided adequate large crabgrass control; however, Palmer amaranth control was poor. Spartan or Valor did not give adequate control of large crabgrass.

Table 1. Sunflower response to soil-applied and postemergence herbicides, Tribune, KS, 1999.

Treatment[1]	Rate	Timing[2]	Yield @ 10% H_2O	Moisture	Test Weight	Plant Stand	Injury 6-15	Injury 8-11
	lb/a		lb/a	%	lb/bu	/1000	%	%
Untreated	0	—	1208	6.3	26.2	14.8	—	—
Dual II Magnum	1.27	EPP	1727	6.9	25.5	12.6	5	4
Dual II Magnum	1.59	EPP	1310	6.8	26.0	11.3	1	0
DIIM + Spartan	1.27+0.125	EPP	1610	5.7	26.0	12.4	19	3
Spartan	0.125	EPP	1311	5.4	25.4	14.0	3	0
Valor	0.078	EPP	1334	8.5	24.9	5.2	59	54
Valor + Select + COC + AMS	0.078 + 0.109 + 2 pt + 2.5 lb	EPP + POST	1117	8.9	23.8	3.9	69	72
Prowl	1.5	EPP	1448	7.4	26.2	12.8	0	0
Dual II Magnum	1.27	PRE	1862	6.3	26.6	14.6	3	0
Dual II Magnum	1.59	PRE	1820	7.8	26.3	12.4	8	0
DIIM + Spartan	1.27 + 0.125	PRE	1579	7.8	24.4	13.3	26	1
Spartan	0.125	PRE	1832	6.6	25.6	12.9	24	0
Valor	0.078	PRE	1225	9.4	26.0	12.0	7	0
Valor + Select + COC + AMS	0.078 + 0.109 + 2 pt + 2.5 lb	PRE + POST	2068	6.9	26.4	12.1	10	0
Prowl	1.5	PRE	1419	8.1	25.3	11.5	7	0
Select + COC + AMS	0.109 +2 pt + 2.5 lb	POST	1514	6.5	25.2	12.7	—	0
Poast + COC + AMS	0.188 + 2 pt + 2.5 lb	POST	1476	9.3	26.2	12.1	—	0
Untreated			912	5.0	24.7	11.6	—	—
LSD (0.05)			NS	4.2	NS	3.5	17	8

[1] DIIM = Dual II Magnum COC = crop oil concentrate AMS = ammonium sulfate
[2] EPP = early preplant PRE = postplant preemergence POST = postemergence

Table 2. Weed control in no-till sunflower, Tribune, KS, 1999.

Treatment[1]	Rate	Timing[2]	Pigweed Species[3] 6-15	Pigweed Species[3] 8-11	Kochia 8-11	Puncture Vine 8-11	Large Crabgrass 6-15	Large Crabgrass 8-11
	lb/a		% control					
Dual II Magnum	1.27	EPP	100	97	98	53	100	100
Dual II Magnum	1.59	EPP	100	96	95	60	99	98
DIIM + Spartan	1.27+0.125	EPP	100	100	100	91	100	100
Spartan	0.125	EPP	99	100	100	79	89	89
Valor	0.078	EPP	93	79	97	56	95	63
Valor + Select + COC + AMS	0.078 + 0.109 + 2 pt + 2.5 lb	EPP + POST	100	79	96	42	96	96
Prowl	1.5	EPP	9	8	10	0	31	20
Dual II Magnum	1.27	PRE	76	99	93	50	76	99
Dual II Magnum	1.59	PRE	100	100	95	45	100	98
DIIM + Spartan	1.27 + 0.125	PRE	100	100	100	85	99	97
Spartan	0.125	PRE	99	100	100	92	98	77
Valor	0.078	PRE	94	98	99	93	88	90
Valor + Select + COC + AMS	0.078 + 0.109 + 2 pt + 2.5 lb	PRE + POST	94	97	99	86	95	96
Prowl	1.5	PRE	95	88	96	69	97	98
Select + COC + AMS	0.109 +2 pt + 2.5 lb	POST	—	0	0	0	—	99
Poast + COC + AMS	0.188 + 2 pt + 2.5 lb	POST	—	0	0	0	—	98
LSD (0.05)			19	12	6	36	21	17

[1] DIIM = Dual II Magnum   COC = crop oil concentrate   AMS = ammonium sulfate
[2] EPP = early preplant   PRE = postplant preemergence   POST = postemergence
[3] Redroot pigweed and tumble pigweed

Table 3. Weed control in no-till sunflowers on a sandy irrigated soil, Stevens County, KS, 1999.

Treatment	Rate	Yield @ 10% H_2O	Plant[1] Stand	Sunflower Injury 7-29	Sunflower Injury 9-2	Palmer Amaranth 7-29	Palmer Amaranth 9-2	Large Crabgrass 7-29	Large Crabgrass 9-2
	lb ai/a	lb/a	/1000	%		% control			
Spartan	0.125	1163	18.5	9	0	91	44	43	10
Spartan	0.187	1053	16.1	10	9	96	85	61	38
Spartan	0.25	1150	23.5	25	16	99	91	78	35
Valor	0.047	1143	17.4	1	4	84	56	39	35
Valor	0.078	1077	15.8	10	10	90	73	46	33
Valor	0.109	1120	15.8	24	18	92	74	65	44
Prowl	1.5	602	14.0	0	2	40	19	93	89
Spartan + Prowl	0.125 + 1.0	1416	19.2	6	0	95	83	93	84
Valor + Prowl	0.047 + 1.0	840	14.3	9	16	85	68	89	86
Untreated		401	9.0	—	—	—	—	—	—
LSD (0.05)		393	4.4	10	15	6	18	23	24

[1] Counts taken at harvest

TWO YEARS OF SUBSURFACE DRIP IRRIGATION WITH LAGOON WASTEWATER

by

Todd Trooien, Freddie Lamm[1], Loyd Stone[2], Mahbub Alam, Danny Rogers[3], Gary Clark[3], and Alan Schlegel

SUMMARY

Subsurface drip irrigation (SDI) laterals have been tested with animal wastewater for 2 years. The challenge of using wastewater with SDI is to design and manage the system to avoid emitter clogging. The second year of research (1999) provided results very similar to the first year (1998), with one surprising exception. The flow rates for the two smallest emitter sizes (0.15 and 0.24 gal/hr/emitter) declined during the growing season. By the end of the 1999 growing season, the flow rate for the 0.15 gal/hr/emitters had decreased by 22% of the design flow rate. This indicates that the emitters had become partially clogged. The decrease was 15% for the 0.24 gal/hr/emitter driplines. Flow rates for the three largest emitters sizes (0.40, 0.60, and 0.92 gal/hr/emitter) decreased by less than 4% during the growing seasons. During the winter when the system was idle, the flow rates for the two smallest emitters sizes increased back to the levels at which they began the 1998 growing season.

INTRODUCTION

Using SDI with lagoon wastewater has many potential advantages. But the small emitters used in SDI systems are prone to clogging when used with water sources such as lagoon wastewater that are high in solids and salts. Worldwide, the leading cause of microirrigation failures is clogging. To make an SDI system economically feasible, it must be operated for many years. The challenge of using wastewater with SDI, then, is to design and manage the SDI system to avoid emitter clogging.

The objective of this study was to test the performance of five different types of driplines when used with lagoon wastewater. This paper presents a summary of 2 years of research. The first year of research was presented in more detail in the 1999 SWREC Field Day Report.

PROCEDURES

This project was conducted at Midwest Feeders, Ingalls, KS.

Driplines were installed 17 inches deep on a lateral spacing of 60 inches in April 1998. Each plot was 20 ft wide by 450 long. The first irrigation with wastewater was on June 17, 1998. In the 2 years of operation, no clean water has been used for irrigation, flushing, or dripline chemical treatment.

Five different dripline types, each with a different emitter flow rate, were tested. Emitter flow rates were 0.15, 0.24, 0.40, 0.60, and 0.92 gal/hr/emitter. The cross-sectional flow areas of the emitters ranged from 0.000663 sq inch for the 0.24 gal/hr emitters to 0.002704 sq inch for the 0.92 gal/hr emitters. The cross-sectional flow area for the 0.15 gal/hr emitter was not provided by the manufacturer.

Wastewater was filtered with a plastic grooved-disk filter. The filters were rated as 200 mesh even though manufacturers' recommendations for all driplines used in this study were 140 mesh or finer. A controller was used to backflush every hour or when the differential pressure across the filter reached 7 psi. Acid and chlorine were injected into the system seven times in 1998 and five times in 1999 to help keep algae and bacteria from growing and accumulating.

Irrigations of 0.20 to 0.40 inches were applied daily from June to early September. Each plot received the same application amount for a given day. A total of 21 inches of wastewater was applied in 1998, and

[1]Northwest Research-Extension Center, Colby.
[2]Department of Agronomy, Kansas State University, Manhattan.
[3]Department of Biological and Agricultural Engineering, Kansas State University, Manhattan.

15 inches were applied in 1999. These amounts, especially the 21 inches in 1998, are in excess of the crop water requirement but provided good tests of the driplines.

Flow rates of entire plots were measured weekly. Pressure gauges were used to indicate the inlet pressure to each plot. Flow meters were used to record the flow amounts and rates to each plot.

RESULTS AND DISCUSSION

The flow rates of plots with the two smallest emitter sizes decreased during both growing seasons (Fig. 1). Those in the plots with 0.15 gal/hr emitters decreased by 15% of the initial flow rate in 1998 and 22% in 1999. Those in the plots with 0.24 gal/hr emitters decreased by 11% of the initial flow rate in 1998 and 14% in 1999. These decreased flow rates indicate that some emitter clogging had occurred.

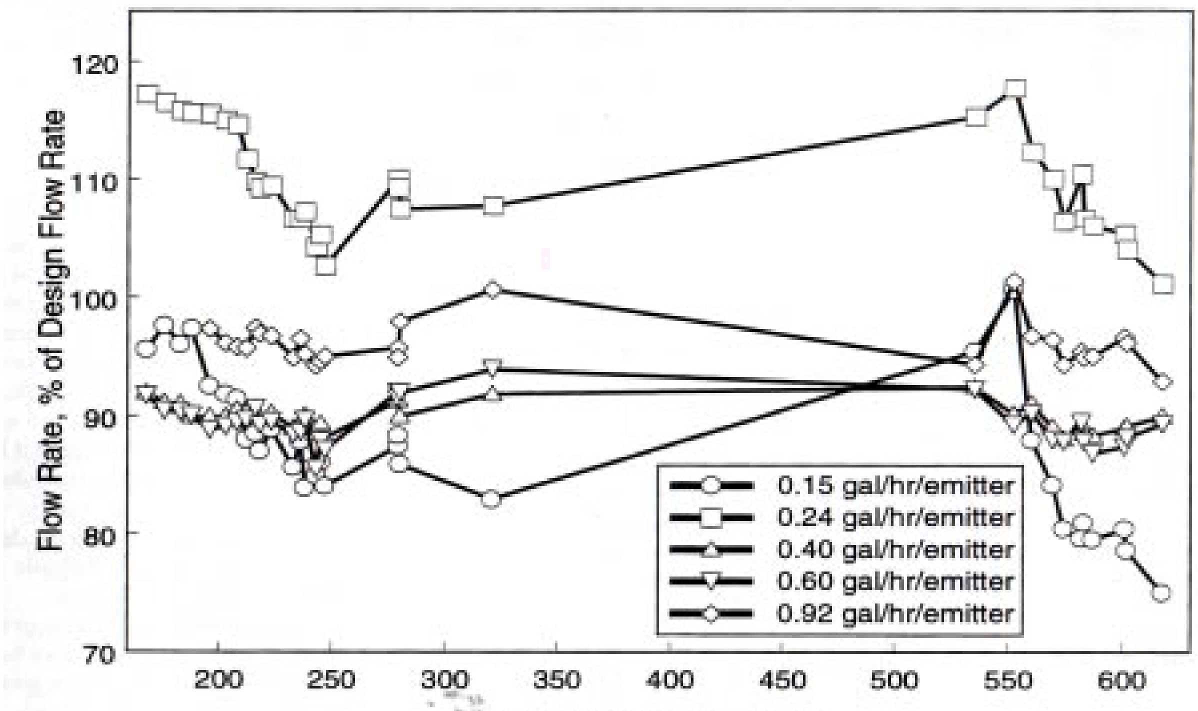
Other management procedures might be employed to prevent performance degradation in the lower flow-rate emitters or remediate it after it occurs. Such procedures might include more frequent flushing, flushing with fresh water, and more frequent and concentrated chemical-injection treatments. Further studies are warranted to determine if the lower flow-rate driplines can be maintained at a higher performance level with more aggressive management.

The three higher-flow emitter sizes (0.40, 0.60, and 0.92 gal/hr/emitter) showed little sign of clogging (Fig. 1). Flow rates at the end of the test for those emitters were within 4% of the initial flow rates, indicating that very little clogging and resultant decrease of flow rate had occurred. The absence of clogging indicates that emitters of these sizes may be adequate for use with lagoon wastewater.

Following the winter idle period, all flow rates had recovered to the initial levels (Fig. 1). Possible explanations for this include (a) the longer time that the acid and chlorine remained in the driplines allowed better control of biological clogging agents, (b) the cooler temperatures during the winter resulted in partial control of the biological clogging agents and the acid and chlorine were then more effective at cleaning up the remaining agents, or (c) the biological clogging agents dessicated and reduced in size.

These results show that the SDI laterals have potential for use with lagoon wastewater. However, the smaller emitter sizes normally used with groundwater sources in western Kansas may be risky for use with lagoon wastewater. Even though the flow rates returned to the initial levels after the winter off-season, the clogging noted in this study may continue and render the SDI system inoperable.

Figure 1. Measured flow rates for five dripline types in a subsurface drip-irrigation system using livestock wastewater, Midwest Feeders, Ingalls, KS, 1998-1999.



Days after January 1, 1998

Acknowledgements

We thank Midwest Feeders for providing the site, wastewater, and assistance with the project. We also thank the numerous companies that donated irrigation products and services in support of the project. Funding for the establishment of this project was recommended by the Governor's office, approved by the Kansas legislature in 1998, and administered through KCARE at Kansas State University. This material is based on work supported in part by the USDA Cooperative Research, Education, and Extension Service under Agreement No. 98-34296-6342.

EVALUATION OF CORN BORER RESISTANCE AND GRAIN YIELD FOR BT AND NON-BT CORN HYBRIDS[1]

by

Larry Buschman, Phil Sloderbeck, Randy Higgins,[2] and Merle Witt

SUMMARY

Fourteen corn hybrids (eight Bt and six non-Bt) were evaluated for corn borer resistance and grain yield performance. Second generation European and southwestern corn borer pressure averaged 0.29 and 0.45 larvae per plant, respectively, in the non-Bt plots. Corn borer tunneling averaged 12.8 cm per plant in the non-Bt corn hybrids. Tunneling was reduced to trace levels in hybrids containing Bt events Bt11, MON810, and CBH351; however, both hybrids with event 176 suffered noticeable tunneling. The yield loss from lodging due to corn borers averaged 13.3 bu/a for the non-Bt hybrids. Hybrids with events MON810, Bt11, and CBH351 generally had less than a bushel or two of grain on the ground at harvest time. Standing corn yields averaged 121.8 bu/a for the six non-Bt hybrids, and 108.0, 134.9, 136.7, and 132.6 for the hybrids with events 176, Bt11, MON810, and CBH351, respectively. The best non-Bt hybrid (Pioneer 32J55) had a standing yield of 161.8, and the best Bt hybrid (Pioneer 33A14) had a standing yield of 164.0.

PROCEDURES

Corn plots were machine-planted on 28 April at 34,400 seeds/a at the Southwest Research-Extension Center near Garden City, KS. Spot replanting was done as necessary. The stand was thinned to 100 plants per 60 row-ft. Atrazine (1.5 lb ai/a) was applied preplant on 29 March. At planting, 2.5 qt Topnotch and 0.5 qt of Atrazine were applied. Postemergence herbicide applications were made on 24 May and 7 June using 0.33 and 0.53 oz of Accent/a, respectively, along with 0.2 gal crop oil concentrate. No insecticides were used. The soil was a saline-Richfield silt-loam with a pH of 7.5 to 8.0. The field was furrow irrigated on 12 July, 28 July, and 14 Aug. with 8.5, 6.7, and 6.3 inches of water, respectively. Monthly rainfalls for April through Aug. were 2.2, 3.5, 4.2, 3.5, and 2.6 inches. The plots were four rows wide (10 ft) by 30 ft long. Two rows (5 ft) of Bt corn were planted between the plots as border rows, and 10-ft alleyways at the end of each plot were left bare. The border rows and alleyways were included to reduce larval migration between plots. The experimental design was a randomized block design with four replications. There were 14 hybrids with relative maturity ratings of 110 to 118 days.

Infestations by second generation corn borer were entirely native. Data for second-generation corn borers were taken from 10 plants in the two center rows of each plot (five consecutive plants in each row). The plants were dissected to record corn borers and corn borer tunneling. Kernel damage was recorded as the estimated percentage of kernels damaged per ear (mostly corn earworm damage). Stalk rot was recorded as the number of nodes at the base of the plant showing noticeable stock rot injury. Yield was determined by separately harvesting ears from standing plants and from plants lodged because of corn borer damage. The lodged corn was harvested by hand, and the standing corn was machine harvested. The two middle rows of each plot were harvested in late October. Grain yield was calculated separately for standing and fallen corn and corrected to 15.5% moisture.

The data were analyzed by an analysis of variance, and means were separated using the least significant difference test. To simplify the discussion, results are averaged across non-Bt hybrids and the hybrids with the four Bt events.

[1]This research was supported by Kansas Corn Commission Check-off Funds through the Kansas Department of Agriculture.

[2]Department of Entomology, Kansas State University, Manhattan.

RESULTS AND DISCUSSION

First generation corn borer pressure was light, and no data were collected. Second generation European and southwestern corn borers averaged 0.29 and 0.45 larvae per plant, respectively, in the non-Bt plots (Table 1). Corn borer tunneling averaged 12.8 cm per plant in the non-Bt corn hybrids. Tunneling was reduced to trace levels in hybrids containing Bt events Bt11, MON810, and CBH351; however, both hybrids with event 176 suffered noticeable tunneling (Table 1). In hybrids with events 176, Bt11, MON810, and CBH351 second generation ECB larvae were reduced by 52, 100, 100, and 100%, respectively (Fig. 1); second generation SWCB larvae were reduced by 61, 100, 95, and 100% (Fig. 2); and corn borer tunneling was reduced by 64, 100, 98, and 100% (Fig. 3).

Corn earworm damage to kernels in the ear was relatively light, averaging only 0.7 % in the non-Bt hybrids (Table 2). The hybrid with Bt11 had about a 60 % reduction in kernel damage compared with the non-Bt hybrids. Hybrids with Bt176, MON810, and CBH351 showed little reduction in kernel damage.

Stalk rot averaged less than one node per plant and did not differ significantly among hybrids.

