2000

Southwest Research-Extension Center, Field Day 2000

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Southwest Research-Extension Center, Field Day 2000

Abstract
Report of agricultural research from Southwest Research-Extension Center of Kansas State University.

Keywords
2000, SRP856, crops, tillage, irrigation, insect control, weed science

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FIELD DAY

2000

REPORT OF PROGRESS
856

KANSAS STATE UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
AND COOPERATIVE EXTENSION SERVICE
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| Paul Hartman       | Area Extension Director                           | Prior to that, he served as County Extension Agricultural Agent in Stanton and Pratt counties.                                            |
| Mahbub Alam        | Extension Specialist, Irrigation and Water Manage- | 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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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°F. January was the coolest with a mean temperature of 32.9°F. 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°F on January 3. Temperatures of 100°F or above were recorded on 6 days in July and 2 days in August. The warmest temperature recorded was 102°F on July 26 and July 31.

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

The last spring freeze (32°F) 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.

| Month   | Precipitation inches | 1999 Average | Temperature (°F) | Wind MPH | Evaporation inches |
|---------|----------------------|--------------|-----------------|----------|-------------------|
|         | 1999 | Avg. | Max. | Min. | Mean 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 |
| May | 3.45 | 3.11 | 75.6 | 48.0 | 61.8 | 62.2 | 89 | 35 | 5.7 | 6.4 |
| June | 4.18 | 2.87 | 83.3 | 57.0 | 70.1 | 72.4 | 93 | 43 | 5.7 | 6.0 |
| July | 3.50 | 2.60 | 92.8 | 65.1 | 79.0 | 77.9 | 102 | 50 | 5.1 | 5.2 |
| August | 2.64 | 2.16 | 91.4 | 64.5 | 77.9 | 75.4 | 101 | 55 | 3.2 | 4.5 |
| September | 2.16 | 1.59 | 78.4 | 52.0 | 65.2 | 66.6 | 96 | 33 | 3.7 | 4.9 |
| October | 0.43 | 0.98 | 72.3 | 36.8 | 54.5 | 55.0 | 91 | 25 | 3.7 | 4.8 |
| 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 |

All averages are for the period 1961-90.

The average latest freeze in spring was April 26, 1999: April 19. The average earliest freeze in fall was Oct. 12, 1999: Oct. 4. The average frost-free period was 169 days, 1999: 168 days.
WEATHER INFORMATION FOR TRIBUNE

by

Dewayne Bond 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 precipitation 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°F), and the coldest day was January 4 (0°F). January was also the coldest month of the year with a mean temperature of 33.0°F and an average low of 16.9°F. July was the warmest month with a mean temperature of 77.4°F and an average high of 92.2°F. For half the year, the air temperature was above normal. November had the greatest departure from normal, 6.5°F above normal. Days with temperatures of 100°F or above (1) and 90°F or above (57) were below their 30-year averages. The last day with temperatures of 32°F 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.

| Month   | Precipitation inches | Temperature (°F) | Wind MPH | Evaporation inches |
|---------|----------------------|------------------|----------|--------------------|
|         | 1999 Normal | 1999 Average | Normal | 1999 Extreme | 1999 Average | 1999 Average |
| January | 0.51 | 0.36 | 49.1 | 16.9 | 43.3 | 14.2 | 72 | 0 | 6.1 | 6.6 | 6.77 | 8.82 |
| February| 0.40 | 0.40 | 59.4 | 20.6 | 48.7 | 18.7 | 77 | 9 | 5.8 | 6.0 | 9.33 | 10.95 |
| March   | 1.48 | 0.99 | 55.5 | 24.3 | 56.6 | 25.4 | 79 | 5 | 5.7 | 5.7 | 12.14 | 13.71 |
| 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 | 55.3 | 94 | 40 | 5.7 | 5.7 | 12.14 | 13.71 |
| 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 | 15.08 | 15.64 |
| November| 0.09 | 0.49 | 66.1 | 26.9 | 54.7 | 25.3 | 83 | 8 | 15.08 | 15.64 |
| December| 0.14 | 0.33 | 52.2 | 18.5 | 44.9 | 16.6 | 70 | 6 | 15.08 | 15.64 |
| Annual  | 21.38 | 15.96 | 69.3 | 36.6 | 67.7 | 37.0 | 102 | 0 | 5.3 | 5.7 | 61.80 | 71.67 |

1Latest 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.

1Department 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

| Hybrid       | Population  | Number of Irrigations^2 | Number of Irrigations |
|--------------|-------------|-------------------------|------------------------|
|              | plants/a    | 0 | 1 | 2 | plants/a | 0 | 1 | 2 |
| 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 |

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

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

^3Numbers in parentheses indicate days to maturity.

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
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.

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

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

| LSD (0.10) Date at same hybrid and population | 1998 | 1999 |
|---------------------------------------------|------|------|
| 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 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.

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%, but was too late to improve yields of the early planting. Except for the first planting date in 1997, higher populations generally improved yields.