A hailstorm on 1 July, when the plants were at the pretassel stage, caused 50 to 60% defoliation and bruised and broke many stalks. The 110-day hybrids had most of their leaves exposed to the hail, but the 116- to 118-day hybrids were able to extend one or two leaves after the hailstorm. Yields probably were reduced 30 to 40%, and the differences between shorter and longer maturity hybrids were exaggerated (Table 2).

Yields of standing corn averaged 121.8 bu/a for the six non-Bt hybrids and averaged 108.0, 134.9, 136.7, and 132.6 for hybrids with events 176, Bt11, MON810, and CBH351, respectively (Table 2). The best non-Bt hybrid (Pioneer 32J55) had a standing yield of 161.8, whereas the best Bt hybrid (Pioneer 33A14) had a standing yield of 164.0. These were two of the longest maturity hybrids in the trial. The yield losses from lodging caused by corn borers averaged 13.26 bu/a for the non-Bt hybrids and 7.84 bu/a for the two hybrids with event 176. Hybrids with Bt11, MON810, and CBH351 had very little yield loss (2.4 bu/a or less) (Table 2). Yield losses from corn borer lodged plants were reduced by 41, 85, 89, and 95 % for events 176, Bt11, MON810, and CBH351, respectively (Fig. 4). Total grain yields (sum of standing plus fallen) were similar for the non-Bt and the Bt hybrids, except for the two 176 hybrids. However, these two hybrids were fairly short-season and probably were damaged more heavily by the hail (Fig. 5).

Fig. 1. European corn borer larvae in Bt and non-Bt corn.

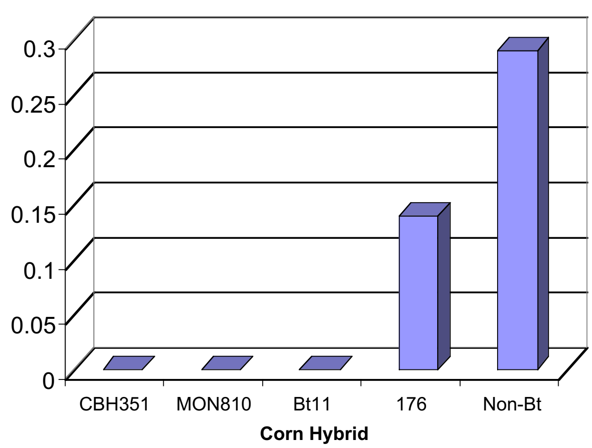


Fig. 2. Southwestern corn borer larvae in Bt and non-Bt corn.

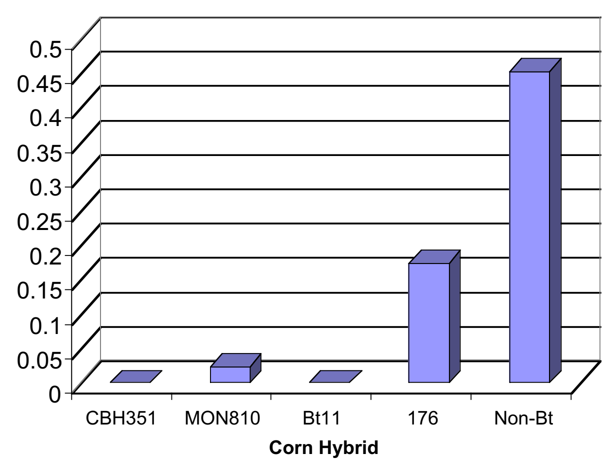


Fig. 3. Corn borer tunneling, in Bt and non-Bt corn.

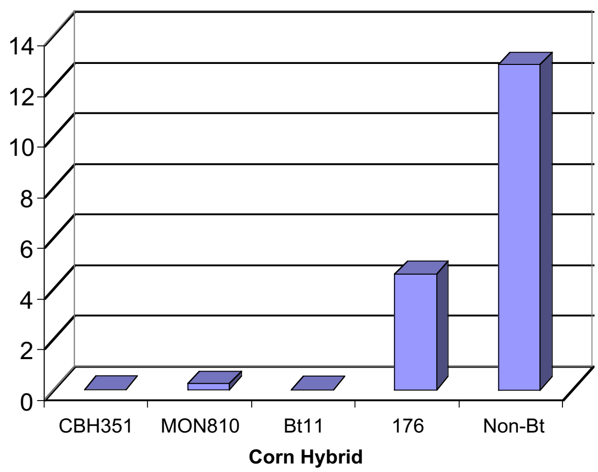


Fig. 5. Grain yields of Bt and non-Bt corn.

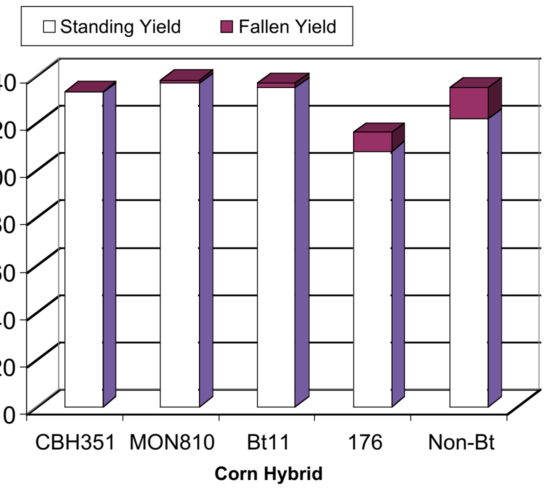


Fig. 4. Fallen grain yields of Bt and non-Bt corn.

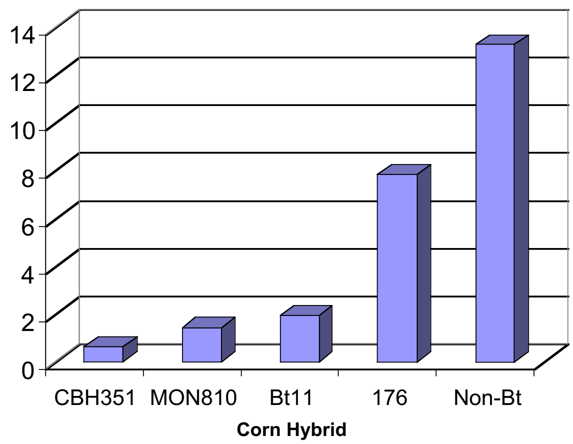


Table 1. Corn borer larvae and tunneling in Bt and non-Bt corn hybrids, Garden City, KS, 1999.

				2nd Generation Corn Borer				
Hybrid	Bt Event	Company	Relative Maturity Rating	ECB Larvae per Plant	SWCB Larvae per Plant	Number of Tunnels per Plant	Cm of Tunneling below Ear	Cm of Tunneling per Plant
4494		Novartis Seeds	110	0.18 bc	0.30 bcd	1.13 cde	7.67 bcd	9.60 bcd
MAX454	176	Novartis Seeds	111	0.23 bc	0.15 cde	0.75 def	3.13 de	4.27 de
2787	176	Mycogen	113	0.05 c	0.20 cde	0.52 efg	3.01 de	4.89 de
7590		Novartis Seeds	114	0.20 bc	0.40 abc	1.30 bcd	9.53 abc	11.28 a-d
7590Bt	Bt11	Novartis Seeds	115	0.00 c	0.00 e	0.00 g	0.00 e	0.00 e
3162IR		Pioneer	118	0.55 a	0.60 a	1.83 ab	10.70 abc	16.13 ab
32J55		Pioneer	116	0.33 ab	0.55 ab	2.13 a	12.99 ab	18.08 a
33A14	MON810	Pioneer	113	0.00 c	0.00 e	0.00 g	0.00 e	0.00 e
7821BT	MON810	Cargill	115	0.00 c	0.07 de	0.15 fg	0.40 e	0.60 e
H-2547		Golden Harvest	112	0.13 bc	0.30 bcd	0.95 cde	6.60 cd	7.47 cde
H-9230Bt	MON810	Golden Harvest	113	0.00 c	0.00 e	0.00 g	0.00 e	0.00 e
8481		Garst	112	0.33 ab	0.57 a	1.45 bc	13.38 a	14.46 abc
8481Bt/LL	CBH351	Garst	112	0.00 c	0.00 e	0.03 g	0.00 e	0.00 e
8366Bt/LL	CBH351	Garst	113	0.00 c	0.00 e	0.03 g	0.00 e	0.01 e
	LSD value p=0.05			0.24	0.27	0.63	5.67	7.87
		F-test Prob.		0.0002	<0.0001	<0.0001	<0.0001	<0.0001

Table 2. Corn borer and earworm damage and yield of Bt and non-Bt corn hybrids, Garden City, KS, 1999.

				2nd Gen. Corn Borer		Earworm	Yield		
Hybrid	Bt Event	Company	Relative Maturity Rating	No. of Plants Infested per 10 Plants	No. of Shanks Tunneled per 10 Plants	Percent of Kernels Damaged	Standing Plts. bu/a	Fallen Plts. bu/a	Total bu/a
4494		Novartis Seeds	110	6.50 ab	0.75 cd	0.95 a	102.5 e	15.20 ab	117.7 d
MAX454	176	Novartis Seeds	111	4.75 bc	1.25 bcd	0.97 a	107.3 de	8.75 a-d	116.0 d
2787	176	Mycogen	113	4.00 c	0.50 d	0.87 ab	108.6 cde	6.93 b-e	115.5 d
7590		Novartis Seeds	114	6.25 ab	2.25 abc	0.50 bcd	120.7 b-e	12.68 ab	133.4 cd
7590Bt	Bt11	Novartis Seeds	115	0.00 d	0.00 d	0.27 d	134.9 b	1.93 cde	136.8 cd
3162IR		Pioneer	118	8.25 a	2.75 ab	0.57 a-d	131.7 bc	16.27 a	147.9 bc
32J55		Pioneer	116	8.25 a	3.00 a	0.80 abc	161.8 a	14.13 ab	175.9 a
33A14	MON810	Pioneer	113	0.00 d	0.00 d	0.60 a-d	164.0 a	1.30 de	165.3 ab
7821BT	MON810	Cargill	115	1.00 d	0.25 d	0.82 abc	122.9 b-e	2.40 cde	125.3 cd
H-2547		Golden Harvest	112	5.75 bc	1.00 cd	0.75 abc	107.8 cde	10.30 abc	118.1 d
H-9230Bt	MON810	Golden Harvest	113	0.00 d	0.00 d	0.77 abc	123.1 b-e	0.57 de	123.7 cd
8481		Garst	112	8.25 a	3.50 a	0.65 a-d	106.1 e	10.95 ab	117.1 d
8481Bt/LL	CBH351	Garst	112	0.25 d	0.25 d	0.62 a-d	135.1 b	1.23 de	136.3 cd
8366Bt/LL	CBH351	Garst	113	0.50 d	0.25 d	0.42 cd	130.1 bcd	0.00 e	130.1 cd
	LSD value p=0.05			2.09	1.59	0.43	23.92	8.54	25.30
	F-test Prob.			<0.0001	0.0001	0.0834	<0.0001	0.0004	0.0001

ECONOMIC COMPARISON OF BT-CORN REFUGE-PLANTING STRATEGIES FOR SOUTH CENTRAL AND SOUTHWESTERN KANSAS

by

Phil Sloderbeck, Larry Buschman, Troy Dumler, and Randy Higgins[1]

SUMMARY

Data from Bt corn trials at Garden City and St. John, KS were analyzed to compare the potential economic returns of various Bt corn refuge-planting strategies. The results of this analysis indicate that the costs of the refuge-planting strategies are relatively small in comparison with the increased returns associated with Bt corn.

INTRODUCTION

The Environmental Protection Agency is now requiring producers who grow Bt-corn to plant a 20% refuge as a resistance management practice. This study was an attempt to determine the economic cost to producers of various refuge strategies. The analysis was based on selected data from Bt-corn efficacy trials conducted in St. John and Garden City, KS during 1997 and 1998 comparing corn hybrids under both insecticide sprayed and unsprayed conditions. Costs associated with the inconvenience of having to plant the refuge are not included.

PROCEDURES

Five pairs of non-Bt and Bt corn hybrids (Table 1) were selected from these trials to obtain representative yield information for four corn growing strategies; unsprayed non-Bt corn, insecticide-sprayed non-Bt corn, unsprayed Bt corn, and insecticide-sprayed Bt corn. The insecticide treatment used in the trials was Capture at 0.08 lb ai/A applied for corn borer control. Capture at this rate also would reduce spider mites and corn rootworm adults if present. These hybrids were used in all four studies. The events MON810 or Bt11 (sold under the Trademark YieldGard) were chosen for this comparison because they provide very good control of southwestern corn borer and are available in corn hybrids that are well-adapted for this area. In these trials, both standing yield and fallen yields were recorded. The corn in these trials was harvested in October, so there was a reasonable chance of lodging from corn borer damage. Standing yield was from plants that did not lodge from corn borer damage and represented the yield that could be expected, if fields were harvested late and lodging was extensive. Total yield was the sum of the standing yield plus the hand-harvested yield from any lodged plants or dropped ears. It represented the overall physiological yield including corn borer losses associated with early harvest.

RESULTS AND DISCUSSION

Yield data for the four corn growing strategies are summarized in Table 2. A significant difference (DMRT at 0.05) occurred between standing yields of

Table 1. Corn hybrids selected from Bt corn trials conducted near St. John and Garden City, KS during 1997 and 1998.

Company	Bt Hybrid — Event	Paired Non-Bt Hybrid
Novartis	7590Bt — Bt11	7590
Novartis	7639Bt — Bt11	4494
Golden Harvest	H-2530Bt – MON810	H-2530
Cargill	8021BT – MON810	7997
Pioneer	31A14 – MON810	3162

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

the unsprayed non-Bt corn and the sprayed non-Bt corn. In addition, both the unsprayed and sprayed Bt corn yielded significantly more than the sprayed non-Bt corn. Similar significant differences also were observed in total yield among the four treatments.

To determine economic returns selected in corn production systems, the effects of seed costs, insecticide plus application costs, and yields were considered. The cost of Bt corn was $1.53/1000 seeds versus $1.21/1000 seeds for non-Bt corn, for a technology fee of $0.32/1000 seeds. On a per acre basis, the cost of Bt-corn was $10.24 higher than that of non-Bt corn. The total cost of applying 0.08 lbs of Capture at $429/gal was $21.20/a, when an application cost of $4.04/a was added. The price of grain was set at $2.40/bu, which was the average harvest price paid in southwest Kansas during 1997-98. The differences in yields and returns for the various corn production strategies are shown in Table 3. Significant differences in yields resulted in higher returns for most corn production strategies. However, the small increase in yield gained from spraying Bt-corn versus not spraying Bt-corn was offset by the cost of spraying. Thus, a small loss in returns occurred where Bt-corn was sprayed with Capture.

These data were employed to estimate potential returns for several recommended non-Bt corn refuge strategies (Table 4). Two conclusions stand out. First, corn growers in southwest and south central Kansas can experience significant losses in returns when nothing is done to control corn borers. Based on standing yields, returns were increased by 15% when timely applications of Capture were made and by from 22 to 27% when various Bt corn strategies were employed. The other interesting observation is that the economic cost of including a 20% or a 40% non-Bt corn refuge-planting was fairly low. The difference in returns for the refuge strategies ranged from only 2 to 4%. Trends were similar when total yields (standing + lodged) were analyzed. Assessing total yields rather than standing yields may be more representative of expected losses, if corn is harvested before any lodging is caused by corn borers. All of the various Bt corn and non-Bt corn refuge combinations exhibited

Table 2. Average corn yields for five Bt corn hybrids and five non-Bt corn hybrids under insecticide sprayed or unsprayed conditions near Garden City and St. John, KS during 97 and 98.

	Standing Yield (Bu/A)		Total Yield (Bu/A)	
Hybrid	Unsprayed	Sprayed	Unsprayed	Sprayed
Non-Bt	138.8 a	168.1 b	163.4 a	175.3 b
Bt	180.5 c	189.2 c	183.0 c	190.4 c

Table 3. Selected comparisons of corn productions strategies showing yield differences and resulting dollar differences on a per acre basis.

Advantage of Strategy Listed Below	Standing Yield (Bu/A) and Cost		
	Vs Unsprayed Non-Bt	Vs Sprayed Non-Bt	Vs Unsprayed Bt
Sprayed Non-Bt	29.3 ($49.12)	—	—
Unsprayed Bt	41.7 ($89.84)	12.4 ($40.72)	—
Sprayed Bt	50.4 ($89.52)	21.1 ($40.40)	8.7 (-$0.32)
Advantage of Strategy Listed Below	**Total Yield (Bu/A) and Cost**		
	Vs Unsprayed Non-Bt	Vs Sprayed Non-Bt	Vs Unsprayed Bt
Sprayed Non-Bt	11.9 ($7.36)	—	—
Unsprayed Bt	19.6 ($36.80)	7.7 ($29.44)	—
Sprayed Bt	27.0 ($33.36)	15.1 ($26.00)	7.4 (-$3.44)

Table 4. Comparison of returns to different corn production systems based on data from trials conducted near St. John and Garden City, KS during 1997 and 1998.