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.

| Hybrid | Population | 1996 |     | 1997 |     | 1998 |     | 1999 |     | 1997-1999 |     |
|--------|------------|------|-----|------|-----|------|-----|------|-----|-----------|-----|
|        |            | Avg  |   4/16 | 5/8 Yield | Avg  |   4/17 | 5/6 Yield | Avg  |   4/15 | 5/12 Yield | Avg  |   4/21 | 5/6 Yield | Avg  |   4/18 | 5/8 Yield |
| 3984 (75) | 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 | 50 | 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 | 73 | 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.

| Hybrid | Population | 1996 Avg |  | 1997 Avg |  | 1998 Avg |  | 1999 Avg |  | 1997-1999 Avg |  |
|--------|------------|----------|---|----------|---|----------|---|----------|---|-------------|---|
|        |            | 4/16 5/8 |   | 4/17 5/6 |   | 4/15 5/12 |   | 4/21 5/6 |   | 4/18 5/8 |   |
|        |            | Yield    |   | Yield    |   | Yield    |   | Yield    |   | Yield      |   |
| 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

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 —
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.

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 |
|------------------------------|------|------|------|------|------|---------|
| 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**<sub>0.05</sub>      | 4    | 7    | 9    | 5    | 5    | 4       |

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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 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 during 1999 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% H2O | Injury 6-15-99 | Injury 8-11-99 |
|-----------------|--------|------------------|----------------|---------------|
|                 | lb ai/a| EPP 1 | PRE 1 | Mean | EPP 1 | PRE 1 | Mean | EPP 1 | PRE 1 | Mean |
| Untreated       |        | 1391 | 1592 | 1491 | 23   | 23   | 23   | 13   | 1    | 7    |
| Spartan         | 0.125  | 1247 | 1405 | 1326 | 14   | 28   | 21   | 6    | 5    | 5    |
| Spartan         | 0.15   | 1100 | 1054 | 1078 | 33   | 43   | 38   | 13   | 13   | 13   |
| Spartan         | 0.188  | 1115 | 1030 | 1072 | 33   | 40   | 38   | 9    | 12   | 10   |
| Spartan         | 0.2    | 1050 | 1106 | 1078 | 35   | 40   | 38   | 10   | 22   | 16   |
| 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    |

LSD (0.05)

|               | Timing | Herbicide | Timing x Herbicide |
|---------------|--------|-----------|--------------------|
|               | NS     | 436       | 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 | Seed Moisture | Stand |
|-----------------|------|-------------|---------------|-------|
|                 |      | EPP<sup>1</sup> | PRE<sup>1</sup> | Mean  | EPP<sup>1</sup> | PRE<sup>1</sup> | Mean  | EPP<sup>1</sup> | PRE<sup>1</sup> | 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           | 15.9           | 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    | NS              | NS              | NS    | NS             | NS             | NS   |

<sup>1</sup> 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 Control | Russian Thistle Control |
|-----------------|------|----------------|-------------------------|
|                 |      | 6-15-99 EPP<sup>1</sup> | 8-11-99 EPP<sup>1</sup> | 6-15-99 EPP<sup>1</sup> | 8-11-99 EPP<sup>1</sup> |
|                 |      | PRE<sup>1</sup> Mean | PRE<sup>1</sup> Mean | PRE<sup>1</sup> Mean | PRE<sup>1</sup> Mean |
|                 |      | %              | %              | %              | %              |
| Spartan         | 0.125| 100            | 98             | 98             | 100            | 100           | 100          | 100           | 100 |
| Spartan         | 0.15 | 100            | 99             | 98             | 100            | 100           | 100          | 100           | 100 |
| Spartan         | 0.188| 100            | 99             | 99             | 100            | 100           | 100          | 100           | 100 |
| Spartan         | 0.2  | 100            | 100            | 100            | 100            | 100           | 100          | 100           | 100 |
| Spartan         | 0.25 | 98             | 97             | 97             | 100            | 100           | 100          | 100           | 100 |
| Spartan + Prowl | 0.125+1.0 | 100            | 98             | 98             | 100            | 100           | 100          | 100           | 100 |
| Spartan + Prowl | 0.15+1.0 | 96             | 97             | 97             | 100            | 100           | 100          | 100           | 100 |
| Spartan + Prowl | 0.188+1.0 | 100            | 100            | 100            | 100            | 100           | 100          | 100           | 100 |
| Spartan + Prowl | 0.2+1.0  | 96             | 100            | 98             | 100            | 100           | 100          | 100           | 100 |
| Prowl           | 1.0  | 96             | 65             | 61             | 50             | 85            | 67           | 39            | 52            | 45           |
| Prowl           | 1.5  | 61             | 70             | 66             | 57             | 89            | 73           | 42            | 52            | 48           |
| Mean            |      | 92             | 93             | 90             | 97             | 87            | 90           | 86            | 92            |
| LSD (0.05)      | Timing | NS           | NS            | NS            | NS            | NS            | NS          | NS            | NS            | NS    |

<sup>1</sup> application timing, EPP = early preplant, PRE = postplant preemergence
Table 4. Control of pigweeds and puncturevine in no-till sunflower, Tribune, KS, 1999.

| Treatment            | Rate  | Pigweed Control |                | Puncturevine Control |                |
|----------------------|-------|-----------------|-----------------|----------------------|-----------------|
|                      |       | 6-15-99 | EPP | PRE | Mean | 8-11-99 | EPP | PRE | Mean | 6-15-99 | EPP | PRE | Mean | 8-11-99 | EPP | PRE | 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 | 98 | 97 | 97 | 88 | 84 | 86 |
| Spartan              | 0.2    | 100  | 100 | 100 | 100 | 100 | 100 | 100 | 98 | 97 | 97 | 88 | 84 | 86 |
| Spartan              | 0.25   | 97   | 98 | 97 | 100 | 100 | 100 | 100 | 98 | 97 | 97 | 88 | 84 | 86 |
| Spartan + Prowl      | 0.125+1.0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 75 | 75 | 75 | 75 | 75 | 75 |
| Spartan + Prowl      | 0.15+1.0 | 98   | 97 | 97 | 100 | 100 | 100 | 100 | 96 | 96 | 96 | 96 | 96 | 96 |
| Spartan + Prowl      | 0.188+1.0 | 99  | 100 | 100 | 100 | 100 | 100 | 100 | 99 | 98 | 98 | 98 | 98 | 98 |
| Spartan + Prowl      | 0.2+1.0 | 98   | 99 | 98 | 100 | 100 | 100 | 100 | 100 | 100 | 99 | 99 | 99 | 99 |
| Prowl                | 1.0    | 71   | 81 | 76 | 74 | 85 | 79 | 13 | 46 | 29 | 44 | 46 | 44 | 46 |
| Prowl                | 1.5    | 77   | 92 | 85 | 84 | 93 | 88 | 62 | 84 | 73 | 73 | 73 | 73 | 73 |
|                      | Mean   | 95   | 97 | 96 | 98 | 98 | 98 | 95 | 97 | 96 | 97 | 97 | 97 | 96 | 97 | 95 | 97 | 95 |
| LSD (0.05)           | Timing | NS   | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

1 application timing  
EPP = early preplant  
PRE = postplant preemergence

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

| Treatment            | Rate  | Large Crabgrass Control |                |                |
|----------------------|-------|--------------------------|-----------------|-----------------|
|                      |       | 6-15-99 | EPP | PRE | Mean | 8-11-99 | EPP | PRE | 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 | 98 | 100 | 100 |
| Spartan + Prowl      | 0.188+1.0 | 99  | 100 | 100 | 100 | 100 | 100 |
| Spartan + Prowl      | 0.2+1.0 | 99   | 99 | 99 | 99 | 100 | 100 |
| Prowl                | 1.0    | 77   | 93 | 85 | 77 | 100 | 97 |
| Prowl                | 1.5    | 92   | 96 | 94 | 92 | 100 | 99 |
|                      | Mean   | 97   | 99 | 98 | 97 | 98 |
| LSD (0.05)           | Timing | NS   | NS | NS | NS | NS | NS |
|                      | Herbicide | 7 | 7 | 7 | 7 | 7 | 7 |
|                      | Timing x Herbicide | NS | NS | NS | NS | NS | NS |

1 application timing  
EPP = early preplant  
PRE = postplant preemergence
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.
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 Palmer 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                  | Rate       | Timing² | Yield @ 10% H₂O | Test Plant Weight | Stand 6-15 | 8-11 | Injury 6-15 | Injury 8-11 |
|----------------------------|------------|---------|-----------------|------------------|------------|------|------------|------------|
| Untreated                  | —          | —       | 1208            | 6.3              | 26.2       | 14.8 | —          | —          |
| Dual II Magnum             | 1.27 lb/a  | EPP     | 1727            | 6.9              | 25.5       | 12.6 | 5          | 4          |
| Dual II Magnum             | 1.59 lb/a  | EPP     | 1310            | 6.8              | 26.0       | 11.3 | 1          | 0          |
| DIIM + Spartan             | 1.27+0.125 lb/a | EPP     | 1610            | 5.7              | 26.0       | 12.4 | 19         | 3          |
| Spartan                    | 0.125 lb/a | EPP     | 1311            | 5.4              | 25.4       | 14.0 | 3          | 0          |
| Valor                      | 0.078 lb/a | EPP     | 1334            | 8.5              | 24.9       | 5.2  | 59         | 54         |
| Valor + Select + COC + AMS | 0.078 + 0.109 lb/a | EPP + POST | 1117          | 8.9              | 23.8       | 3.9  | 69         | 72         |
| Prowl                      | 1.5 lb/a   | EPP     | 1448            | 7.4              | 26.2       | 12.8 | 0          | 0          |
| Dual II Magnum             | 1.27 lb/a  | PRE     | 1862            | 6.3              | 26.6       | 14.6 | 3          | 0          |
| Dual II Magnum             | 1.59 lb/a  | PRE     | 1820            | 7.8              | 26.3       | 12.4 | 8          | 0          |
| DIIM + Spartan             | 1.27 + 0.125 lb/a | PRE     | 1579            | 7.8              | 24.4       | 13.3 | 26         | 1          |
| Spartan                    | 0.125 lb/a | PRE     | 1832            | 6.6              | 25.6       | 12.9 | 24         | 0          |
| Valor                      | 0.078 lb/a | PRE     | 1225            | 9.4              | 26.0       | 12.0 | 7          | 0          |
| Valor + Select + COC + AMS | 0.078 + 0.109 lb/a | PRE + POST | 2068          | 6.9              | 26.4       | 12.1 | 10         | 0          |
| Prowl                      | 1.5 lb/a   | PRE     | 1419            | 8.1              | 25.3       | 11.5 | 7          | 0          |
| Select + COC + AMS         | 0.109 +2 pt + 2.5 lb/a | POST | 1514 | 6.5 | 25.2 | 12.7 | — | 0 |
| Prowl + COC + AMS          | 0.188 + 2 pt + 2.5 lb/a | POST | 1476 | 9.3 | 26.2 | 12.1 | — | 0 |
| Untreated                  | —          | —       | 912             | 5.0              | 24.7       | 11.6 | —          | —          |
| LSD (0.05)                 | —          | —       | 4.2             | NS               | 3.5        | 17   | 8          |            |