	Comparison Based on Standing Yields			
Production System [a]	Total Returns	Increase in Returns [a]	% Increase [b]	% Decrease [c]
100 acres of unsprayed non-Bt Corn	$33,312.00	—	—	—
100 acres of sprayed non-Bt Corn	$38,224.00	$4,912.00	14.75%	—
20 acres of unsprayed non-Bt corn plus 80 acres of unsprayed Bt corn	$40,499.20	$7,187.20	21.58%	4.25%
20 acres of sprayed non-Bt corn plus 80 acres of unsprayed Bt corn	$41,481.60	$8,169.60	24.52%	1.93%
40 acres of sprayed non-Bt corn plus 60 acres of unsprayed Bt corn	$40,667.20	$7,355.20	22.08%	3.85%
20 acres of sprayed non-Bt corn plus 80 acres of sprayed Bt corn	$41,456.00	$8,144.00	24.45%	1.99%
100 acres of unsprayed Bt corn	$42,296.00	$8,984.00	26.97%	—
100 acres of sprayed Bt corn.	$42,264.00	$8,952.00	26.87%	—
	Comparison Based on Total Yield			
Production System	Total Returns	Increase in Returns [a]	% Increase [b]	% Decrease [c]
100 acres of unsprayed non-Bt Corn	$40,850.00	—	—	—
100 acres of sprayed non-Bt Corn	$41,725.00	$736.00	1.88%	—
20 acres of unsprayed non-Bt corn plus 80 acres of unsprayed Bt corn	$43,970.00	$2,944.00	7.51%	1.72%
20 acres of sprayed non-Bt corn plus 80 acres of unsprayed Bt corn	$44,145.00	$3,091.20	7.88%	1.37%
40 acres of sprayed non-Bt corn plus 60 acres of unsprayed Bt corn	$43,540.00	$2,502.40	6.38%	2.75%
20 acres of sprayed non-Bt corn plus 80 acres of sprayed Bt corn	$43,945.00	$2,816.00	7.18%	2.01%
100 acres of unsprayed Bt corn	$44,750.00	$3,680.00	9.38%	—
100 acres of sprayed Bt corn.	$44,500.00	$3,336.00	8.51%	—

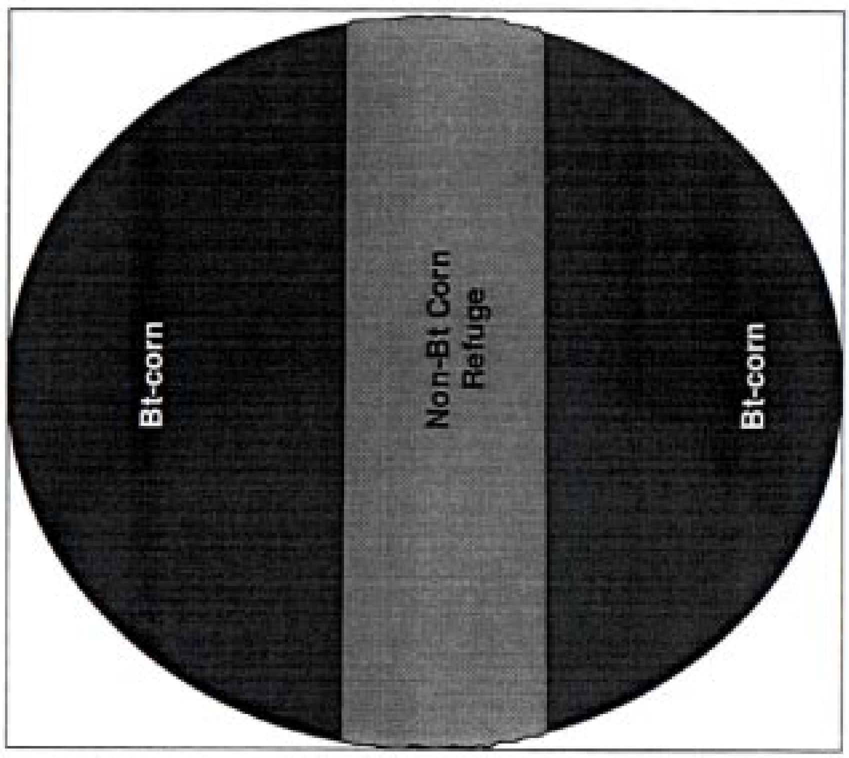
[a] These production systems included 20% or 40% refuge-planting of non-Bt corn or none. (The EPA currently requires a 20% refuge-planting).
[b] Relative to 100% unsprayed non-Bt corn.
[c] Relative to 100% unsprayed Bt corn.

higher returns than either unsprayed or sprayed non-Bt corn. Returns obviously vary as the cost of inputs and price paid for corn grain changes. As the price of corn increases or as the costs of control decrease, the returns for the sprayed options improve in relative terms. If the technology fees decline and other factors remain constant, then the returns for Bt corn grow even higher. However, the percentage differences in economic returns appear to remain fairly stable among a fairly wide range of economic inputs.

This analysis highlights the importance of controlling corn borers and the potential advantages of using Bt corn–hybrids as part of a corn borer management system. These data also indicate that refuge-plantings should not cause a significant reduction in economic returns. Returns from the refuge-planting systems were within 1 to 4% of returns expected for field wide use (100% plantings) of Bt corn (using data from either standing or total yields) and were still 4 to 6% above returns from the standard practice of using an insecticide to protect non-Bt hybrids from corn borers (using the total yield data, which is a more conservative estimate of corn borer injury).

A significant portion of the data used to develop this report originated from studies sponsored in part by K-State Research and Extension and the Kansas Corn Commission.

Center Strip as Refuge (25-50%)



CHANGES IN SUSCEPTIBILITY OF SPIDER MITES TO MITICIDES IN LABORATORY-SELECTED STRAINS AND ASSOCIATED CHANGES IN PESTICIDE DETOXIFICATION ENZYMES

by

Xuemei Yang[1], Larry Buschman, Kun Yan Zhu[1] and David Margolies[1]

SUMMARY

We examined changes in the susceptibility of Banks grass mite (BGM) and twospotted spider mite (TSM) strains exposed repeatedly to three miticides including two synthetic pyrethroids, Capture™ (bifenthrin) and Warrior™ (λ-cyhalothrin), and one organophosphate, dimethoate. The mites were exposed to each miticide for 10 cycles of selection at the LC_{60} rate for each miticide. An untreated strain was maintained as a control. After 10 cycles of selection, susceptibility to Capture, Warrior, and dimethoate decreased 4.5-, 6.0- and 286.8-fold, respectively, in the BGM strains and 18.9-, 5.4-, and 110.7-fold, respectively, in the TSM strains. An 89.8-fold cross-resistance to dimethoate occurred in the BGM Capture-selected strain. A 12.2-fold cross-resistance to Capture occurred in the TSM dimethoate-selected strain. These results suggest that cross-resistance between Capture and dimethoate could be important in field management of spider mites. Elevated general esterase activity and reduced GST activity were associated with the decrease in susceptibility to pyrethroids in both BGM and TSM. The increased general esterase level was more dramatic in BGM than in TSM. These results suggest that general esterases may play an important role in conferring pyrethroid resistance in spider mites. However, some untested mechanism, such as target site insensitivity, appears to be involved in dimethoate resistance.

INTRODUCTION

Banks grass mite (BGM) and twospotted spider mites (TSM) are important pests of corn and sorghum across Kansas. Generally, natural enemies can suppress spider mites populations, but the natural enemies can be disrupted by pesticides targeting other pests or by hot dry weather conditions. Chemical control has become increasingly difficult, because spider mites have developed resistance to many of the miticides available for use in these crops.

In this study, we evaluated the potential for the BGM and TSM to develop resistance to three currently used miticides, including two synthetic pyrethroids, Capture™ (bifenthrin) and Warrior™ (λ-cyhalothrin), and one organophosphate, dimethoate. This was done by repeatedly exposing laboratory populations to the three miticides. The two pyrethroids were expected to show cross-resistance because they are chemically related. Therefore, we examined the patterns of cross-resistance across the three miticides. After changes in susceptibility to mitides were found, we examined these spider mite strains for changes in several possible biochemical mechanisms that might play a role in conferring resistance.

PROCEDURES

The initial BGM and TSM colonies were established from mites collected from corn and soybean, respectively, near Garden City, KS, in September 1997. They had been maintained on corn and lima bean, respectively, in the greenhouse. The two initial colonies were divided into four groups for the selection experiment. Each group was reared in separate mite-proof cages.

Bioassays were conducted with glass vials coated with 100 ml/vial of the appropriate concentrations of the test miticide dissolved in acetone. Each bioassay included at least four replicates with six concentrations of the test miticide, calibrated to give approximately 10% to 90% mortality. Vials treated with acetone only were used as controls. Twenty adult female mites were transferred into each vial with a fine brush, and the vial was sealed with parafilm. Mortality

[1]Department of Entomology, Kansas State University, Manhattan

was assessed after 24 hours. Mites were scored "dead" if they failed to make active movement. The LC_{50} values and 95% confidence limits (CL) were estimated using probit analysis. LC_{50} values were considered not significantly different from each other when they had overlapping 95% CL.

The selections were done by placing at least 2000 female mites in vials treated with the test miticide at a concentration equal to the LC_{60} for that strain. After 24 hr, the surviving mites were transferred to plants and allowed to reproduce. The final mortality in each selection was over 90%, because some postexposure mortality occurred. The next selection cycle was conducted when there were enough mites to work with, two or three generations later. The bioassays were conducted on the mite populations when the mortality of mites appeared to change. The new LC_{60} then was applied in the next selection cycle. After 10 cycles of selection, the susceptibility of each selected strain was determined for all three miticides.

Enzyme assays were conducted for activities of general esterase, glutathione S-transferase (GST), and cytochrome P450 dependent demethylase (P450) after the 10th selection cycle. Xuemei Yang's MS Thesis (submitted to the Department of Entomology, May 2000) describes additional details of the methods utilized.

RESULTS AND DISCUSSION

The TSM had higher LC_{50} values, indicating that they were generally less susceptible to the three miticides than were the BGM (Fig. 1). For the BGM, dimethoate had the lowest LC_{50} followed by Capture. For TSM, Capture and dimethoate had similar LC_{50} values. Warrior had the highest LC_{50} values and was the least toxic miticide for both species. The differences in susceptibility between BGM and TSM were 40.4-fold for dimethoate, 9.5-fold for Capture, and 51.8-fold for Warrior. This suggests that Capture should continue to provide good control for the BGM, but its usefulness against the TSM is questionable.

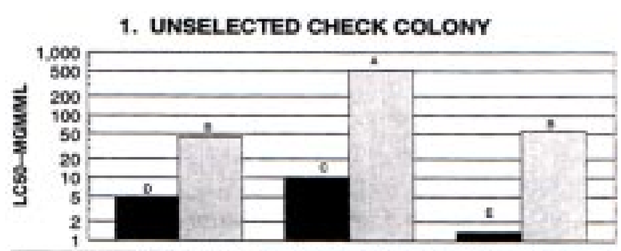
Progressive changes in the resistance ratio for the two mite species over the 10 selection cycles was more rapid for dimethoate than for the two pyrethroids (Figs. 2 & 3). After 10 selection cycles, BGM susceptibility to Capture, Warrior, and dimethoate decreased 4.5-, 6.0-, and 286.8-fold, respectively (Fig. 2). TSM susceptibility to the three miticides decreased 18.9-, 5.4-, and 110.7-fold, respectively (Fig. 3).

Selection with Capture led to a significant cross-resistance to dimethoate, 89.8- and 2.7-fold in the BGM and TSM, respectively (Figs. 4a & 5a). At the same time, selection with dimethoate led to a significant, but low, cross-resistance to Capture, 2.6- and 12.2-fold in the BGM and TSM, respectively (Figs. 4c & 5c). Selection with Capture also led to significant, but low, cross-resistance to Warrior, 8.8- and 1.7-fold in the BGM and TSM, respectively. However, selection with dimethoate did not lead to measurable cross-resistance to Warrior. Selection with Warrior led to a significant, but low, cross-resistance to Capture, 2.8- and 2.7-fold in the BGM and TSM, respectively (Figs 4b & 5b). Selection with Warrior led to significant, but low, cross-resistance to dimethoate in the BGM (7.9-fold), but not in the TSM.

These results demonstrate that development of resistance was much slower for the two pyrethroids than it was for dimethoate. This was probably due to the long history of dimethoate use in this area. There appears to be a significant risk of cross-resistance between dimethoate and Capture and between the two pyrethroids. In the field, we will need to be careful about using these miticides in sequence. When these miticides are used on mixed BGM and TSM populations, the TSM will tend to survive better and will predominate thereafter.

In the evaluation of common pesticide detoxifying enzymes, both the BGM and TSM strains selected with the pyrethroids and the BGM strain selected with dimethoate had noticeably higher levels of general

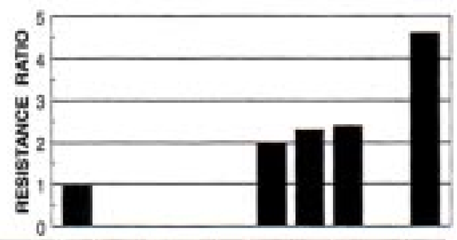
Fig. 1. Mean miticide concentrations (LC_{50}) required to kill 50% of unselected western Kansas BGM and TSM. Means (columns) that were significantly ($P \leq 0.05$) different have different letters over the bars.



	CAPTURE	WARRIOR	DIMETHOATE
BGM	4.8	10.2	1.4
TSM	45.7	528.0	56.5

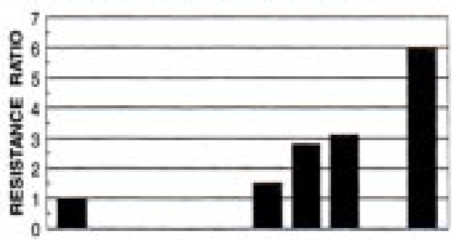
Fig. 2. Changes in the resistance ratio for three BGM strains selected with three miticides over 10 selection cycles. The resistance ratio is calculated as the LC_{50} of the test strain divided by the LC_{50} of the check strain. Bioassays were not conducted after each selection cycle. Note that the y-axis scale is different for the different strains.

2a. CAPTURE–SELECTED BGM COLONY



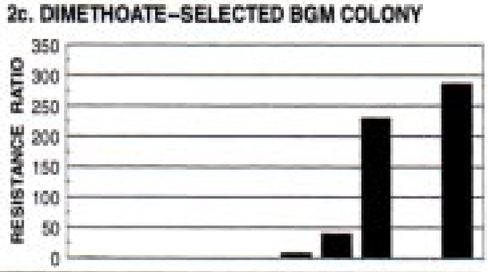
SEL. CYCLE	1	2	3	4	5	6	7	8	9	10
BGM ■	1.0					2.0	2.3	2.4		4.6

2b. WARRIOR–SELECTED BGM COLONY



SEL. CYCLE	1	2	3	4	5	6	7	8	9	10
BGM ■	1.0					1.5	2.8	3.1		6.0

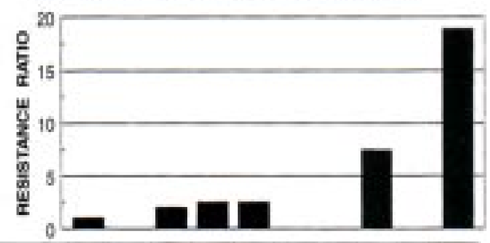
2c. DIMETHOATE–SELECTED BGM COLONY



SEL. CYCLE	1	2	3	4	5	6	7	8	9	10
BGM ■	1					8	40	230		287

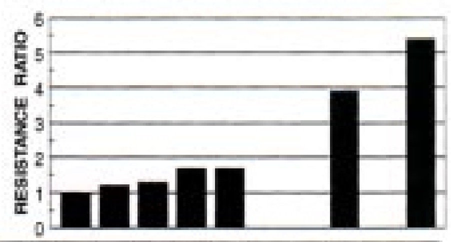
Fig. 3. Changes in the resistance ratio for three TSM strains selected with three miticides over 10 selection cycles. The resistance ratio is calculated as the LC_{50} of the test strain divided by the LC_{50} of the check strain. Bioassays were not conducted after each selection cycle. Note that the y-axis scale is different for the different strains.

3a. CAPTURE–SELECTED TSM COLONY



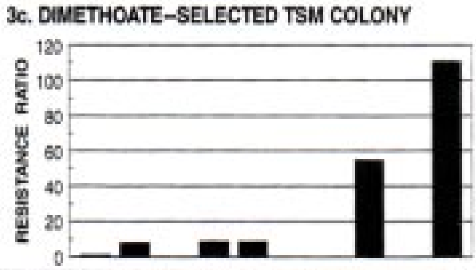
SEL. CYCLE	1	2	3	4	5	6	7	8	9	10
BGM ■	1.0		2.0	2.5	2.5			7.5		18.9

3b. WARRIOR–SELECTED TSM COLONY



SEL. CYCLE	1	2	3	4	5	6	7	8	9	10
BGM ■	1.0	1.2	1.3	1.7	1.7			3.9		5.4

3c. DIMETHOATE–SELECTED TSM COLONY



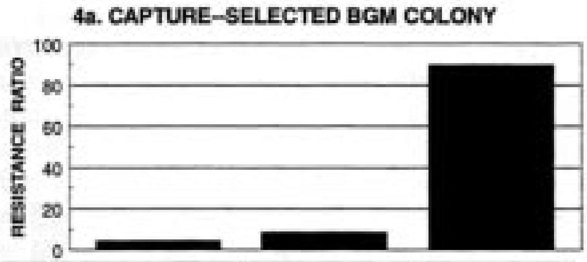
SEL. CYCLE	1	2	3	4	5	6	7	8	9	10
BGM ■	1	8		9	9			55		111

esterase activity (Fig. 6a), but the dimethoate-selected TSM strain did not. Capture-selected strains of both species had the highest general esterase activity. The Warrior-selected strains also had high activity. This suggests that general esterase may play an important role in detoxifying or in sequestering pyrethroid miticides. Resistance to pyrethroids in several other mites has been associated with elevated esterase activity. This suggests the existence of cross-resistance among pyrethroids, because detoxification mechanisms for pyrethroids may be similar in different spider mites.

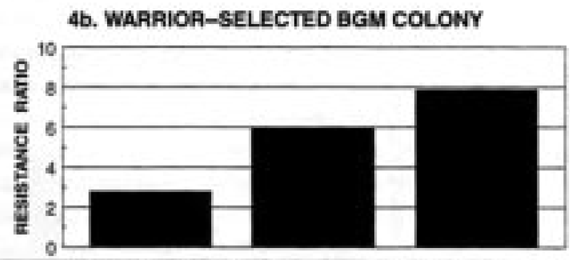
Reduced GST activity also was associated with resistance to the pyrethroids in both BGM and TSM (Fig. 6b). These results suggest that GST activity esterases are not involved in the detoxification or sequestration of pyrethroids in the BGM and TSM.

Total general esterase activity also was significantly higher in the dimethoate-selected BGM strain (Fig. 6) but not the dimethoate-selected TSM

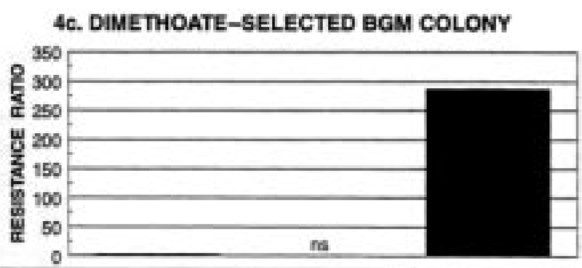
Fig. 4. Resistance ratios for the three BGM strains selected with three miticides over 10 selection cycles showing cross-resistance to all three test miticides in each strain. Strains (columns) were significantly different (P ≤ 0.05) from the unselected control strain unless identified as "ns".



	CAPTURE	WARRIOR	DIMETHOATE
BGM ■	4.5	8.8	89.8

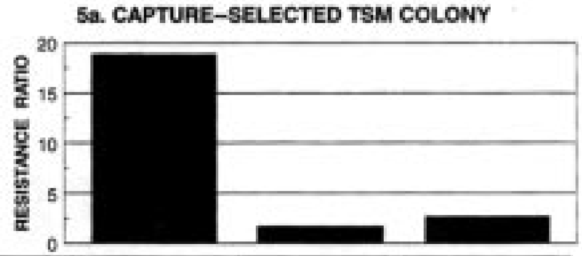


	CAPTURE	WARRIOR	DIMETHOATE
BGM ■	2.8	6.0	7.9

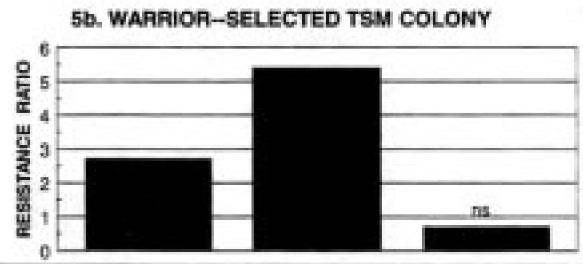


	CAPTURE	WARRIOR	DIMETHOATE
BGM ■	2.6	0.9	286.8

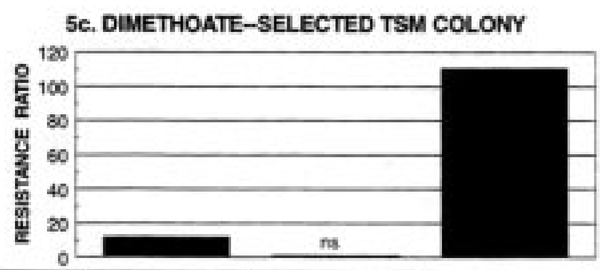
Fig. 5. Resistance ratios for the three TSM strains selected with three miticides over 10 selection cycles showing cross-resistance to all three test miticides in each strain. Strains (columns) were significantly different (P ≤ 0.05) from the unselected control strain unless identified as "ns".