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

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

| Treatment           | Rate | Timing | Pigweed Species<sup>3</sup> | Kochia | Puncture | Large Crabgrass |
|---------------------|------|--------|-----------------------------|--------|----------|-----------------|
|                     |      |        | 6-15 | 8-11 | 6-15 | 8-11 | 6-15 | 8-11 |
| 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 +    | 0.078 + 0.109 | EPP + | 100  | 79  | 96   | 42   | 96   | 96  |
| COC + AMS           | 2 pt + 2.5 lb | POST | 94   | 97  | 99   | 86   | 95   | 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 | 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 +    | 0.078 + 0.109 | PRE + | 94   | 97  | 99   | 86   | 95   | 96  |
| COC + AMS           | 2 pt + 2.5 lb | POST | 95   | 88  | 96   | 69   | 97   | 98  |
| Prowl               | 1.5  | PRE    | 95   | 98  | 88   | 69   | 97   | 98  |
| Select + COC + AMS  | 0.109 +2 pt + 2.5 lb | POST | 94   | 97  | 99   | 86   | 95   | 96  |
| Poast + COC + AMS   | 0.188 + 2 pt + 2.5 lb | POST | 94   | 97  | 99   | 86   | 95   | 96  |
| LSD (0.05)          |      |        | 19   | 12  | 6    | 36   | 21   | 17  |

<sup>1</sup> DIIM = Dual II Magnum  
<sup>2</sup> COC = crop oil concentrate  
<sup>3</sup> AMS = ammonium sulfate 
<sup>3</sup> EPP = early preplant  
<sup>4</sup> PRE = postplant preemergence  
<sup>5</sup> POST = postemergence 
<sup>6</sup> 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 @ Plant<sup>1</sup> | Sunflower Injury | Palmer Amaranth | Large Crabgrass |
|---------------------|------|--------------------------|------------------|----------------|-----------------|
|                     |      | 10% H₂O Stand 7-29 9-2   | 7-29 9-2         | 7-29 9-2       | 7-29 9-2        |
| 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 |

<sup>1</sup> Counts taken at harvest
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/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.

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
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.

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

by
Larry Buschman, Phil Sloderbeck, Randy Higgins, 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 borers 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.
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. 3. Corn borer tunneling, in Bt and non-Bt corn.

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

Fig. 5. 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.

| 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 c               | 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 cde              | 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

|                | ECB       | SWCB      | Number of Tunnels | Cm of Tunneling below Ear | Cm of Tunneling per Plant |
|----------------|-----------|-----------|-------------------|---------------------------|----------------------------|
|                | 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.

| Hybrid       | Bt Event | Company         | 2nd Gen. Corn Borer | Earworm | Yield |
|--------------|----------|-----------------|---------------------|---------|-------|
|              |          |                 | Relative Maturity   | 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

|          |          |          |          |          |          |          |          |          |          |          |
|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| F-test Prob. | <0.0001 | 0.0001  | 0.0834   | <0.0001 | 0.0004  | 0.0001 |
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           | 8021 BT – MON810  | 7997                  |
| Pioneer           | 31A14 – MON810    | 3162                  |

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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.

| Hybrid | Standing Yield (Bu/A) | Total Yield (Bu/A) |
|--------|-----------------------|--------------------|
|        | 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 production strategies showing yield differences and resulting dollar differences on a per acre basis.

| Advantage of Strategy Listed Below | Standing Yield (Bu/A) and Cost | Total 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)    |

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 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.

| Production System          | Total Returns | Increase in Returns<sup>a</sup> | % Increase<sup>b</sup> | % Decrease<sup>c</sup> |
|----------------------------|---------------|---------------------------------|------------------------|------------------------|
| 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<sup>a</sup> | % Increase<sup>b</sup> | % Decrease<sup>c</sup> |
|----------------------------|---------------|---------------------------------|------------------------|------------------------|
| 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%                  | —                      |

<sup>a</sup> These production systems included 20% or 40% refuge-planting of non-Bt corn or none. (The EPA currently requires a 20% refuge-planting).

<sup>b</sup> Relative to 100% unsprayed non-Bt corn.

<sup>c</sup> 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.
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 LC₆₀ 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 miticides 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
was assessed after 24 hours. Mites were scored “dead” if they failed to make active movement. The LC50 values and 95% confidence limits (CL) were estimated using probit analysis. LC50 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 LC60 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 LC60 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 LC50 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 LC50 followed by Capture. For TSM, Capture and dimethoate had similar LC50 values. Warrior had the highest LC50 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 enzymatic activities.
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
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.

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 organophosphate 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 shattercane. 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 |
| Depth, unit:              | Shattercane at 5 lbs/a = approx. 119,400 seeds/a |
| 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: | H₂O | H₂O | H₂O |
| Propellant: | Hydraulic pump | CO₂ | CO₂ |
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 adjusted 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.

| Treatment | Rate(lbs ai/a) | Appl. Stage | 6/28/99 | 7/26/99 |
|-----------|----------------|-------------|---------|---------|
| 1 Banvel + Poast + Atrazine + NIS | 0.5, 0.56, 0.25, 0.5% | Post | 0.0 | 100.0 |
| 2 FullTime | 3.0 | Pre | 49.5 | 75.0 |
| 3 ZA1296/ICIA5676 | 2.2 | Pre | 0.0 | 100.0 |
| 4 ZA1296/ICIA5676 + Atrazine | 2.2, 0.5 | Pre | 0.0 | 100.0 |
| 5 FullTime : ZA1296 | 3.0 : 0.094 | Pre:Post | 0.0 | 100.0 |
| 6 TopNotch : ZA1296 | 1.92, 0.094 | Pre:Post | 12.0 | 91.1 |
| 7 Balance + Atrazine | 0.025, 1.5 | Pre | 0.0 | 100.0 |
| 8 Balance + Atrazine | 0.031, 1.5 | Pre | 0.0 | 100.0 |
| 9 Balance + Atrazine | 0.038, 1.5 | Pre | 0.0 | 100.0 |
| 10 Balance + Atrazine | 0.052, 1.5 | Pre | 0.0 | 100.0 |
| 11 Balance + Atrazine | 0.061, 1.5 | Pre | 0.0 | 100.0 |
| 12 Balance + Atrazine | 0.07, 1.5 | Pre | 0.0 | 100.0 |
| 13 Balance | 0.07 | Pre | 0.0 | 100.0 |
| 14 Balance + Bicep II | 0.047, 1.5 | Pre | 2.0 | 92.0 |
| 15 Dual II | 1.22 | Pre | 152.3 | 13.7 |
| 16 Balance + Surpass | 0.07, 1.6 | Pre | 0.0 | 100.0 |
| 17 Balance + Harness Xtra | 0.07, 1.96 | Pre | 0.0 | 100.0 |
| 18 Balance + Axiom | 0.047, 0.425 | Pre | 11.5 | 75.0 |
| 19 EPIC | 0.399 | Pre | 13.8 | 83.4 |
| 20 Axiom : Spirit | 0.64 : 0.04 | Pre:Post | 6.0 | 95.6 |
| 21 Axiom : Basis Gold + Banvel | 0.34 : 0.79, 0.125 | Pre:Post | 29.5 | 53.0 |
| 22 Axiom + Atrazine | 0.64, 1.5 | Pre | 0.0 | 100.0 |
| 23 EPIC + Atrazine | 0.145, 1.5 | Pre | 4.0 | 84.0 |
| 24 EPIC + Atrazine | 0.18, 1.5 | Pre | 1.8 | 93.0 |
| 25 EPIC + Atrazine | 0.22, 1.5 | Pre | 0.0 | 100.0 |
| 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 | 0.0 | 100.0 |
| 29 Buctril/Atrazine + Banvel + Poast + NIS | 0.75, 0.25, 0.56, 0.5% | Post | 0.0 | 100.0 |
| 30 Check | — | — | 56.1 | 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 | 7/26/99 |
|-----------|----------------|-------------|---------|---------|
|           |                |             | Ht x no. | %Red.  | Ht x no. | %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 | 7/26/99 |
|-----------|----------------|-------------|---------|---------|
|           |                |             | Ht x no. | %Red.   | Ht x no. | %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 | %Red. |
|-----------|-----------------|-------------|---------|-------|
| 1 Banvel + Poast + Atrazine + NIS | 0.5, 0.56, 0.25, 0.5% | Post | 56.3 | 0.0 |
| 2 FulTime | 3.0 | Pre | 0.06 | 98.9 |
| 3 ZA1296/ICIA5676 | 2.2 | Pre | 0.00 | 100.0 |
| 4 ZA1296/ICIA5676 + Atrazine | 2.2, 0.5 | Pre | 0.00 | 100.0 |
| 5 FulTime : ZA1296 | 3.0 : 0.094 | Pre:Post | 0.00 | 100.0 |
| 6 TopNotch : ZA1296 | 1.92, 0.094 | Pre:Post | 0.00 | 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 | 0.00 | 100.0 |
| 16 Balance + Surpass | 0.07, 1.6 | Pre | 0.00 | 100.0 |
| 17 Balance + Harness Xtra | 0.07, 1.96 | Pre | 10.8 | 86.1 |
| 18 Balance + Axiom | 0.047, 0.425 | Pre | 0.00 | 100.0 |
| 19 EPIC | 0.399 | Pre | 0.00 | 100.0 |
| 20 Axiom : Spirit | 0.64 : 0.04 | Pre:Post | 0.00 | 100.0 |
| 21 Axiom : Basis Gold + Banvel | 0.34 : 0.79, 0.125 | Pre:Post | 2.50 | 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 | — | — | 0.00 | 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 in Table 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: | 72 F | 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 | Pre treatments | Post treatments |
| 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: | H₂O | H₂O | H₂O |
| Propellant: | Hydraulic pump | CO₂ | CO₂ |