	CAPTURE	WARRIOR	DIMETHOATE
TSM ■	18.9	1.7	2.7



	CAPTURE	WARRIOR	DIMETHOATE
TSM ■	2.7	5.4	0.7



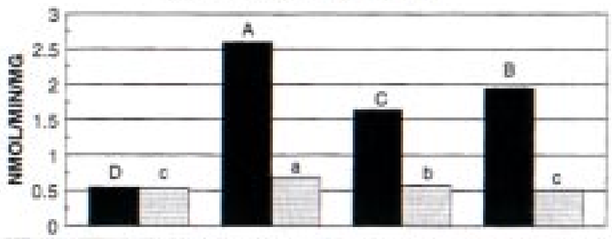
	CAPTURE	WARRIOR	DIMETHOATE
TSM ■	12.2	1.2	110.7

strain. In both species, the esterase activity was not elevated enough to account for the levels of dimethoate resistance (110.7 to 286.8-fold) recorded. Resistance to dimethoate may involve esterase activity to some extent, but another mechanism of resistance probably is responsible for these high levels. Decreased sensitivity of acetylcholinesterase (AChE) has been reported to be associated with resistance to OP pesticides in the TSM and in other spider mites such as the carmine spider mite, *T. cinnabarinus* and the bulb mite, *Rhizoglyphus robini.* AChE sensitivity studies have not yet been conducted for the BGM and TSM strains. We need to determine whether insensitivity of AChE might be involved in resistance to dimethoate in these BGM or the TSM.

The rapid increase in resistance to dimethoate in BGM and TSM and the cross-resistance, particularly in the BGM to Capture, suggest that such resistance probably is common in BGM and TSM field populations. Selection with the two pyrethroids did

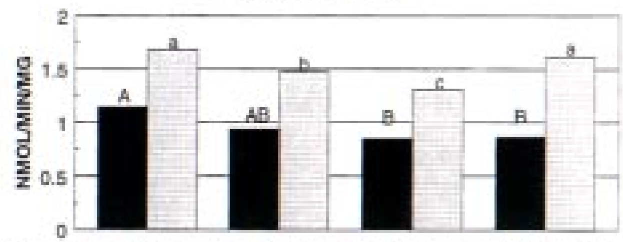
Fig. 6. General esterase and GST activities for four BGM and four TSM strains unselected or selected with three miticides over 10 selection cycles. Mean general esterase or GST activity values for strains (columns) that were significantly different (P ≤ 0.05) are identified by different uppercase or lowercase letters over them.

6a. ESTERASE ACTIVITY



COLONY	CHECK	CAPTURE	WARRIOR	DIMETHOATE
BGM ■	0.55	2.60	1.64	1.95
TSM □	0.54	0.69	0.57	0.51

6b. GST ACTIVITY



STRAIN	CHECK	CAPTURE	WARRIOR	DIMETHOATE
BGM ■	1.14	0.94	0.85	0.87
TSM □	1.68	1.48	1.31	1.62

not produce very high levels of resistance, so field resistance to those miticides may not be as common as is dimethoate resistance. Because cross-resistance occurs between the two pyrethroid miticides and between pyrethroid and organophospate pesticides, there appears to be increased risk of developing resistance to Capture when fields are treated with Warrior and Capture to control corn borers. However, resistance to Capture did not increase to very high levels over the 10 selection cycles, so we may not yet have true resistance that could threaten the field usefulness of the miticide, Capture.

COMPARISON OF NUMEROUS BALANCE RATES TO TANK MIXES OF SEVERAL OTHER HERBICIDES FOR WEED CONTROL IN CORN

by
Randall Currie

SUMMARY

Balance and tank mixes containing Balance provided excellent season-long weed control in corn.

INTRODUCTION

Balance and Epic, a package mix of Balance and flufenacet, are new herbicides with chemistries that provide broad-spectrum weed and grass control in corn. They were compared to several other tank mixes.

PROCEDURES

Weeds were seeded as described in Table 1. Corn was planted as described in Table 2. Treatments were applied as described in Table 3. Corn was combine harvested, and yields were adjusted to 15.5%. Weed and crop stages at given dates are described in Table 4.

RESULTS AND DISCUSSION

Many treatments containing Balance had top yields (Table 5). Treatments followed by the letter T produced top yields and were not statistically better than one another. Treatments followed by the letter G also provided some weed control and were not statistically different from one another. All treatments but 2 and 15 provided good control of volunteer sunflower (Table 6) . This is not surprising, because analogs of these compounds once had labels for weed control in sunflowers.

Treatments except 2, 3, 4, 5, 6, 15, and 22 provided good control of sorghum species, (Table 7). Because seedling Johnsongrass and shattercane are difficult to distinguish, they were rated together. Greater than 80% of the sorghum species pressure was provided by the shatter cane. Treatments except 2, 15, and 18, provided excellent long-season control of Palmer pigweed (Table 8). Although redroot pigweed was also seeded with Palmer pigweed, very

Table 1. Weed seeding information, corn herbicide study, Garden City, KS, 1999.

Planting date:	5-11-99
Planting method:	14 ft Great Plains Drill
Carrier:	Cracked corn at 40 lbs/a
Rate, unit:	Palmer amaranth at 276 grams/a = approx. 700,000 seeds/a, Redroot pigweed at 136.5 grams/a = approx. 400,000 seeds/a, Yellow foxtail at 2010 grams/a = approx. 670,000 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:	Seeds of all weeds but shattercane were dropped on top of soil. The tubes were pulled off the drill. Shattercane seed was drilled with 1/3 at ˚ inch deep, 1/3 at 1 inch deep, and 1/3 at 2 inches deep.
Row spacing, unit:	10 inches
Soil temperature, unit:	59 F
Soil moisture:	Good

little was observed in these plots. This is not surprising, because Palmer pigweed has supplanted redroot pigweed as the major amaranth species in southwestern Kansas. Palmer is assumed to be a more vigorous competitor that chokes out the perhaps less aggressive redroot pigweed. All treatments other than 1, 7, 8, 9, 11, 12, 13, and 29 provided good control of crabgrass (Table 9). Although treatment 10 appeared to provide control, this is assumed to be a statistically anomaly. Treatments 1 and 29 in other tests has provided excellent crabgrass control. However, at the time of application, crabgrass had not yet emerged, so the lack of control was due to poor timing not a lack of efficacy of these compounds. Also, the good broadleaf control of atrazine and buctril has been observed many times by this researcher to exacerbate late-season grass pressure by removing competition.

Table 2. Production information for corn, herbicide study, Garden City, KS, 1999.

Variety:	DK592SR
Planting date:	5-11-99
Planting method:	John Deere Max Emerge II, 6-row planter
Rate, unit:	35,000 seeds/a
Depth, unit:	1.5 inches
Row spacing, unit:	30 inches
Soil temperature, unit:	59 F
Soil moisture:	Good
Emergence date:	5-18-99

Note: Field was infested with aphids around 7/26/99 and was sprayed on 8/8/99 with Capture for control of aphids and corn borer. On June 30th, a hailstorm caused 60-70% defoliation of the corn.

Table 3. Application information, corn herbicide study, Garden City, KS, 1999.

Application date:	5-8-99	5-11-99	6-15-99
Application method:	Broadcast	Broadcast	Broadcast
Application timing:	Postemergence weeds	Pre	Post
Air temperature, unit:	70 F	58 F	78 F
Wind velocity, unit:	0-5 mph SW	10-18 mph NE	0-10 mph NW
Soil temperature, unit:	72 F	59 F	77 F
Soil moisture:	Very good	Good	Dry top ∫", moist below
% Relative humidity:	52%	46%	46%
% Cloud cover:	0%	80%	100%
Chemical applied:	Roundup Ultra over entire test	Pre treatments from protocols	Post treatments from protocols
Application equipment:	Farm sprayer	Windshield sprayer	Windshield sprayer
Nozzle type/brand:	Greenleaf Turbo drop XL	Teejet XR	Teejet XR
Nozzle size:	TDXL-11002 + part-02	8004 VS	8004 VS
Nozzle spacing, unit:	20 in.	20 in.	20 in.
Boom length, unit:	30 ft.	10 ft.	10 ft.
Boom height, unit:	23 in.	18 in.	18 in.
Pressure, unit:	38 psi	38 psi	38 psi
Ground speed:	3.0 mph	3.3 mph	3.3 mph
Application rate:	20 gpa	20 gpa	20 gpa
Spray volume, unit:	30 gal	3 liter	3 liter
Carrier:	H_2O	H_2O	H_2O
Propellant:	Hydraulic pump	CO_2	CO_2

Table 4. Corn yield and weed stages of growth at various dates, herbicide study, Garden City, KS, 1999.

Date	Corn	Weeds
5/21/99	1-collar, approx. 2 inches tall	—
6/4/99	3-collar, approx. 5-7 inches tall	—
6/15/99	5-collar	Sunflowers = 4-leaf, 5 in.; Shattercane = 13 in.; Pigweed = 6-leaf, 4 in.
7/12/99	9-collar	Sunflowers = 34 in.; Shattercane = 54 in.; Pigweed = 36 in.; Yellow foxtail = 21 in.; Crabgrass = 3 in.
8/9/99	—	Sunflowers = 53 in.; Shattercane = 54 in.; Pigweed = 70 in.; Yellow foxtail = 34 in.; Crabgrass = 25 in.
8/31/99	—	Sunflowers = 43 in.; Shattercane = 58 in.; Pigweed = 69 in.; Yellow foxtail = 30 in.; Crabgrass = 29 in. Johnsongrass = 78 in.

Table 5. Corn yield in bu/a adusted to 15.5% moisture with herbicide treatments, Garden City, KS, 1999.

Treatment	Rate (lbs ai/a)	Appl. Stage	Yield bu/a
1 Banvel + Poast + Atrazine + NIS	0.5, 0.56, 0.25, 0.5%	Post	75.1G
2 FulTime	3.0	Pre	67.8
3 ZA1296/ICIA5676	2.2	Pre	86.9G
4 ZA1296/ICIA5676 + Atrazine	2.2, 0.5	Pre	81.1G
5 FulTime **:** ZA1296	3.0 **:** 0.094	Pre**:**Post	73.9
6 TopNotch **:** ZA1296	1.92, 0.094	Pre**:**Post	77.5G
7 Balance + Atrazine	0.025, 1.5	Pre	88.2G
8 Balance + Atrazine	0.031, 1.5	Pre	89.0G
9 Balance + Atrazine	0.038, 1.5	Pre	91.6T
10 Balance + Atrazine	0.052, 1.5	Pre	83.7G
11 Balance + Atrazine	0.061, 1.5	Pre	83.7G
12 Balance + Atrazine	0.07, 1.5	Pre	88.9G
13 Balance	0.07	Pre	80.1G
14 Balance + Bicep II	0.047, 1.5	Pre	74.5G
15 Dual II	1.22	Pre	63.1
16 Balance + Surpass	0.07, 1.6	Pre	90.5T
17 Balance + Harness Xtra	0.07, 1.96	Pre	89.2G
18 Balance + Axiom	0.047, 0.425	Pre	82.4G
19 EPIC	0.399	Pre	88.9G
20 Axiom **:** Spirit	0.64 **:** 0.04	Pre**:**Post	82.2G
21 Axiom **:** Basis Gold + Banvel	0.34 **:** 0.79, 0.125	Pre**:**Post	88.1G
22 Axiom + Atrazine	0.64, 1.5	Pre	70.2
23 EPIC + Atrazine	0.145, 1.5	Pre	82.5G
24 EPIC + Atrazine	0.18, 1.5	Pre	86.7G
25 EPIC + Atrazine	0.22, 1.5	Pre	94.0T
26 EPIC + Atrazine	0.29, 1.5	Pre	89.5G
27 EPIC + Atrazine	0.38, 1.5	Pre	105.4T
28 Axiom + Balance + Atrazine	0.38, 0.047, 1.0	Pre	96.7T
29 Buctril/Atrazine + Banvel + Poast + NIS	0.75, 0.25, 0.56, 0.5%	Post	76.0G
30 Check	--	--	57.1
LSD (0.05) =			14.4

Table 6. Sunflower height (in) multiplied by the number of sunflowers per square foot and percent reduction, corn herbicide study, Garden City, KS, 1999.

			6/28/99		7/26/99	
Treatment	Rate(lbs ai/a)	Appl. Stage	Ht x no.	%Red.	Ht x no.	%Red.
1 Banvel + Poast + Atrazine + NIS	0.5, 0.56, 0.25, 0.5%	Post	0.0	100.0	0.0	100.0
2 FulTime	3.0	Pre	49.5	75.0	49.0	75.0
3 ZA1296/ICIA5676	2.2	Pre	0.0	100.0	13.0	85.6
4 ZA1296/ICIA5676 + Atrazine	2.2, 0.5	Pre	0.0	100.0	0.0	100.0
5 FulTime : ZA1296	3.0 : 0.094	Pre:Post	0.0	100.0	0.0	100.0
6 TopNotch : ZA1296	1.92, 0.094	Pre:Post	12.0	91.1	3.8	96.6
7 Balance + Atrazine	0.025, 1.5	Pre	0.0	100.0	0.0	100.0
8 Balance + Atrazine	0.031, 1.5	Pre	0.0	100.0	12.0	88.7
9 Balance + Atrazine	0.038, 1.5	Pre	0.0	100.0	0.0	100.0
10 Balance + Atrazine	0.052, 1.5	Pre	0.0	100.0	0.0	100.0
11 Balance + Atrazine	0.061, 1.5	Pre	0.0	100.0	0.0	100.0
12 Balance + Atrazine	0.07, 1.5	Pre	0.0	100.0	0.0	100.0
13 Balance	0.07	Pre	0.0	100.0	0.0	100.0
14 Balance + Bicep II	0.047, 1.5	Pre	2.0	92.0	0.0	100.0
15 Dual II	1.22	Pre	152.3	13.7	208.5	25.0
16 Balance + Surpass	0.07, 1.6	Pre	0.0	100.0	0.0	100.0
17 Balance + Harness Xtra	0.07, 1.96	Pre	0.0	100.0	0.0	100.0
18 Balance + Axiom	0.047, 0.425	Pre	11.5	75.0	0.0	100.0
19 EPIC	0.399	Pre	13.8	83.4	25.5	77.0
20 Axiom : Spirit	0.64 : 0.04	Pre:Post	6.0	95.6	0.0	100.0
21 Axiom : Basis Gold + Banvel	0.34 : 0.79, 0.125	Pre:Post	29.5	53.0	2.0	98.1
22 Axiom + Atrazine	0.64, 1.5	Pre	0.0	100.0	0.0	100.0
23 EPIC + Atrazine	0.145, 1.5	Pre	4.0	84.0	10.5	90.1
24 EPIC + Atrazine	0.18, 1.5	Pre	1.8	93.0	10.0	90.7
25 EPIC + Atrazine	0.22, 1.5	Pre	0.0	100.0	0.0	100.0
26 EPIC + Atrazine	0.29, 1.5	Pre	0.0	100.0	0.0	100.0
27 EPIC + Atrazine	0.38, 1.5	Pre	0.0	100.0	0.0	100.0
28 Axiom + Balance + Atrazine	0.38, 0.047, 1.0	Pre	0.0	100.0	0.0	100.0
29 Buctril/Atrazine + Banvel + Poast + NIS	0.75, 0.25, 0.56, 0.5%	Post	0.0	100.0	0.0	100.0
30 Check	—	—	56.1	0.0	88.3	0.0
LSD (0.05) =			51.9	24.3	61.6	25.0

Table 7. Shattercane and Johnsongrass heights (in) multiplied by the number of shattercane/seedling Johnsongrass in 3.3 feet of row and percent reduction, corn herbicide study, Garden City, KS, 1999.

Treatment	Rate (lbs ai/a)	Appl. Stage	6/28/99 Ht x no.	6/28/99 %Red.	7/26/99 Ht x no.	7/26/99 %Red.
1 Banvel + Poast + Atrazine + NIS	0.5, 0.56, 0.25, 0.5%	Post	7.5	98.9	12.3	98.1
2 FulTime	3.0	Pre	550.8	23.7	300.8	47.7
3 ZA1296/ICIA5676	2.2	Pre	214.1	64.8	260.7	51.5
4 ZA1296/ICIA5676 + Atrazine	2.2, 0.5	Pre	286.8	62.4	231.1	58.2
5 FulTime **:** ZA1296	3.0 **:** 0.094	Pre**:**Post	132.3	80.5	165.7	72.1
6 TopNotch **:** ZA1296	1.92, 0.094	Pre**:**Post	372.8	54.6	242.7	57.3
7 Balance + Atrazine	0.025, 1.5	Pre	26.2	95.9	26.6	95.0
8 Balance + Atrazine	0.031, 1.5	Pre	67.7	86.5	43.4	90.5
9 Balance + Atrazine	0.038, 1.5	Pre	27.9	95.6	34.6	91.8
10 Balance + Atrazine	0.052, 1.5	Pre	9.2	98.4	16.7	95.3
11 Balance + Atrazine	0.061, 1.5	Pre	10.7	98.8	25.3	92.6
12 Balance + Atrazine	0.07, 1.5	Pre	6.4	98.8	4.7	98.8
13 Balance	0.07	Pre	18.8	96.6	20.0	95.2
14 Balance + Bicep II	0.047, 1.5	Pre	102.5	83.7	69.1	88.8
15 Dual II	1.22	Pre	667.0	8.3	335.6	41.2
16 Balance + Surpass	0.07, 1.6	Pre	34.6	94.4	34.9	93.8
17 Balance + Harness Xtra	0.07, 1.96	Pre	14.3	97.6	39.0	93.8
18 Balance + Axiom	0.047, 0.425	Pre	139.8	80.0	93.2	74.1
19 EPIC	0.399	Pre	23.3	97.0	29.8	94.6
20 Axiom **:** Spirit	0.64 **:** 0.04	Pre**:**Post	174.6	70.7	12.1	97.9
21 Axiom **:** Basis Gold + Banvel	0.34 **:** 0.79, 0.125	Pre**:**Post	228.8	64.5	75.1	80.9
22 Axiom + Atrazine	0.64, 1.5	Pre	242.4	56.2	176.7	60.9
23 EPIC + Atrazine	0.145, 1.5	Pre	60.7	90.7	69.3	87.3
24 EPIC + Atrazine	0.18, 1.5	Pre	55.9	91.7	88.6	84.1
25 EPIC + Atrazine	0.22, 1.5	Pre	15.2	98.0	28.5	93.2
26 EPIC + Atrazine	0.29, 1.5	Pre	25.0	96.8	38.7	92.8
27 EPIC + Atrazine	0.38, 1.5	Pre	11.2	97.8	24.0	93.7
28 Axiom + Balance + Atrazine	0.38, 0.047, 1.0	Pre	23.6	97.5	12.2	98.1
29 Buctril/Atrazine + Banvel + Poast + NIS	0.75, 0.25, 0.56, 0.5%	Post	9.3	98.5	34.5	93.6
30 Check	—	—	633.1	0.0	422.5	0.0
LSD (0.05) =			192.2	24.6	144.5	19.6

Table 8. Palmer pigweed height (in) multiplied by the number of pigweed in 3.3 feet of row and percent reduction corn herbicide study, Garden City, KS, 1999.