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, | Pre:Post | 110.5T |
| 10 Balance + Atrazine : Liberty + Atrazine + AMS + Herbimax COC | 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, 3.0 | Pre:Post | 110.5T |
| 14 Balance : LibertyATZ + AMS + Herbimax COC | 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 | Ht x no. | %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 + AMS + Herbimax COC    | 0.02, 1.0 : 0.37, 0.5, 3.0                       | 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  | 6/28/99  | 7/27/99  |
|------------------------------------------------|--------------------------------------|-------------|----------|----------|----------|
|                                                 | Ht x % Ht                          |             | Ht x % Ht | Ht x % Ht | Ht x % Ht |
| 1 Lightning + Clarity + NIS + 28%UAN            | 0.056, 0.19, 0.25%, 2.5%            | Post        | 31.3     | 46.8     | 9.4      |
| 2 Lightning + Clarity + COC + 28%UAN           | 0.056, 0.19, 1.0%, 2.5%             | Post        | 45.0     | 50.0     | 3.6      |
| 3 Lightning + Tough + COC + 28%UAN             | 0.056, 0.47, 1.0%, 2.5%             | Post        | 28.5     | 78.8     | 94.9     |
| 4 Prowl : Pursuit + Clarity + NIS + 28%UAN     | 0.99 : 0.063, 0.19, 0.25%, 2.5%     | Pre:Post    | 28.0     | 75.0     | 41.5     |
| 5 Prowl + Balance                              | 0.99, 0.047                         | Pre         | 0.3      | 99.3     | 2.0      |
| 6 Harness + Balance                            | 0.875, 0.047                        | Pre         | 11.8     | 75.0     | 88.1     |
| 7 Balance : Liberty                            | 0.047 : 0.37                        | Pre:Post    | 0.8      | 96.3     | 44.2     |
| 8 Balance : Liberty                            | 0.07 : 0.26                         | Pre:Post    | 1.0      | 98.1     | 15.6     |
| 9 Balance + Atrazine : Liberty + Atrazine + AMS| 0.02, 1.0 : 0.37, 0.5, 3.0         | Pre:Post    | 0.0      | 100.0    | 0.8      |
| 10 Balance + Atrazine : Liberty + Atrazine +  | 0.02, 1.0 : 0.37, 0.5,              |             |          |          |          |
| AMS + Herbimax COC                              | 3.0, 1.25%                         |             |          |          |          |
| 11 Atrazine : Liberty + AMS                    | 1.5 : 0.44, 3.0                     | Pre:Post    | 9.8      | 63.8     | 219.4    |
| 12 Balance : LibertyATZ + AMS                  | 0.05 : 1.36, 3.0                    | Pre:Post    | 2.0      | 91.6     | 30.0     |
| 13 Balance : LibertyATZ + Liberty + AMS        | 0.05 : 1.36, 0.13, 3.0              | Pre:Post    | 0.0      | 100.0    | 0.5      |
| 14 Balance : LibertyATZ + AMS + Herbimax COC   | 0.05 : 1.36, 3.0, 1.25%             | Pre:Post    | 0.2      | 99.4     | 5.4      |
| 15 Check                                       | —                                   | —           | 53.0     | 0.0      | 96.5     |
| LSD (0.05) =                                   |                                     |             | 48.6     | 38.9     | 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 |
|-------------------------------------------------------------|-----------------|---------|
|                                                             | Stage           | Ht x %  |
| 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 | 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.

| Parameter           | Details                                                                                                                                 |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| 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 ½ 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.

| Parameter          | Details                                                                                     |
|--------------------|---------------------------------------------------------------------------------------------|
| 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 | Post | Late Post |
| 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: | H₂O | H₂O | H₂O | H₂O |
| Propellant: | CO₂ | CO₂ | CO₂ | CO₂ |
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:LPPost | 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       | 753        |
| 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       | 723        |
| 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       | 746        |
| 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
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. %Red. | 7/9/99 Ht x no. %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:LPPost | 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.

| Treatment | Rate (lbs ai/a) | Appl. Stage | 6/14/99 | 7/9/99 |
|-----------|----------------|-------------|---------|--------|
| 33 Dual II Magnum : Exceed | 1.6 : 0.036 | Pre:Post | 9.7 | 194.8 |
| 34 Dual II Magnum : Spirit | 1.6 : 0.036 | Pre:Post | 13.2 | 298.5 |
| 35 Dual II Magnum : Northstar | 1.6 : 0.137 | Pre:Post | 20.8 | 377.3 |
| 36 Marksman+28%UAN | 1.4 , 2.5% | EPost | 0.0 | 0.0 |
| 37 Clarity+28%UAN | 0.5, 2.5% | EPost | 0.0 | 100.0 |
| 38 Distinct+NIS+28%UAN | 0.26, 0.25%, 1.25% | Post | 20.8 | 429.8 |
| 39 Buctril/Atrazine | 0.75 | Post | 5.0 | 145.0 |
| 40 Spirit+NIS+28%UAN | 0.036, 0.25%, 2.5% | Post | 0.0 | 0.0 |
| 41 Northstar+NIS+28%UAN | 0.148, 0.25%, 2.5% | Post | 13.7 | 111.5 |
| 42 Hornet+NIS+28%UAN | 0.128, 0.25%, 2.5% | Post | 19.6 | 64.5 |
| 43 Laddock+28%UAN | 1.25, 2.5% | Post | 9.0 | 352.5 |
| 44 Basis Gold+COC+28%UAN | 0.782, 1.0%, 2.5% | Post | 31.3 | 547.0 |
| 45 Distinct+NIS+28%UAN | 0.175, 0.25%, 1.25% | LPost | 75.6 | 381.5 |
| 46 Hornet+NIS+28%UAN | 0.128, 0.25%, 2.5% | LPost | 87.8 | 108.8 |
| 47 Spirit+NIS+28%UAN | 0.036, 0.25%, 2.5% | LPost | 61.3 | 11.3 |
| 48 Northstar+NIS+28%UAN | 0.148, 0.25%, 2.5% | LPost | 53.4 | 203.0 |
| 49 Roundup Ultra | 0.75 | LPost | 76.7 | 324.3 |
| 50 Check | — | — | 92.8 | 1679.8 |

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       |
|------------------------------------------------|-----------------|-------------|---------------|--------------|
| 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.

| Treatment                        | Rate (lbs ai/a) | Appl. Stage | 6/14/99 | 7/9/99 |
|----------------------------------|-----------------|-------------|---------|--------|
| 31 Bicep II Magnum : Spirit      | 2.2 : 0.036     | Pre:Post    | 62.3    | 61.2   |
| 32 Bicep II Magnum : Exceed     | 2.2 : 0.036     | Pre:Post    | 101.2   | 43.7   |
| 33 Dual II Magnum : Exceed      | 1.6 : 0.036     | Pre:Post    | 29.3    | 83.3   |
| 34 Dual II Magnum : Spirit      | 1.6 : 0.036     | Pre:Post    | 30.1    | 83.8   |
| 35 Dual II Magnum : Northstar   | 1.6 : 0.137     | Pre:Post    | 32.7    | 79.9   |
| 36 Marksman+28%UAN              | 1.4 , 2.5%      | EPost       | 234.3   | 7.0    |
| 37 Clarity+28%UAN               | 0.5, 2.5%       | EPost       | 195.3   | 20.3   |
| 38 Distinct+NIS+28%UAN          | 0.26, 0.25%, 1.25% | Post | 179.8  | 3.1    |
| 39 Buctril/Atrazine             | 0.75            | Post        | 137.0   | 29.0   |
| 40 Spirit+NIS+28%UAN            | 0.036, 0.25%, 2.5% | Post | 60.8   | 66.0   |
| 41 Northstar+NIS+28%UAN         | 0.148, 0.25%, 2.5% | Post | 127.5   | 26.2   |
| 42 Hornet+NIS+28%UAN            | 0.128, 0.25%, 2.5% | Post | 124.5   | 32.6   |
| 43 Laddock+28%UAN               | 1.25, 2.5%      | Post        | 249.0   | 10.4   |
| 44 Basis Gold+COC+28%UA         | 0.782, 1.0%, 2.5% | Post | 18.3    | 90.6   |
| 45 Distinct+NIS+28%UAN          | 0.175, 0.25%, 1.25% | LPost | 143.0   | 22.9   |
| 46 Hornet+NIS+28%UAN            | 0.128, 0.25%, 2.5% | LPost | 168.0   | 20.3   |
| 47 Spirit+NIS+28%UAN            | 0.036, 0.25%, 2.5% | LPost | 88.3    | 47.4   |
| 48 Northstar+NIS+28%UAN         | 0.148, 0.25%, 2.5% | LPost | 191.0   | 8.1    |
| 49 Roundup Ultra                | 0.75            | LPost       | 190.3   | 10.6   |
| 50 Check                        | —               | —           | 193.8   | 0.0    |

LSD (0.05) =

|       | 65.8 | 22.2 | 211.9 | 21.2 |

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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.

| Treatment | Rate (lbs ai/a) | Appl. Stage | 6/14/99 | 7/9/99 |
|-----------|----------------|-------------|---------|--------|
| 1 Roundup Ultra | 0.75 | LPost | 59.0 | 32.4 | 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 | 0.0 | 100.0 |
| 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.