Treatment	Rate(lbs ai/a)	Appl. Stage	6/28/99 Ht x no.	6/28/99 %Red.	7/26/99 Ht x no.	7/26/99 %Red.
1 Banvel + Poast + Atrazine + NIS	0.5, 0.56, 0.25, 0.5%	Post	0.5	100.0	0.5	100.0
2 FulTime	3.0	Pre	237.2	70.8	281.1	74.5
3 ZA1296/ICIA5676	2.2	Pre	1.5	99.8	13.7	98.6
4 ZA1296/ICIA5676 + Atrazine	2.2, 0.5	Pre	1.1	99.9	3.6	99.7
5 FulTime : ZA1296	3.0 : 0.094	Pre:Post	6.8	99.2	7.2	99.1
6 TopNotch : ZA1296	1.92, 0.094	Pre:Post	4.3	99.5	18.6	98.3
7 Balance + Atrazine	0.025, 1.5	Pre	6.7	98.7	20.1	97.9
8 Balance + Atrazine	0.031, 1.5	Pre	17.3	97.9	18.2	98.1
9 Balance + Atrazine	0.038, 1.5	Pre	0.9	99.9	9.5	99.1
10 Balance + Atrazine	0.052, 1.5	Pre	5.6	99.5	3.0	99.7
11 Balance + Atrazine	0.061, 1.5	Pre	6.2	98.8	20.4	99.1
12 Balance + Atrazine	0.07, 1.5	Pre	0.6	99.9	17.1	98.3
13 Balance	0.07	Pre	78.1	85.2	31.6	96.9
14 Balance + Bicep II	0.047, 1.5	Pre	38.4	95.4	18.2	98.0
15 Dual II	1.22	Pre	287.3	62.2	396.1	58.9
16 Balance + Surpass	0.07, 1.6	Pre	0.8	99.9	2.2	99.7
17 Balance + Harness Xtra	0.07, 1.96	Pre	0.3	100.0	2.2	99.8
18 Balance + Axiom	0.047, 0.425	Pre	197.3	81.9	177.7	84.4
19 EPIC	0.399	Pre	14.7	97.8	23.1	97.7
21 Axiom : Spirit	0.64 : 0.04	Pre:Post	144.8	83.8	75.4	92.5
22 Axiom : Basis Gold + Banvel	0.34 : 0.79, 0.125	Pre:Post	6.0	99.1	6.4	99.5
23 Axiom + Atrazine	0.64, 1.5	Pre	14.9	97.6	32.0	96.9
24 EPIC + Atrazine	0.145, 1.5	Pre	1.1	99.9	7.2	99.2
25 EPIC + Atrazine	0.18, 1.5	Pre	4.9	99.3	16.6	98.1
26 EPIC + Atrazine	0.22, 1.5	Pre	4.2	99.5	14.4	98.3
27 EPIC + Atrazine	0.29, 1.5	Pre	1.3	99.9	8.1	99.3
28 EPIC + Atrazine	0.38, 1.5	Pre	0.0	100.0	1.3	99.9
29 Axiom + Balance + Atrazine	0.38, 0.047, 1.0	Pre	3.4	99.5	13.3	98.7
36 Buctril/Atrazine + Banvel + Poast + NIS	0.75, 0.25, 0.56, 0.5%	Post	22.5	97.3	14.6	98.3
30 Check	—	—	647.3	0.0	880.2	0.0
LSD (0.05) =			158.8	16.1	151.2	14.6

Table 9. Crabgrass height (in) multiplied by the number of crabgrass in 3.3 feet of row and percent reduction corn herbicide study, Garden City, KS, 1999.

Treatment	Rate (lbs ai/a)	Appl. Stage	7/26/99 Ht x no.	7/26/99 %Red.
1 Banvel + Poast + Atrazine + NIS	0.5, 0.56, 0.25, 0.5%	Post	56.3	0.0
2 FulTime	3.0	Pre	0.6	98.9
3 ZA1296/ICIA5676	2.2	Pre	0.0	100.0
4 ZA1296/ICIA5676 + Atrazine	2.2, 0.5	Pre	0.0	100.0
5 FulTime : ZA1296	3.0 : 0.094	Pre:Post	0.0	100.0
6 TopNotch : ZA1296	1.92, 0.094	Pre:Post	0.0	100.0
7 Balance + Atrazine	0.025, 1.5	Pre	91.7	44.7
8 Balance + Atrazine	0.031, 1.5	Pre	28.7	62.5
9 Balance + Atrazine	0.038, 1.5	Pre	35.8	70.3
10 Balance + Atrazine	0.052, 1.5	Pre	0.8	96.8
11 Balance + Atrazine	0.061, 1.5	Pre	25.4	57.4
12 Balance + Atrazine	0.07, 1.5	Pre	20.3	67.1
13 Balance	0.07	Pre	51.8	68.6
14 Balance + Bicep II	0.047, 1.5	Pre	0.6	97.1
15 Dual II	1.22	Pre	0.0	100.0
16 Balance + Surpass	0.07, 1.6	Pre	0.0	100.0
17 Balance + Harness Xtra	0.07, 1.96	Pre	10.8	86.1
18 Balance + Axiom	0.047, 0.425	Pre	0.0	100.0
19 EPIC	0.399	Pre	0.0	100.0
20 Axiom : Spirit	0.64 : 0.04	Pre:Post	0.0	100.0
21 Axiom : Basis Gold + Banvel	0.34 : 0.79, 0.125	Pre:Post	2.5	93.0
22 Axiom + Atrazine	0.64, 1.5	Pre	0.5	97.5
23 EPIC + Atrazine	0.145, 1.5	Pre	1.1	99.2
24 EPIC + Atrazine	0.18, 1.5	Pre	0.0	100.0
25 EPIC + Atrazine	0.22, 1.5	Pre	0.3	99.6
26 EPIC + Atrazine	0.29, 1.5	Pre	0.0	100.0
27 EPIC + Atrazine	0.38, 1.5	Pre	0.0	100.0
28 Axiom + Balance + Atrazine	0.38, 0.047, 1.0	Pre	0.3	98.4
29 Buctril/Atrazine + Banvel + Poast + NIS	0.75, 0.25, 0.56, 0.5%	Post	67.9	25.0
30 Check	—	—	0.0	0.0
LSD (0.05) =			43.3	29.0

COMPARISON OF 14 HERBICIDE TANK MIXES FOR WEED CONTROL IN CORN CONTAINING RESISTANCE GENES FOR LIBERTY AND PURSUIT

by
Randall Currie

SUMMARY

Treatments containing Pursuit and Clarity or Balance, atrazine, and Liberty produced top yields. As has been seen in many tests done by this author, tank mixes of Tough provided poor or inconsistent results. All treatments dramatically increased yield over that for the untreated control.

INTRODUCTION

Genes for resistance to both Liberty and Pursuit are now available in many corn hybrids. Direct comparisons of these sorts of tank mixes were hitherto impossible to make. Therefore, the objective of this study was to make side-by-side comparisons of these herbicides with divergent chemistries.

PROCEDURES

Weeds were seeded as described in Table 1. Corn was planted as described inTable 2. Treatments were applied as described in Table 3. Corn was combine harvested, and yields were adjusted to 15.5%. Weed and corn stages at given dates are presented in Table 4.

RESULTS AND DISCUSSION

All treatments greatly increased yield over that of the untreated control (Table 5). Treatments follow by the letter T did not yield statistically more than the best treatment. All treatments produced dramatic reductions in Palmer pigweed (Table 6). However, control by treatments followed by the letter T were not statistically different from 100% control. Redroot pigweed also was seeded over this experiment, but very little was observed. This underscores Palmers extremely competitive nature and may explain why this species has supplanted most other pigweed species in southwestern Kansas.

All treatments provided some foxtail control during some part of the season (Table 7). However, only treatments 5,9,10, and 13 provided consistent season-long control. Foxtail pressure was not intense in this study, so the reader is advised to use this information with care. It should be used as supporting data to other studies and not as a sole source on which to base a buying decision. All treatments but 9,10,11,13 provided crabgrass control (Table 8). Crabgrass was choked out of the control plots by broadleaf weeds; therefore, control is put in relation to treatment 13. As with foxtail data, these data should be used with care and as supporting data only.

Table 1. Weed seeding information, herbicide-resistant corn study, Garden City, KS, 1999.

Planting date:	5-13-99
Planting method:	14 ft Great Plains drill
Carrier:	Cracked corn at 40 lb/a
Rate, unit:	Palmer amaranth at 267 grams/a = approx. 700,000 seeds/a, Redroot pigweed at 136.5 grams/a = approx. 400,000 seeds/a, Yellow foxtail at 2010 grams/a = approx. 670,000 seeds/a, Crabgrass at 5557 grams/a = approx. 9.8 million seeds/a, Sunflowers at 1814 grams/a= approx. 40,000 seeds/a, Shattercane = 5 lb/a = approx. 119,400 seeds/a
Depth, unit:	Seeds of all weeds but shattercane were dropped on top of test area. The tubes were pulled off the drill. Shattercane seed was drilled with 1/3 at ˚ inch deep, 1/3 at 1 inch deep, and 1/3 at 2 inches deep.
Row spacing, unit:	10 inches
Soil temperature, unit:	67 F
Soil moisture:	Dry top ˘ inch, moist below

Table 2. Production information for herbicide-resistant corn, Garden City, KS, 1999.

Variety:	Garst 8540 LL IT
Planting date:	5-13-99
Planting method:	John Deere Max Emerge II, 6-row planter
Rate, unit:	35,000 seeds/a
Depth, unit:	1.5 inches
Row spacing, unit:	30 inches
Soil temperature, unit:	67 F
Soil moisture:	Dry top ˘ inch, moist below
Emergence date:	5-18-99

Note: On June 30th, a hailstorm caused about 60-70% defoliation of the corn. The field was infested with aphids around 7/26/99 and was sprayed on 8/8/99 with Capture for control of aphids and corn borer.

Table 3. Application information, herbicide-resistant corn study, Garden City, KS, 1999.

Application date:	5-8-99	5-13-99	6-8-99
Time of day:	11:30 am	2:00 pm	8:45 pm
Application method:	Broadcast	Broadcast	Broadcast
Application timing:	Postemergence weeds	Pre	Post
Air temperature, unit:	70 F	74 F	74 F
Wind velocity, unit:	0-5 mph SW	30 mph S	18 mph S
Dew presence:	None	None	None
Soil temperature, unit:	72F	67 F	75 F
Soil moisture:	Very good	Dry top ˘”, moist below	Dry top ˚”, moist below
% Relative humidity:	52%	42%	71%
% Cloud cover:	0%	85%	0%
Chemical applied:	Roundup Ultra over entire test	Pre treatments from protocols	Post treatments from protocols
Application equipment:	Farm sprayer	Windshield sprayer	Windshield sprayer
Nozzle type/brand:	Greenleaf Turbo drop XL	Teejet XR	Teejet XR
Nozzle size:	TDXL-11002 + part-02	8004 VS	8004 VS
Nozzle spacing, unit:	20 in.	20 in.	20 in.
Boom length, unit:	30 ft.	10 ft.	10 ft.
Boom height, unit:	23 in.	16 in.	18 in.
Pressure, unit:	38 psi	38 psi	38 psi
Ground speed:	3.0 mph	3.4 mph	3.3 mph
Application rate:	20 gpa	20 gpa	20 gpa
Spray volume, unit:	30 gal	3 liter	3 liter
Carrier:	H_2O	H_2O	H_2O
Propellant:	Hydraulic pump	CO_2	CO_2

Table 4. Corn and weed stages of growth at seven dates, herbicide-resistant corn study, Garden City, KS, 1999.

Date	Corn	Weeds
6/7/99	2-collar	Sunflowers = 2-leaf, 2 inch; Shattercane = 4-leaf, 5 inch; Pigweed = 4-leaf, ˚ inch; Yellow foxtail = 2-leaf, 4 inch; Crabgrass = 1 inch.
6/16/99	4-collar	Weed heights are in tables.
6/28/99	6-collar	Weed heights are in tables.
7/12/99	9-collar	Sunflowers = 30 inches; Shattercane = 34 inches; Pigweed = 36 inches; Yellow foxtail = 24 inches; Crabgrass = 8 inches.
8/10/99	—	Sunflowers = 50 inches; Shattercane = 65 inches; Pigweed = 66 inches; Yellow foxtail = 28 inches; Crabgrass = 18 inches.
9/2/99	—	Sunflowers = 48 inches; Shattercane = 65 inches; Pigweed = 70 inches; Yellow foxtail = 25 inches; Crabgrass = 20 inches; Johnsongrass = 75 inches.
10/1/99	—	Sunflowers completely matured and dead; Shattercane = 65 inches; Pigweed = 68 inches; Yellow foxtail = 24 inches; Crabgrass = 20 inches; Johnsongrass = 75 inches.

Table 5. Yield of herbicide-resistant corn in bushels per acre corrected to 15.5% moisture, Garden City, KS, 1999.

Treatment	Rate (lbs ai/a)	Appl. Stage	Yield bu/A
1 Lightning + Clarity + NIS + 28%UAN	0.056, 0.19, 0.25%, 2.5%	Post	105.0T
2 Lightning + Clarity + COC + 28%UAN	0.056, 0.19, 1.0%, 2.5%	Post	119.0T
3 Lightning + Tough + COC + 28%UAN	0.056, 0.47, 1.0%, 2.5%	Post	82.5
4 Prowl **:** Pursuit + Clarity + NIS + 28%UAN	0.99 **:** 0.063, 0.19, 0.25%, 2.5%	Pre**:**Post	102.7T
5 Prowl + Balance	0.99, 0.047	Pre	94.4
6 Harness + Balance	0.875, 0.047	Pre	101.3
7 Balance **:** Liberty	0.047 **:** 0.37	Pre**:**Post	84.4
8 Balance **:** Liberty	0.07 **:** 0.26	Pre**:**Post	88.6
9 Balance + Atrazine **:** Liberty + Atrazine + AMS	0.02, 1.0 **:** 0.37, 0.5, 3.0	Pre**:**Post	110.5T
10 Balance + Atrazine **:** Liberty + Atrazine + AMS + Herbimax COC	0.02, 1.0 **:** 0.37, 0.5, 3.0, 1.25%	Pre**:**Post	106.4T
11 Atrazine **:** Liberty + AMS	1.5 **:** 0.44, 3.0	Pre**:**Post	90.8
12 Balance **:** LibertyATZ + AMS	0.05 **:** 1.36, 3.0	Pre**:**Post	108.5T
13 Balance **:** LibertyATZ + Liberty + AMS	0.05 **:** 1.36, 0.13, 3.	Pre**:**Post	110.5T
14 Balance **:** LibertyATZ + AMS + Herbimax COC	0.05 **:** 1.36, 3.0, 1.25%	Pre**:**Post	104.0T
15 Check	—	—	32.3
LSD (0.05) =			16.4

Table 6. Palmer pigweed heights (in.) multiplied by the number of pigweed per 3.3 feet of row and percent reduction, herbicide resistant corn study, Garden City, KS, 1999.

Treatment	Rate (lbs ai/a)	Appl. Stage	7/27/9 Ht x no.	7/27/9 %Red.
1 Lightning + Clarity + NIS + 28%UAN	0.056, 0.19, 0.25%, 2.5%	Post	48.4	96.0T
2 Lightning + Clarity + COC + 28%UAN	0.056, 0.19, 1.0%, 2.5%	Post	29.7	97.5T
3 Lightning + Tough + COC + 28%UAN	0.056, 0.47, 1.0%, 2.5%	Post	123.0	89.5
4 Prowl **:** Pursuit + Clarity + NIS + 28%UAN	0.99 **:** 0.063, 0.19, 0.25%, 2.5%	Pre**:**Post	55.3	95.8T
5 Prowl + Balance	0.99, 0.047	Pre	156.8	88.1
6 Harness + Balance	0.875, 0.047	Pre	32.1	97.7T
7 Balance **:** Liberty	0.047 **:** 0.37	Pre**:**Post	145.0	88.3
8 Balance **:** Liberty	0.07 **:** 0.26	Pre**:**Post	120.7	90.2
9 Balance + Atrazine **:** Liberty + Atrazine + AMS	0.02, 1.0 **:** 0.37, 0.5, 3.0	Pre**:**Post	0.4	100.0T
10 Balance + Atrazine **:** Liberty + Atrazine + AMS + Herbimax COC	0.02, 1.0 **:** 0.37, 0.5, 3.0, 1.25%	Pre**:**Post	6.0	99.4T
11 Atrazine **:** Liberty + AMS	1.5 **:** 0.44, 3.0	Pre**:**Post	22.3	98.4T
12 Balance **:** LibertyATZ + AMS	0.05 **:** 1.36, 3.0	Pre**:**Post	0.0	100.0T
13 Balance **:** LibertyATZ + Liberty + AMS	0.05 **:** 1.36, 0.13, 3.0	Pre**:**Post	8.9	99.1T
14 Balance **:** LibertyATZ + AMS + Herbimax COC	0.05 **:** 1.36, 3.0, 1.25%	Pre**:**Post	3.2	99.7T
16 Check		—	1006.5	0.0
LSD (0.05) =			179.0	6.4

Table 7. Yellow foxtail heights (in.) multiplied by the number of yellow foxtail per square foot and percent reduction, herbicide-resistant corn study, Garden City, KS, 1999.

Treatment	Rate (lbs ai/a)	Appl. Stage	6/16/99 Ht x no.	6/16/99 % Red.	6/28/99 Ht x no.	6/28/99 % Red.	7/27/99 Ht x no.	7/27/99 % Red.
1 Lightning + Clarity + NIS + 28%UAN	0.056, 0.19, 0.25%, 2.5%	Post	31.3	46.4	46.8	57.1	9.4	88.7
2 Lightning + Clarity + COC + 28%UAN	0.056, 0.19, 1.0%, 2.5%	Post	45.0	50.0	21.4	74.9	3.6	94.9
3 Lightning + Tough + COC + 28%UAN	0.056, 0.47, 1.0%, 2.5%	Post	28.5	78.8	2.5	94.9	0.0	100.0
4 Prowl **:** Pursuit + Clarity + NIS + 28%UAN	0.99 **:** 0.063, 0.19, 0.25%, 2.5%	Pre:Post	28.0	75.0	44.7	74.7	41.5	73.9
5 Prowl + Balance	0.99, 0.047	Pre	0.3	99.3	2.0	99.2	2.0	99.3
6 Harness + Balance	0.875, 0.047	Pre	11.8	75.0	38.9	74.7	88.1	74.1
7 Balance **:** Liberty	0.047 **:** 0.37	Pre:Post	0.8	96.3	60.9	71.7	44.2	62.0
8 Balance **:** Liberty	0.07 **:** 0.26	Pre:Post	1.0	98.1	6.4	88.7	15.6	84.7
9 Balance + Atrazine **:** Liberty + Atrazine + AMS	0.02, 1.0 **:** 0.37, 0.5, 3.0	Pre:Post	0.0	100.0	0.2	99.8	5.7	96.9
10 Balance + Atrazine **:** Liberty + Atrazine + AMS + Herbimax COC	0.02, 1.0 **:** 0.37, 0.5, 3.0, 1.25%	Pre:Post	0.0	100.0	0.0	100.0	1.2	97.4
11 Atrazine **:** Liberty + AMS	1.5 **:** 0.44, 3.0	Pre:Post	9.8	63.8	96.0	47.1	219.4	49.1
12 Balance **:** LibertyATZ + AMS	0.05 **:** 1.36, 3.0	Pre:Post	2.0	91.6	60.0	75.0	30.0	75.0
13 Balance **:** LibertyATZ + Liberty + AMS	0.05 **:** 1.36, 0.13, 3.0	Pre:Post	0.0	100.0	0.8	96.6	0.5	99.1
14 Balance **:** LibertyATZ + AMS + Herbimax COC	0.05 **:** 1.36, 3.0, 1.25%	Pre:Post	0.2	99.4	1.5	94.9	5.4	91.6
15 Check	—	—	53.0	0.0	90.8	0.0	96.5	0.0
LSD (0.05) =			48.6	38.9	88.4	39.9	121.8	34.0

Table 8. Crabgrass heights (in.) multiplied by the number of crabgrass in 3.3 feet of row and percent reduction, herbicide-resistant corn study, Garden City, KS, 1999.

Treatment	Rate (lbs ai/a)	7/27/99 Appl. Stage	Ht x no.	% Red.
1 Lightning + Clarity + NIS + 28%UAN	0.056, 0.19, 0.25%, 2.5%	Post	3.6	96.7
2 Lightning + Clarity + COC + 28%UAN	0.056, 0.19, 1.0%, 2.5%	Post	5.3	97.1
3 Lightning + Tough + COC + 28%UAN	0.056, 0.47, 1.0%, 2.5%	Post	0.3	99.9
4 Prowl : Pursuit + Clarity + NIS + 28%UAN	0.99 : 0.063, 0.19, 0.25%, 2.5%	Pre:Post	0.3	99.8
5 Prowl + Balance	0.99, 0.047	Pre	0.0	100.0
6 Harness + Balance	0.875, 0.04	Pre	0.0	100.0
7 Balance : Liberty	0.047 : 0.37	Pre:Post	25.0	80.5
8 Balance : Liberty	0.07 : 0.26	Pre:Post	13.2	89.2
9 Balance + Atrazine : Liberty + Atrazine + AMS	0.02, 1.0 : 0.37, 0.5, 3.0	Pre:Post	96.7	42.2
10 Balance + Atrazine : Liberty + Atrazine + AMS + Herbimax COC	0.02, 1.0 : 0.37, 0.5, 3.0, 1.25%	Pre:Post	208.5	17.7
11 Atrazine : Liberty + AMS	1.5 : 0.44, 3.0	Pre:Post	66.0	63.1
12 Balance : LibertyATZ + AMS	0.05 : 1.36, 3.0	Pre:Post	12.4	91.3
13 Balance : LibertyATZ + Liberty + AMS	0.05 : 1.36, 0.13, 3.0	Pre:Post	102.8	47.2
14 Balance : LibertyATZ + AMS + Herbimax COC	0.05 : 1.36, 3.0, 1.25%	Pre:Post	98.5	0.0
15 Check	—	—	0.0*	100.0
LSD (0.05) =			84.9	29.5

*The percent height times number reduction is based on treatment 14 as the check, because broadleaf weeds eliminated crabgrass in true controls.

COMPARISON OF 49 DIFFERENT HERBICIDE TREATMENTS ON ROUNDUP READY CORN

by
Randall Currie

SUMMARY

A single application of only Roundup did not produce top yields. Two applications of Roundup and 32 other tank mixes produced yields not statistically different from those of the best-yielding treatments.

INTRODUCTION

Roundup if applied enough times to Roundup Ready corn can achieve 100% control of most known weeds. In southwestern Kansas, comparisons of one or two applications or Roundup in irrigated corn to other herbicide tank mixes in replicated trials are rare. Therefore, the objective of this study was to make these comparisons.

PROCEDURES

Weeds were seeded as described in Table 1. Roundup Ready corn was planted as described in Table 2. Treatments were applied as described in Table 3. Corn was combine harvested and yields were adjusted to 15.5%. Weed and crop stages at various dates are supplied in Table 4.

RESULTS AND DISCUSSION

Yields followed by the letter T were not statistically different from those of the best treatments (Table 5). Although there were exceptions, the majority of the top-yielding treatments contained some sort of preemergence herbicide. A single application of Roundup alone did not produce yields equal to those of the best treatments.

Many treatments produced 90% or greater control of volunteer sunflower at one or more ratings with the exception of treatments 22, 23, 25, 26, 27, 34, 35, 38, 43, 44, and 45 (Table 6). Treatments 3, 6, 8, 9, 10, 11, 12, 17, 18, 21, 32, 36, 37, and 40 produced greater than 99% sunflower control in two or more ratings.

Many treatments produced 80% or more control of seedling Johnsongrass or shattercane with the exception of treatments 8, 16, 22 to 32, 35 to 43, 45, and 46 (Table 7). Only treatments 3, 9, 10, 11, 12, 13, and 14 produced greater than 99% control of these species at 2 or more ratings.

Many treatments produced 80% Palmer amaranth control with the exception of 13, 14, 25, 26, 27, 40, 42, 44, 46, 47, and 48 (Table 8). Treatments 2, 3, 6, 7, 9, 16, 18, 19, 20, 28, 29, 30, 31, 32, 33, 34, 35, and 36 produced greater than 99% Palmer amaranth control at two or more ratings.

Many treatments produced greater than 80% foxtail control at one or more ratings with the exception of treatments 8, 13, 23 to 27, 36 to 43, and 45 to 49 (Table 9). Treatments 2, 3, 9, 12, 17 to 21, and 29 to 35, provided greater than 99% control of foxtail.

Many treatments produced greater than 80% crabgrass control at one or more ratings with the exception of 8, 26, 36, 37, 38, 39, 43, 44, 46, 47, and 48 (Table 10). Treatments 5, 16, 20, 22, 28, 29, 30, 31, 33 and 40 provided greater than 99% crabgrass control at two or more ratings.

Table 1. Weed seeding information, Roundup Ready corn study, Garden City, KS, 1999.

Planting date:	4-20-99
Planting method:	14 ft Great Plains drill
Carrier:	Cracked corn at 40 lbs/a
Rate, unit:	Palmer amaranth at 267 grams/a= approx. 700,000 seeds/a, redroot pigweed at 136.5 grams/a = approx. 400,000 seeds/a, yellow foxtail at 2010 grams/a= approx. 670,000 seeds/a, crabgrass at 5557 grams/a = approx. 9.8 million seeds/a, sunflowers at 1814 grams/a = approx. 40,000 seeds/a, shattercane = 5 lbs/a = approx. 119,400 seeds/a.
Depth, unit:	Seeds of all weeds but shattercane were dropped on top of test area. The tubes were pulled off the drill. Shattercane seed was drilled with a 1/3 at ˚ inch deep, 1/3 at 1 inch deep, and 1/3 at 2 inches deep.
Row spacing, unit:	10 inches
Soil temperature, unit:	65 F
Soil moisture:	Good

Table 2. Production information for Roundup Ready corn, Garden City, KS, 1999.

Variety:	DK580RR
Planting date:	4-20-99
Planting method:	John Deere Max Emerge II, 6-row planter
Rate, unit:	35,700 seeds/a
Depth, unit:	1.5 inches
Row spacing, unit:	30 inches
Soil temperature, unit:	73 F
Soil moisture:	Good
Emergence date:	5-3-99

Note: On June 30th, a hailstorm caused around 60-70% defoliation of the corn. The field also was infested with aphids around 7/26/99 and was sprayed on 8/8/99 with Capture for control of aphids and corn borer.

Table 3. Application information for Roundup Ready corn study, Garden City, KS, 1999.

Application date:	4-20-99	5-20-99	6-4-99	6-14-99
Time of day:	3:00 pm - 8:00 pm	2:00 pm	7:30 am – 12:00 pm	1:30 pm
Application method:	Broadcast	Broadcast	Broadcast	Broadcast
Application timing:	Pre	Early Post	Post	Late Post
Air temperature, unit:	84 F	78 F	90 F	73 F
Wind velocity, unit:	0–5 mph N	0 mph	0-10 mph S	0 mph
Soil temperature, unit:	66 F	70 F	80 F	76 F
Soil moisture:	Good	Dry top ˚”, moist below	Dry top ∫”, moist below	Dry top 1”, moist below
% Relative humidity:	32%	61%	45%	45%
% Cloud cover:	0%	100%	20%	20%
Chemical applied:	Pre treatments from protocols	Early Post trt. from protocols	Post treatments from protocols	Late Post trt. from protocols
Application equipment:	Windshield sprayer	Windshield sprayer	Windshield sprayer	Windshield sprayer
Nozzle type/brand:	Teejet XR	Teejet XR	Teejet XR	Teejet XR
Nozzle size:	8004 VS	8004 VS	8004 VS	8004 VS
Nozzle spacing, unit:	20 in.	20 in.	20 in.	20 in.
Boom length, unit:	10 ft.	10 ft.	10 ft.	10 ft.
Boom height, unit:	18 in.	18 in.	18 in.	18 in.
Pressure, unit:	38 psi	38 psi	38 psi	38 psi
Ground speed:	3.3 mph	3.3 mph	3.3 mph	3.3 mph
Application rate:	20 gpa	20 gpa	20 gpa	20 gpa
Spray volume, unit:	3 liter	3 liter	3 liter	3 liter
Carrier:	H_2O	H_2O	H_2O	H_2O
Propellant:	CO_2	CO_2	CO_2	CO_2

Table 4. Corn and weed stages of growth at various dates, Roundup Ready corn study, Garden City, KS , 1999.

Date	Corn	Weeds
5/21/99	2-collar, approx. 7 inches tall	Sunflowers = 4-leaf, 3 in.; Shattercane = 3-leaf, 2 in.; Pigweed = 4-leaf, ˚ in.;
6/3/99	3-collar, approx. 13 inches tall	Sunflowers = 8-leaf, 8 in.; Shattercane = 4-leaf, 6 in.; Pigweed = 2 in.; Y.Foxtail = 3 in.; Crabgrass = 1 in.
6/22/99	7-collar	Sunflowers = 25 in.; Shattercane = 23 in.; Pigweed = 25 in.; Y.Foxtail = 15 in.; Crabgrass = 5 in.
7/20/99	Tassel	Sunflowers = 56 in.; Shattercane = 57 in.; Pigweed = 42 in.; Y.Foxtail = 33 in.; Crabgrass = 30 in.
8/6/99	—	Sunflowers = 48 in.; Shattercane = 57 in.; Pigweed = 69 in.; Y.Foxtail = 45 in.; Crabgrass = 24 in.
8/23/99	—	Sunflowers = 40 in.; Shattercane = 60 in.; Pigweed = 78 in.; Y.Foxtail = 55 in.; Crabgrass = 24 in.; Johnsongrass = 67 in.
10/4/99	—	Sunflowers = 40 in.; Shattercane = 59 in.; Pigweed = 75 in.; Y.Foxtail = 52 in.; Crabgrass = 20 in.; Johnsongrass = 63 in.

Table 5. Yield of Roundup Ready corn in bushels per acre and percent moisture, Garden City, KS, 1999.

Treatment	Rate (lbs ai/a)	Appl. Stage	% Moisture	Yield bu/a
1 Roundup Ultra	0.75	LPost	11.4	78.4T
2 Guardsman : Basis Gold+Clarity+COC+28%UAN	1.25 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	11.3	83.2T
3 Guardsman : Accent Gold+Clarity+COC+28%UAN	1.25 : 0.152, 0.125, 1.0% 4.0%	Pre:Post	10.9	84.0T
4 Basis+Atrazine	0.023, 1.0	Pre	11.6	80.7T
5 Basis : Basis Gold+Clarity+COC+28%UAN	0.015 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	11.1	78.0T
6 Balance : Basis Gold+Clarity+COC+28%UAN	0.05 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	11.1	76.8T
7 Axiom : Basis Gold+Clarity+COC+28%UAN	0.425 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	11.4	87.5T
8 Basis Gold+Distinct+COC+28%UAN	0.79, 0.175, 1.0%, 4.0%	Post	11.6	79.8T
9 Harness Xtra : Roundup Ultra+AMS	1.73 : 0.75, 2.0%	Pre:Post	11.4	84.3T
10 Roundup Ultra+AMS : Roundup Ultra+AMS	0.75, 2.0% : 0.75, 2.0%	Post:LPost	11.0	91.1T
11 Roundup Ultra+AMS	0.75, 2.0%	Post	10.9	75.9
12 Bullet : Roundup Ultra+AMS	2.25 : 0.75, 2.0%	Pre:Post	11.1	84.0T
13 Harness Xtra+Roundup Ultra+AMS	1.73, 0.75, 2.0%	Post	11.2	83.3T
14 Bullet+Roundup Ultra+AMS	2.25, 0.75, 2.0%	Post	11.7	86.3T
15 Atrazine+Roundup Ultra+AMS	1.0, 0.75, 2.0%	Post	11.1	92.8T
16 Dual II Magnum : Marksman	1.60 : 1.4	Pre:Post	11.9	81.3T
17 Harness Xtra : Roundup Ultra+AMS	1.73 : 0.75, 2.0%	Pre:Post	11.2	91.4T
18 Bicep II Magnum : Exceed+Clarity+NIS	2.2 : 0.028, 0.2, 0.25%	Pre:Post	11.9	79.6T
19 Frontier : Distinct+NIS	1.17 : 0.263, 0.25%	Pre:Post	11.8	81.7T
20 Guardsman : Basis Gold+NIS+28%UAN	2.5 : 0.783, 0.25%, 5.0%	Pre:Post	11.2	69.8T
21 Balance+Atrazine	0.07, 1.5	Pre	11.8	89.1T
22 Axiom	0.68	Pre	11.6	77.3T
23 Aim+Atrazine+NIS	0.01, 0.75, 0.25%	Post	11.6	72.3
24 Aim+Atrazine+Banvel+NIS	0.01, 0.5, 0.25, 0.25%	Post	11.6	79.6T
25 Aim+Tough	0.01, 0.35	Post	11.3	63.4
26 Aim+Tough+NIS	0.01, 0.35, 0.25%	Post	11.2	68.1
27 Aim+Roundup+NIS	0.01, 1.0, 0.25%	Post	11.0	56.0
28 Bicep II Magnum	2.2	Pre	14.4	81.1T
29 Bicep II Magnum : Northstar	2.2 : 0.137	Pre:Post	12.1	82.6T
30 Bicep II Magnum : Beacon	2.2 : 0.036	Pre:Post	12.1	86.4T
31 Bicep II Magnum : Spirit	2.2 : 0.036	Pre:Post	12.2	82.4T
32 Bicep II Magnum : Exceed	2.2 : 0.036	Pre:Post	11.9	78.2T

Table 5. Yield of Roundup Ready corn in bushels per acre and percent moisture, Garden City, KS, 1999, continued.

Treatment	Rate (lbs ai/a)	Appl. Stage	% Moisture	Yield bu/a
33 Dual II Magnum : Exceed	1.6 : 0.036	Pre:Post	12.0	77.1T
34 Dual II Magnum : Spirit	1.6 : 0.036	Pre:Post	11.6	92.6T
35 Dual II Magnum : Northstar	1.6 : 0.137	Pre:Post	11.9	84.5T
36 Marksman+28%UAN	1.4, 2.5%	EPost	11.2	59.2
37 Clarity+28%UAN	0.5, 2.5%	EPost	11.6	77.3T
38 Distinct+NIS+28%UAN	0.26,0.25%,1.25%	Post	12.1	80.1T
39 Buctril/Atrazine	0.75	Post	11.3	75.3
40 Spirit+NIS+28%UAN	0.036,0.25%,2.5%	Post	11.4	61.8
41 Northstar+NIS+28%UAN	0.148,0.25%,2.5%	Post	12.2	77.4T
42 Hornet+NIS+28%UAN	0.128,0.25%,2.5%	Post	11.0	61.6
43 Laddock+28%UAN	1.25,2.5%	Post	11.8	72.3
44 Basis Gold+COC+28%UAN	0.782,1.0%,2.5%	Post	11.2	77.0T
45 Distinct+NIS+28%UAN	0.175,0.25%,1.25%	LPost	11.8	74.6
46 Hornet+NIS+28%UAN	0.128, 0.25%, 2.5%	LPost	11.6	72.6
47 Spirit+NIS+28%UAN	0.036, 0.25%, 2.5%	LPost	11.3	73.2
48 Northstar+NIS+28%UAN	0.148, 0.25%, 2.5%	LPost	11.5	83.9T
49 Check	—	—	11.6	55.3
50 Roundup Ultra	0.75	LPost	11.2	75.5
LSD (0.05) =			1.1	16.6

Table 6. Sunflower height (in) multiplied by the number of sunflowers per foot of row and percent reduction, Roundup-Ready corn study, Garden City, KS, 1999.

Treatment	Rate (lbs ai/a)	Appl. Stage	6/14/99 Ht x no.	6/14/99 %Red.	7/9/99 Ht x no.	7/9/99 %Red.
1 Roundup Ultra	0.75	LPost	68.1	0.0	165.8	92.3
2 Guardsman : Basis Gold+Clarity+COC+28%UAN	1.25 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	2.0	97.6	21.5	99.0
3 Guardsman : Accent Gold+Clarity+COC+28%UAN	1.25 : 0.152, 0.125, 1.0% 4.0%	Pre:Post	0.0	100.0	0.0	100.0
4 Basis+Atrazine	0.023, 1.0	Pre	0.4	99.6	38.0	98.2
5 Basis : Basis Gold+Clarity+COC+28%UAN	0.015 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	1.5	98.2	0.0	100.0
6 Balance : Basis Gold+Clarity+COC+28%UAN	0.05 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	0.2	99.8	0.0	100.0
7 Axiom : Basis Gold+Clarity+COC+28%UAN	0.425 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	10.1	86.2	27.5	98.6
8 Basis Gold+Distinct+COC+28%UAN	0.79, 0.175, 1.0%, 4.0%	Post	0.7	99.0	17.8	99.1
9 Harness Xtra : Roundup Ultra+AMS	1.73 : 0.75, 2.0%	Pre:Post	0.0	100.0	0.0	100.0
10 Roundup Ultra+AMS : Roundup Ultra+AMS	0.75, 2.0% : 0.75, 2.0%	Post:LPost	0.0	100.0	3.5	99.8
11 Roundup Ultra+AMS	0.75, 2.0%	Post	0.6	99.2	46.3	97.9
12 Bullet : Roundup Ultra+AMS	2.25 : 0.75, 2.0%	Pre:Post	0.0	100.0	0.0	100.0
13 Harness Xtra+Roundup Ultra+AMS	1.73, 0.75, 2.0%	Post	8.7	88.0	171.0	92.7
14 Bullet+Roundup Ultra+AMS	2.25, 0.75, 2.0%	Post	1.5	98.3	88.5	95.8
15 Atrazine+Roundup Ultra+AMS	1.0, 0.75, 2.0%	Post	2.8	96.2	150.5	92.6
16 Dual II Magnum : Marksman	1.60 : 1.4	Pre:Post	17.4	77.1	112.5	94.3
17 Harness Xtra : Roundup Ultra+AMS	1.73 : 0.75, 2.0%	Pre:Post	0.0	100.0	7.0	99.7
18 Bicep II Magnum : Exceed+Clarity+NIS	2.2 : 0.028, 0.2, 0.25%	Pre:Post	0.0	100.0	0.0	100.0
19 Frontier : Distinct+NIS	1.17 : 0.263, 0.25%	Pre:Post	19.0	75.1	185.8	90.5
20 Guardsman : Basis Gold+NIS+28%UAN	2.5 : 0.783, 0.25%, 5.0%	Pre:Post	2.3	97.5	59.0	97.2
21 Balance+Atrazine	0.07, 1.5	Pre	0.2	99.8	17.0	99.2
22 Axiom	0.68	Pre	28.1	64.1	734.0	64.0
23 Aim+Atrazine+NIS	0.01, 0.75, 0.25%	Post	42.2	49.7	997.5	52.6
24 Aim+Atrazine+Banvel+NIS	0.01, 0.5, 0.25, 0.25%	Post	44.7	45.5	182.5	90.4
25 Aim+Tough	0.01, 0.35	Post	71.7	23.6	1387.8	35.9
26 Aim+Tough+NIS	0.01, 0.35, 0.25%	Post	70.0	16.8	1562.5	24.0
27 Aim+Roundup+NIS	0.01, 1.0, 0.25%	Post	56.1	32.6	1305.5	35.9
28 Bicep II Magnum	2.2	Pre	6.4	92.1	173.5	91.7
29 Bicep II Magnum : Northstar	2.2 : 0.137	Pre:Post	1.0	98.8	18.0	98.9
30 Bicep II Magnum : Beacon	2.2 : 0.036	Pre:Post	4.1	95.0	176.8	91.7
31 Bicep II Magnum : Spirit	2.2 : 0.036	Pre:Post	1.7	98.1	39.8	98.1
32 Bicep II Magnum : Exceed	2.2 : 0.036	Pre:Post	0.1	99.9	3.0	99.8

continued

Table 6. Sunflower height (in) multiplied by the number of sunflowers per foot of row and percent reduction, Roundup Ready corn study, Garden City, KS, 1999, continued.

			6/14/99		7/9/99	
Treatment	Rate (lbs ai/a)	Appl. Stage	Ht x no.	%Red.	Ht x no.	%Red.
33 Dual II Magnum **:** Exceed	1.6 **:** 0.036	Pre**:**Post	9.7	87.7	194.8	90.5
34 Dual II Magnum **:** Spirit	1.6 **:** 0.036	Pre**:**Post	13.2	84.4	298.5	84.9
35 Dual II Magnum **:** Northstar	1.6 **:** 0.137	Pre**:**Post	20.8	75.6	377.3	81.4
36 Marksman+28%UAN	1.4 , 2.5%	EPost	0.0	100.0	0.0	100.0
37 Clarity+28%UAN	0.5, 2.5%	EPost	0.0	100.0	0.0	100.0
38 Distinct+NIS+28%UAN	0.26, 0.25%, 1.25%	Post	20.8	72.5	429.8	82.8
39 Buctril/Atrazine	0.75	Post	5.0	94.4	145.0	93.6
40 Spirit+NIS+28%UAN	0.036, 0.25%, 2.5%	Post	0.0	100.0	0.0	100.0
41 Northstar+NIS+28%UAN	0.148, 0.25%, 2.5%	Post	13.7	83.6	111.5	94.9
42 Hornet+NIS+28%UAN	0.128, 0.25%, 2.5%	Post	19.6	76.8	64.5	97.1
43 Laddock+28%UAN	1.25, 2.5%	Post	9.0	88.3	352.5	82.4
44 Basis Gold+COC+28%UAN	0.782, 1.0%, 2.5%	Post	31.3	63.8	547.0	72.2
45 Distinct+NIS+28%UAN	0.175, 0.25%, 1.25%	LPost	75.6	18.6	381.5	80.6
46 Hornet+NIS+28%UAN	0.128, 0.25%, 2.5%	LPost	87.8	13.0	108.8	94.1
47 Spirit+NIS+28%UAN	0.036, 0.25%, 2.5%	LPost	61.3	32.1	11.3	99.3
48 Northstar+NIS+28%UAN	0.148, 0.25%, 2.5%	LPost	53.4	36.3	203.0	90.5
49 Roundup Ultra	0.75	LPost	76.7	0.0	324.3	85.3
50 Check	—	—	92.8	0.0	1679.8	0.0
LSD (0.05) =			23.1	19.9	310.8	12.2

Table 7. Shattercane and Johnsongrass heights (in) multiplied by the number of shattercane/Johnsongrass in 3.3 feet of row and percent reduction, Roundup Ready corn study, Garden City, KS, 1999.

Treatment	Rate(lbs ai/a)	Appl. Stage	6/14/99		7/9/99	
			Ht x no.	%Red.	Ht x no.	%Red.
1 Roundup Ultra	0.75	LPost	116.5	32.9	0.8	99.9
2 Guardsman : Basis Gold+Clarity+COC+28%UAN	1.25 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	2.4	98.6	3.4	99.3
3 Guardsman : Accent Gold+Clarity+COC+28%UAN	1.25 : 0.152, 0.125, 1.0% 4.0%	Pre:Post	1.4	99.0	0.0	100.0
4 Basis+Atrazine	0.023, 1.0	Pre	3.1	98.1	13.7	95.8
5 Basis : Basis Gold+Clarity+COC+28%UAN	0.015 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	2.8	98.5	0.5	99.9
6 Balance : Basis Gold+Clarity+COC+28%UAN	0.05 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	2.3	98.6	0.9	99.8
7 Axiom : Basis Gold+Clarity+COC+28%UAN	0.425 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	25.4	87.0	0.5	99.9
8 Basis Gold+Distinct+COC+28%UAN	0.79, 0.175, 1.0%, 4.0%	Post	68.0	64.0	25.3	92.1
9 Harness Xtra : Roundup Ultra+AMS	1.73 : 0.75, 2.0%	Pre:Post	0.1	100.0	0.8	99.7
10 Roundup Ultra+AMS : Roundup Ultra+AMS	0.75, 2.0% : 0.75, 2.0%	Post:LPost	0.0	100.0	0.0	100.0
11 Roundup Ultra+AMS	0.75, 2.0%	Post	0.0	100.0	3.3	99.4
12 Bullet : Roundup Ultra+AMS	2.25 : 0.75, 2.0%	Pre:Post	0.3	99.9	3.0	99.1
13 Harness Xtra+Roundup Ultra+AMS	1.73, 0.75, 2.0%	Post	7.3	96.1	52.8	88.2
14 Bullet+Roundup Ultra+AMS	2.25, 0.75, 2.0%	Post	0.0	100.0	4.4	99.1
15 Atrazine+Roundup Ultra+AMS	1.0, 0.75, 2.0%	Post	0.0	100.0	11.0	96.9
16 Dual II Magnum : Marksman	1.60 : 1.4	Pre:Post	42.9	76.2	198.1	47.8
17 Harness Xtra : Roundup Ultra+AMS	1.73 : 0.75, 2.0%	Pre:Post	0.0	100.0	4.2	99.1
18 Bicep II Magnum : Exceed+Clarity+NIS	2.2 : 0.028, 0.2, 0.25%	Pre:Post	23.0	86.8	61.0	83.6
19 Frontier : Distinct+NIS	1.17 : 0.263, 0.25%	Pre:Post	16.2	91.1	58.2	84.7
20 Guardsman : Basis Gold+NIS+28%UAN	2.5 : 0.783, 0.25%, 5.0%	Pre:Post	3.3	98.1	6.7	97.9
21 Balance+Atrazine	0.07, 1.5	Pre	3.8	97.8	10.5	96.5
22 Axiom	0.68	Pre	71.3	60.3	213.0	46.8
23 Aim+Atrazine+NIS	0.01, 0.75, 0.25%	Post	222.0	0.0	496.5	2.5
24 Aim+Atrazine+Banvel+NIS	0.01, 0.5, 0.25, 0.25%	Post	180.8	8.8	566.0	0.0
25 Aim+Tough	0.01, 0.35	Post	188.8	10.6	325.0	20.4
26 Aim+Tough+NIS	0.01, 0.35, 0.25%	Post	204.5	11.6	363.8	21.7
27 Aim+Roundup+NIS	0.01, 1.0, 0.25%	Post	166.5	23.1	394.8	23.5
28 Bicep II Magnum	2.2	Pre	150.3	24.6	745.8	24.3
29 Bicep II Magnum : Northstar	2.2 : 0.137	Pre:Post	53.2	68.8	182.0	51.9
30 Bicep II Magnum : Beacon	2.2 : 0.036	Pre:Post	54.7	69.0	94.8	71.9

continued

Table 7. Shattercane and Johnsongrass heights (in) multiplied by the number of shattercane/Johnsongrass in 3.3 feet of row and percent reduction, Roundup Ready corn study, Garden City, KS, 1999, continued.

			6/14/99		7/9/99	
Treatment	Rate (lbs ai/a)	Appl .Stage	Ht x no.	%Red.	Ht x no.	%Red.
31 Bicep II Magnum : Spirit	2.2 : 0.036	Pre:Post	62.3	61.2	186.9	49.7
32 Bicep II Magnum : Exceed	2.2 : 0.036	Pre:Post	101.2	43.7	246.5	34.6
33 Dual II Magnum : Exceed	1.6 : 0.036	Pre:Post	29.3	83.3	105.5	71.8
34 Dual II Magnum : Spirit	1.6 : 0.036	Pre:Post	30.1	83.8	79.9	78.7
35 Dual II Magnum : Northstar	1.6 : 0.137	Pre:Post	32.7	79.9	102.0	72.3
36 Marksman+28%UAN	1.4 , 2.5%	EPost	234.3	7.0	478.5	0.0
37 Clarity+28%UAN	0.5, 2.5%	EPost	195.3	20.3	480.0	11.9
38 Distinct+NIS+28%UAN	0.26, 0.25%, 1.25%	Post	179.8	3.1	453.8	6.3
39 Buctril/Atrazine	0.75	Post	137.0	29.0	519.0	8.9
40 Spirit+NIS+28%UAN	0.036, 0.25%, 2.5%	Post	60.8	66.0	155.5	58.7
41 Northstar+NIS+28%UAN	0.148, 0.25%, 2.5%	Post	127.5	26.2	277.5	29.9
42 Hornet+NIS+28%UAN	0.128, 0.25%, 2.5%	Post	124.5	32.6	225.5	40.9
43 Laddock+28%UAN	1.25, 2.5%	Post	249.0	10.4	594.2	13.7
44 Basis Gold+COC+28%UA	0.782, 1.0%, 2.5%	Post	18.3	90.6	19.5	96.3
45 Distinct+NIS+28%UAN	0.175, 0.25%, 1.25%	LPost	143.0	22.9	162.0	55.7
46 Hornet+NIS+28%UAN	0.128, 0.25%, 2.5%	LPost	168.0	20.3	210.5	41.7
47 Spirit+NIS+28%UAN	0.036, 0.25%, 2.5%	LPost	88.3	47.4	32.5	92.1
48 Northstar+NIS+28%UAN	0.148, 0.25%, 2.5%	LPost	191.0	8.1	46.0	84.7
49 Roundup Ultra	0.75	LPost	190.3	10.6	8.0	97.4
50 Check	—	—	193.8	0.0	312.5	0.0
LSD (0.05) =			65.8	22.2	211.9	21.2

Table 8. Pigweed height (in) multiplied by the number of pigweed in 3.3 feet of row and percent reduction, Roundup Ready corn study, Garden City, KS, 1999.

			6/14/99		7/9/99	
Treatment	Rate (lbs ai/a)	Appl. Stage	Ht x no.	%Red.	Ht x no.	%Red.
1 Roundup Ultra	0.75	LPost	59.0	83.2	0.5	99.8
2 Guardsman : Basis Gold+Clarity+COC+28%UAN	1.25 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	0.0	100.0	0.0	100.0
3 Guardsman : Accent Gold+Clarity+COC+28%UAN	1.25 : 0.152, 0.125, 1.0% 4.0%	Pre:Post	0.0	100.0	0.4	99.7
4 Basis+Atrazine	0.023, 1.0	Pre	1.0	99.6	17.4	94.0
5 Basis : Basis Gold+Clarity+COC+28%UAN	0.015 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	5.8	97.1	6.8	97.3
6 Balance : Basis Gold+Clarity+COC+28%UAN	0.05 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	0.0	100.0	0.0	100.0
7 Axiom : Basis Gold+Clarity+COC+28%UAN	0.425 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	0.0	100.0	0.0	100.0
8 Basis Gold+Distinct+COC+28%UAN	0.79, 0.175, 1.0%, 4.0%	Post	11.5	96.5	14.0	97.5
9 Harness Xtra : Roundup Ultra+AMS	1.73 : 0.75, 2.0%	Pre:Post	0.0	100.0	2.9	99.5
10 Roundup Ultra+AMS : Roundup Ultra+AMS	0.75, 2.0% : 0.75, 2.0%	Post:LPost	41.0	89.2	8.0	98.3
11 Roundup Ultra+AMS	0.75, 2.0%	Post	12.8	95.6	103.0	80.3
12 Bullet : Roundup Ultra+AMS	2.25 : 0.75, 2.0%	Pre:Post	0.0	100.0	3.9	98.4
13 Harness Xtra+Roundup Ultra+AMS	1.73, 0.75, 2.0%	Post	98.1	58.2	229.0	40.9
14 Bullet+Roundup Ultra+AMS	2.25, 0.75, 2.0%	Post	49.5	77.2	64.5	79.1
15 Atrazine+Roundup Ultra+AMS	1.0, 0.75, 2.0%	Post	19.3	93.4	62.3	89.5
16 Dual II Magnum : Marksman	1.60 : 1.4	Pre:Post	0.0	100.0	0.0	100.0
17 Harness Xtra : Roundup Ultra+AMS	1.73 : 0.75, 2.0%	Pre:Post	0.0	100.0	17.2	92.8
18 Bicep II Magnum : Exceed+Clarity+NIS	2.2 : 0.028, 0.2, 0.25%	Pre:Post	0.0	100.0	0.0	100.0
19 Frontier : Distinct+NIS	1.17 : 0.263, 0.25%	Pre:Post	0.0	100.0	0.0	100.0
20 Guardsman : Basis Gold+NIS+28%UAN	2.5 : 0.783, 0.25%, 5.0%	Pre:Post	0.0	100.0	0.0	100.0
21 Balance+Atrazine	0.07, 1.5	Pre	0.0	100.0	5.0	98.4
22 Axiom	0.68	Pre	4.5	98.4	7.5	98.4
23 Aim+Atrazine+NIS	0.01, 0.75, 0.25%	Post	32.0	86.9	156.0	46.7
24 Aim+Atrazine+Banvel+NIS	0.01, 0.5, 0.25, 0.25%	Post	16.5	93.7	4.3	98.6
25 Aim+Tough	0.01, 0.35	Post	123.0	60.6	184.5	62.2
26 Aim+Tough+NIS	0.01, 0.35, 0.25%	Post	181.5	47.8	149.3	55.3
27 Aim+Roundup+NIS	0.01, 1.0, 0.25%	Post	230.8	42.9	405.8	40.3
28 Bicep II Magnum	2.2	Pre	0.0	100.0	0.4	99.9
29 Bicep II Magnum : Northstar	2.2 : 0.137	Pre:Post	0.0	100.0	0.0	100.0
30 Bicep II Magnum : Beacon	2.2 : 0.036	Pre:Post	0.0	100.0	0.0	100.0
31 Bicep II Magnum : Spirit	2.2 : 0.036	Pre:Post	0.0	100.0	0.0	100.0

continued

Table 8. Pigweed height (in) multiplied by the number of pigweed in 3.3 feet of row and percent reduction, Roundup Ready corn study, Garden City, KS, 1999, continued.

			6/14/99		7/9/99	
Treatment	Rate (lbs ai/a)	Appl. Stage	Ht x no.	%Red.	Ht x no.	%Red.
32 Bicep II Magnum : Exceed	2.2 : 0.036	Pre:Post	0.0	100.0	0.0	100.0
33 Dual II Magnum : Exceed	1.6 : 0.036	Pre:Post	0.0	100.0	0.0	100.0
34 Dual II Magnum : Spirit	1.6 : 0.036	Pre:Post	0.0	100.0	0.0	100.0
35 Dual II Magnum : Northstar	1.6 : 0.137	Pre:Post	0.0	100.0	0.0	100.0
36 Marksman+28%UAN	1.4 , 2.5%	EPost	0.0	100.0	0.0	100.0
37 Clarity+28%UAN	0.5, 2.5%	EPost	0.0	100.0	2.8	98.5
38 Distinct+NIS+28%UAN	0.26, 0.25%, 1.25%	Post	38.3	82.9	24.5	82.8
39 Buctril/Atrazine	0.75	Post	15.0	96.0	113.5	72.6
40 Spirit+NIS+28%UAN	0.036, 0.25%, 2.5%	Post	180.5	41.1	431.8	14.9
41 Northstar+NIS+28%UAN	0.148, 0.25%, 2.5%	Post	17.5	91.7	17.0	95.4
42 Hornet+NIS+28%UAN	0.128, 0.25%, 2.5%	Post	122.8	65.8	255.0	22.7
43 Laddock+28%UAN	1.25, 2.5%	Post	33.0	85.5	89.1	72.3
44 Basis Gold+COC+28%UAN	0.782, 1.0%, 2.5%	Post	159.8	35.6	489.0	26.5
45 Distinct+NIS+28%UAN	0.175, 0.25%, 1.25%	LPost	326.8	37.3	17.5	92.0
46 Hornet+NIS+28%UAN	0.128, 0.25%, 2.5%	LPost	193.5	56.7	239.0	56.0
47 Spirit+NIS+28%UAN	0.036, 0.25%, 2.5%	LPost	261.3	46.2	419.8	19.7
48 Northstar+NIS+28%UAN	0.148, 0.25%, 2.5%	LPost	267.5	25.5	116.3	55.6
40 Roundup Ultra	0.75	LPost	98.8	63.6	2.0	99.4
50 Check	—	—	83.3	0.0	214.0	0.0
LSD (0.05) =			138.0	27.9	186.7	23.9

Table 9. Yellow foxtail height (in) multiplied by the number of yellow foxtail in 3.3 feet of row and percent reduction, Roundup Ready corn study, Garden City, KS, 1999.

			6/14/99		7/9/99	
Treatment	Rate (lbs ai/a)	Appl. Stage	Ht x no.	%Red.	Ht x no.	%Red.
1 Roundup Ultra	0.75	LPost1	105.8	44.9	1.5	99.5
2 Guardsman : Basis Gold+Clarity+COC+28%UAN	1.25 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	0.0	100.0	1.9	99.4
3 Guardsman : Accent Gold+Clarity+COC+28%UAN	1.25 : 0.152, 0.125, 1.0% 4.0%	Pre:Post	0.2	99.9	0.0	100.0
4 Basis+Atrazine	0.023, 1.0	Pre	2.5	99.0	11.8	96.4
5 Basis : Basis Gold+Clarity+COC+28%UAN	0.015 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	20.1	90.2	82.2	74.3
6 Balance : Basis Gold+Clarity+COC+28%UAN	0.05 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	0.1	99.9	4.6	98.6
7 Axiom : Basis Gold+Clarity+COC+28%UAN	0.425 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	1.9	98.7	22.5	92.6
8 Basis Gold+Distinct+COC+28%UAN	0.79, 0.175, 1.0%, 4.0%	Post	108.8	47.6	208.0	34.4
9 Harness Xtra : Roundup Ultra+AMS	1.73 : 0.75, 2.0%	Pre:Post	0.2	99.9	0.0	100.0
10 Roundup Ultra+AMS : Roundup Ultra+AMS	0.75, 2.0% : 0.75, 2.0%	Post:LPost	13.0	93.2	0.0	100.0
11 Roundup Ultra+AMS	0.75, 2.0%	Post	16.5	91.9	39.7	86.7
12 Bullet : Roundup Ultra+AMS	2.25 : 0.75, 2.0%	Pre:Post	0.0	100.0	0.4	99.9
13 Harness Xtra+Roundup Ultra+AMS	1.73, 0.75, 2.0%	Post	55.8	70.2	149.5	57.7
14 Bullet+Roundup Ultra+AMS	2.25, 0.75, 2.0%	Post	33.2	86.9	21.6	94.3
15 Atrazine+Roundup Ultra+AMS	1.0, 0.75, 2.0%	Post	115.3	42.6	56.4	83.7
16 Dual II Magnum : Marksman	1.60 : 1.4	Pre:Post	7.0	96.3	6.3	97.7
17 Harness Xtra : Roundup Ultra+AMS	1.73 : 0.75, 2.0%	Pre:Post	0.0	100.0	0.3	99.9
18 Bicep II Magnum : Exceed+Clarity+NIS	2.2 : 0.028, 0.2, 0.25%	Pre:Post	0.0	100.0	1.3	99.6
19 Frontier : Distinct+NIS	1.17 : 0.263, 0.25%	Pre:Post	0.4	99.8	0.5	99.8
20 Guardsman : Basis Gold+NIS+28%UAN	2.5 : 0.783, 0.25%, 5.0%	Pre:Post	0.0	100.0	0.0	100.0
21 Balance+Atrazine	0.07, 1.5	Pre	0.0	100.0	3.5	98.7
22 Axiom	0.68	Pre	0.6	99.6	15.3	95.8
23 Aim+Atrazine+NIS	0.01, 0.75, 0.25%	Post	146.5	31.9	246.8	28.0
24 Aim+Atrazine+Banvel+NIS	0.01, 0.5, 0.25, 0.25%	Post	169.0	19.4	378.3	3.3
25 Aim+Tough	0.01, 0.35	Post	178.8	18.2	268.5	25.1
26 Aim+Tough+NIS	0.01, 0.35, 0.25%	Post	189.8	28.7	220.8	31.5
27 Aim+Roundup+NIS	0.01, 1.0, 0.25%	Post	142.8	30.9	450.8	3.3
28 Bicep II Magnum	2.2	Pre	5.9	97.1	0.6	99.8
29 Bicep II Magnum : Northstar	2.2 : 0.137	Pre:Post	0.0	100.0	0.0	100.0
30 Bicep II Magnum : Beacon	2.2 : 0.036	Pre:Post	0.6	99.8	0.4	99.9
31 Bicep II Magnum : Spirit	2.2 : 0.036	Pre:Post	0.3	99.8	0.0	100.0
32 Bicep II Magnum : Exceed	2.2 : 0.036	Pre:Post	0.4	99.9	4.3	99.0

continued

Table 9. Yellow foxtail height (in) multiplied by the number of yellow foxtail in 3.3 feet of row and percent reduction, Roundup Ready corn study, Garden City, KS, 1999, continued.

			6/14/99		7/9/99	
Treatment	Rate (lbs ai/a)	Appl. Stage	Ht x no.	%Red.	Ht x no.	%Red.
33 Dual II Magnum : Exceed	1.6 : 0.036	Pre:Post	0.0	100.0	0.4	99.9
34 Dual II Magnum : Spirit	1.6 : 0.036	Pre:Post	0.6	99.7	0.3	99.9
35 Dual II Magnum : Northstar	1.6 : 0.137	Pre:Post	0.0	100.0	0.0	100.0
36 Marksman+28%UAN	1.4 , 2.5%	EPost	159.3	31.9	124.0	60.8
37 Clarity+28%UAN	0.5, 2.5%	EPost	141.3	26.0	274.5	24.5
38 Distinct+NIS+28%UAN	0.26, 0.25%, 1.25%	Post	107.5	43.9	296.5	21.0
39 Buctril/Atrazine	0.75	Post	155.0	18.2	438.8	8.3
40 Spirit+NIS+28%UAN	0.036, 0.25%, 2.5%	Post	116.0	39.5	184.5	47.9
41 Northstar+NIS+28%UAN	0.148, 0.25%, 2.5%	Post	120.3	41.2	194.0	40.0
42 Hornet+NIS+28%UAN	0.128, 0.25%, 2.5%	Post	113.3	45.7	262.0	19.3
43 Laddock+28%UAN	1.25, 2.5%	Post	131.0	35.5	178.0	39.8
44 Basis Gold+COC+28%UAN	0.782, 1.0%, 2.5%	Post	23.0	90.0	310.5	17.4
45 Distinct+NIS+28%UAN	0.175, 0.25%, 1.25%	LPost	156.8	25.2	254.8	30.3
46 Hornet+NIS+28%UAN	0.128, 0.25%, 2.5%	LPost	150.5	30.9	201.5	33.9
47 Spirit+NIS+28%UAN	0.036, 0.25%, 2.5%	LPost	133.5	29.9	86.5	71.6
48 Northstar+NIS+28%UAN	0.148, 0.25%, 2.5%	LPost	126.0	40.1	125.5	57.2
49 Roundup Ultra	0.75	LPost	120.0	36.4	3.0	98.9
50 Check	—	—	155.8	0.0	221.6	0.0
LSD (0.05) =			69.6	28.7	120.7	26.5

Table 10. Crabgrass height (in) multiplied by the number of crabgrass in 3.3 feet of row and percent reduction, Roundup Ready corn study, Garden City, KS, 1999.

Treatment	Rate (lbs ai/a)	Appl. Stage	6/14/99 Ht x no.	6/14/99 %Red.	7/9/99 Ht x no.	7/9/99 %Red.
1 Roundup Ultra	0.75	LPost	13.3	47.5	3.3	97.7
2 Guardsman : Basis Gold+Clarity+COC+28%UAN	1.25 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	0.0	100.0	6.0	95.9
3 Guardsman : Accent Gold+Clarity+COC+28%UAN	1.25 : 0.152, 0.125, 1.0% 4.0%	Pre:Post	0.0	100.0	12.4	89.1
4 Basis+Atrazine	0.023, 1.0	Pre	0.2	99.0	59.5	71.1
5 Basis : Basis Gold+Clarity+COC+28%UAN	0.015 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	0.0	100.0	0.5	99.6
6 Balance : Basis Gold+Clarity+COC+28%UAN	0.05 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	0.0	100.0	4.4	98.2
7 Axiom : Basis Gold+Clarity+COC+28%UAN	0.425 : 0.79, 0.125, 1.0%, 4.0%	Pre:Post	0.0	100.0	14.5	87.7
8 Basis Gold+Distinct+COC+28%UAN	0.79, 0.175, 1.0%, 4.0%	Post	8.8	64.2	82.5	57.2
9 Harness Xtra : Roundup Ultra+AMS	1.73 : 0.75, 2.0%	Pre:Post	0.0	100.0	6.9	93.6
10 Roundup Ultra+AMS : Roundup Ultra+AMS	0.75, 2.0% : 0.75, 2.0%	Post:LPost	1.0	97.0	35.5	69.9
11 Roundup Ultra+AMS	0.75, 2.0%	Post	0.0	100.0	46.2	60.5
12 Bullet : Roundup Ultra+AMS	2.25 : 0.75, 2.0%	Pre:Post	0.0	100.0	14.4	86.4
13 Harness Xtra+Roundup Ultra+AMS	1.73, 0.75, 2.0%	Post	0.0	100.0	17.4	92.5
14 Bullet+Roundup Ultra+AMS	2.25, 0.75, 2.0%	Post	2.8	86.7	20.2	80.3
15 Atrazine+Roundup Ultra+AMS	1.0, 0.75, 2.0%	Post	1.3	95.7	140.0	0.0
16 Dual II Magnum : Marksman	1.60 : 1.4	Pre:Post	0.0	100.0	0.0	100.0
17 Harness Xtra : Roundup Ultra+AMS	1.73 : 0.75, 2.0%	Pre:Post	0.0	100.0	104.4	49.0
18 Bicep II Magnum : Exceed+Clarity+NIS	2.2 : 0.028, 0.2, 0.25%	Pre:Post	0.0	100.0	11.0	92.4
19 Frontier : Distinct+NIS	1.17 : 0.263, 0.25%	Pre:Post	0.0	100.0	4.0	98.3
20 Guardsman : Basis Gold+NIS+28%UAN	2.5 : 0.783, 0.25%, 5.0%	Pre:Post	0.0	100.0	0.0	100.0
21 Balance+Atrazine	0.07, 1.5	Pre	0.0	100.0	77.1	68.7
22 Axiom	0.68	Pre	0.0	100.0	0.0	100.0
23 Aim+Atrazine+NIS	0.01, 0.75, 0.25%	Post	4.5	88.8	77.5	47.5
24 Aim+Atrazine+Banvel+NIS	0.01, 0.5, 0.25, 0.25%	Post	0.5	98.5	23.1	78.7
25 Aim+Tough	0.01, 0.35	Post	16.0	65.0	42.5	82.1
26 Aim+Tough+NIS	0.01, 0.35, 0.25%	Post	16.0	75.0	32.5	69.5
27 Aim+Roundup+NIS	0.01, 1.0, 0.25%	Post	6.3	81.2	0.0	100.0
28 Bicep II Magnum	2.2	Pre	0.0	100.0	0.0	100.0
29 Bicep II Magnum : Northstar	2.2 : 0.137	Pre:Post	0.0	100.0	0.0	100.0
30 Bicep II Magnum : Beacon	2.2 : 0.036	Pre:Post	0.0	100.0	0.0	100.0
31 Bicep II Magnum : Spirit	2.2 : 0.036	Pre:Post	0.0	100.0	0.0	100.0
32 Bicep II Magnum : Exceed	2.2 : 0.036	Pre:Post	0.0	100.0	34.0	85.7

continued

Table 10. Crabgrass height (in) multiplied by the number of crabgrass in 3.3 feet of row and percent reduction, Roundup Ready corn study, Garden City, KS, 1999, continued.

			6/14/99		7/9/99	
Treatment	Rate (lbs ai/a)	Appl. Stage	Ht x no.	%Red.	Ht x no.	%Red.
33 Dual II Magnum : Exceed	1.6 : 0.036	Pre:Post	0.0	100.0	0.0	100.0
34 Dual II Magnum : Spirit	1.6 : 0.036	Pre:Post	0.1	99.8	2.1	98.0
35 Dual II Magnum : Northstar	1.6 : 0.137	Pre:Post	0.0	100.0	3.3	98.6
36 Marksman+28%UAN	1.4 , 2.5%	EPost	7.0	75.0	44.0	63.
37 Clarity+28%UAN	0.5, 2.5%	EPost	13.8	55.3	86.5	41.6
38 Distinct+NIS+28%UAN	0.26, 0.25%, 1.25%	Post	9.5	62.3	47.5	55.4
39 Buctril/Atrazine	0.75	Post	32.5	31.3	146.8	37.2
40 Spirit+NIS+28%UAN	0.036, 0.25%, 2.5%	Post	0.0	100.0	0.0	100.0
41 Northstar+NIS+28%UAN	0.148, 0.25%, 2.5%	Post	6.5	81.4	46.5	65.0
42 Hornet+NIS+28%UAN	0.128, 0.25%, 2.5%	Post	1.5	92.5	57.0	63.0
43 Laddock+28%UAN	1.25, 2.5%	Post	5.0	75.0	45.0	75.0
44 Basis Gold+COC+28%UAN	0.782, 1.0%, 2.5%	Post	6.8	79.6	51.0	75.0
45 Distinct+NIS+28%UAN	0.175, 0.25%, 1.25%	LPost	5.8	84.4	74.3	45.3
46 Hornet+NIS+28%UAN	0.128, 0.25%, 2.5%	LPost	9.0	70.0	72.0	67.4
47 Spirit+NIS+28%UAN	0.036, 0.25%, 2.5%	LPost	12.0	66.0	118.0	29.0
48 Northstar+NIS+28%UAN	0.148, 0.25%, 2.5%	LPost	15.0	75.0	69.0	75.0
49 Roundup Ultra	0.75	LPost	19.5	38.1	12.7	91.2
50 Check	—	—	8.6	0.0	29.1	0
LSD (0.05) =			14.1	34.9	83.9	43.2

HERBICIDE RESPONSE OF ROUNDUP READY SOYBEANS

by Merle Witt

SUMMARY

In this 2-year study, we evaluated the influence of applying a residual soil herbicide treatment to dryland Roundup Ready soybeans in plots at planting time in addition to later application of Roundup versus leaving Roundup Ready soybean plots untreated until Roundup was applied. Yields harvested were equal and not affected negatively by the addition of a soil-applied herbicide to Roundup Ready soybeans.

INTRODUCTION

Although genetically modified soybeans have been rapidly accepted by crop producers, initial concern by some in the seed industry implied that Roundup Ready soybeans would be inherently susceptible to yield reduction if other herbicides in addition to Roundup were used. Thus, a two-year study was initiated at Garden City, KS in 1998 to make this comparison.

PROCEDURES

During 1998 and 1999, Roundup Ready soybeans were planted such that half of the plots received a planting-time soil application of Pursuit Plus herbicide (Prowl + Pursuit) at 2.5 pts/a. Roundup was applied at the V4 growth stage to all plots using 4 pts/a. Six replications of 250 sq ft plots (four rows x 25 ft long) were used in a randomized complete block design. A seeding rate of 40 lbs/a was used each year with planting dates of May 23 in 1998 and May 31 in 1999. The soybean variety was DSS3620.

RESULTS AND DISCUSSION

No grain yield reductions of Roundup Ready soybeans occurred in either year with the additional soil-applied herbicide treatment (Table 1). Test weight and harvest moisture also were unaffected by the addition of a residual soil-applied herbicide.

Table 1. Response of Roundup Ready soybeans to a residual herbicide, Garden City, KS.

	1998	1999	Avg.
Grain yield (bu/a)			
Pursuit Plus + Roundup	35.5	30.7	33.1
Roundup	35.2	31.4	33.3
LSD (5%)	n.s.	n.s.	n.s.
Test weight			
Pursuit Plus + Roundup	60.1	57.7	58.9
Roundup	60.0	58.2	59.1
LSD (5%)	n.s.	n.s.	n.s.
Harvest moisture			
Pursuit Plus + Roundup	11.1	9.8	10.5
Round up	11.2	9.5	10.3
LSD (5%)	n.s.	n.s.	n.s.

STARTER FERTILIZER ON CORN

by
Merle Witt

SUMMARY

The addition of 5 gal/a of row-banded 10-34-0 liquid starter fertilizer at planting time had no notable influence on corn planted at a recommended date on a leveled silt loam soil using conventional tillage. Emerged stands, vigor ratings, and seedling plant height, as well as grain moisture, test weight and grain yield were unaffected in both dryland and irrigated studies by the addition of 6 lbs N and 20 lbs P_2O_5 at planting time.

INTRODUCTION

Starter fertilizer applications have sometimes been effective in enhancing nutrient uptake even on soils high in available nutrients, particularly with early planting dates in cold weather. The objective of this study was to determine if starter fertilizer had beneficial effects on corn growth and ultimate grain yields when an optimum planting date and silt loam soil were used for both dryland and irrigated studies. Soil temperatures during the recommended corn planting period of April 15 to May 20 allow mineralization of organic matter and increased P solubility to make N and P available.

PROCEDURES

Both the dryland and irrigated sites, were on silt loams that previously had been flat leveled. The dryland area had been fallowed in the previous year, whereas the irrigated area had been in soybeans. Prior to planting, the dryland site received 90 lbs N/a and the irrigated site received 180 lbs N/a as anhydrous ammonia. Planting date for both studies was May 13, 1999, and the corn hybrid Pioneer 33A14 was used. The herbicide combination Prowl/Bladex at 1.5/3.0 lbs/a provided excellent weed control. Planting rates were 16,750 seeds/a on dryland and 33,490 seeds/a on the irrigated plots. This was attained by using seed spacings in 30-inch rows of 12.5 inches on dryland and 6.2 inches under irrigation. Plots were four rows x 35 ft long on dryland and four rows x 25 ft long under irrigation. A randomized complete block design with four replications was employed for each study.

RESULTS AND DISCUSSION

Emerged plant counts and vigor ratings on June 1 showed no starter fertilizer effect in either the dryland or irrigated trial. Plant heights recorded on June 17 also indicated no significant influence. Harvesting was completed on Oct 6; results are given in Tables 1 and 2. Differences for grain yield, test weight, or grain moisture at harvest were not significant.

Table 1. Starter fertilizer effects on dryland corn, Garden City, KS, 1999.

Treatment	Number Plants	Vigor 1-5	Height inches	Grain %H_20	Grain lb/bu	Grain bu/a
Check	63.0	2.0	24.0	15.8	57.5	102.5
10-34-0 Starter	63.3	1.8	24.0	16.2	57.1	106.4
LSD (5%)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

Table 2. Starter fertilizer effects on irrigated corn, Garden City, KS, 1999.

Treatment	Number Plants	Vigor 1-5	Height inches	Grain %H_20	Grain lb/bu	Grain bu/a
Check	90.5	2.0	26.8	18.8	56.0	202.1
10-34-0 Starter	91.8	2.0	26.8	18.9	56.1	206.6
LSD (5%)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

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W-L Research

Lance Huck - Ruminant Nutritionist. Lance received his B.S., M.S. and Ph.D. degrees from Kansas State University. He began as a Livestock Production specialist in 1998. His extension responsibilities are in the areas of growing and finishing cattle, high-moisture grain, and preservation of forage as silage.

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.

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.

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.

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.

Todd Trooien - Agricultural Engineer. Todd received his M.S. from South Dakota State University and his Ph.D. from Colorado State University. He joined the staff in 1996. Research interests include technology and management for more efficient use of water.

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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