| Treatment                          | Rate (lbs ai/a) | Appl. Stage | 6/14/99 | 6/14/99 | 7/9/99 | 7/9/99 |
|------------------------------------|-----------------|-------------|---------|---------|--------|--------|
| 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 : 0.25%     | EPost       | 0.0     | 100.0   | 2.8    | 98.5   |
| 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.

| Treatment                        | Rate (lbs ai/a) | Appl. Stage | 6/14/99 | 7/9/99 |
|----------------------------------|-----------------|-------------|---------|--------|
| 1 Roundup Ultra                  | 0.75            | LPost1      | 105.8   | 1.5    |
| 2 Guardsman : Basis Gold+Clarity+COC+28%UAN | 1.25 : 0.79, 0.125, 1.0%, 4.0% | Pre:Post    | 0.0     | 1.9    |
| 3 Guardsman : Accent Gold+Clarity+COC+28%UAN | 1.25 : 0.152, 0.125, 1.0%, 4.0% | Pre:Post    | 0.2     | 0.0    |
| 4 Basis+Atrazine                 | 0.023, 1.0      | Pre         | 2.5     | 11.8   |
| 5 Basis : Basis Gold+Clarity+COC+28%UAN | 0.015 : 0.79, 0.125, 1.0%, 4.0% | Pre:Post    | 20.1    | 82.2   |
| 6 Balance : Basis Gold+Clarity+COC+28%UAN | 0.05 : 0.79, 0.125, 1.0%, 4.0% | Pre:Post    | 0.1     | 4.6    |
| 7 Axiom : Basis Gold+Clarity+COC+28%UAN | 0.425 : 0.79, 0.125, 1.0%, 4.0% | Pre:Post    | 1.9     | 22.5   |
| 8 Basis Gold+Distinct+COC+28%UAN | 0.79, 0.175, 1.0%, 4.0% | Post         | 108.8   | 34.4   |
| 9 Harness Xtra : Roundup Ultra+AMS | 1.73 : 0.75, 2.0% | Pre:Post    | 0.2     | 0.0    |
| 10 Roundup Ultra+AMS : Roundup Ultra+AMS | 0.75, 2.0% : 0.75, 2.0% | Post:LP | 13.0    | 100.0  |
| 11 Roundup Ultra+AMS             | 0.75, 2.0%      | Post         | 16.5    | 39.7   |
| 12 Bullet : Roundup Ultra+AMS    | 2.25 : 0.75, 2.0% | Pre:Post    | 0.0     | 0.4    |
| 13 Harness Xtra+Roundup Ultra+AMS | 1.73, 0.75, 2.0% | Post        | 55.8    | 149.5  |
| 14 Bullet+Roundup Ultra+AMS      | 2.25, 0.75, 2.0% | Post         | 33.2    | 21.6   |
| 15 Atrazine+Roundup Ultra+AMS    | 1.0, 0.75, 2.0% | Post         | 115.3   | 56.4   |
| 16 Dual II Magnum : Marksman     | 1.60 : 1.4      | Pre:Post     | 7.0     | 6.3    |
| 17 Harness Xtra : Roundup Ultra+AMS | 1.73 : 0.75, 2.0% | Pre:Post    | 0.0     | 0.3    |
| 18 Bicep II Magnum : Exceed+Clarity+NIS | 2.2 : 0.028, 0.2, 0.25% | Pre:Post    | 0.0     | 1.3    |
| 19 Frontier : Distinct+NIS       | 1.17 : 0.263, 0.25% | Pre:Post    | 0.4     | 0.5    |
| 20 Guardsman : Basis Gold+NIS+28%UAN | 2.5 : 0.783, 0.25%, 5.0% | Pre:Post    | 0.0     | 0.0    |
| 21 Balance+Atrazine              | 0.07, 1.5       | Pre          | 0.0     | 3.5    |
| 22 Axiom                         | 0.68            | Pre          | 0.6     | 15.3   |
| 23 Axiom+NIS                     | 0.01, 0.75, 0.25% | Post        | 146.5   | 246.8  |
| 24 Axiom+Atrazine+NIS            | 0.01, 0.75, 0.25% | Post        | 169.0   | 378.3  |
| 25 Aim+Tough                     | 0.01, 0.35      | Post         | 178.8   | 268.5  |
| 26 Aim+Tough+NIS                 | 0.01, 0.35, 0.25% | Post        | 189.8   | 220.8  |
| 27 Aim+Roundup+NIS               | 0.01, 1.0, 0.25% | Post         | 142.8   | 450.8  |
| 28 Bicep II Magnum               | 2.2             | Pre          | 5.9     | 97.1   |
| 29 Bicep II Magnum : Northstar   | 2.2 : 0.137     | Pre:Post     | 0.0     | 0.0    |
| 30 Bicep II Magnum : Beacon      | 2.2 : 0.036     | Pre:Post     | 0.6     | 0.4    |
| 31 Bicep II Magnum : Spirit      | 2.2 : 0.036     | Pre:Post     | 0.3     | 0.0    |
| 32 Bicep II Magnum : Exceed      | 2.2 : 0.036     | Pre:Post     | 0.4     | 0.4    |

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.

| Treatment                          | Rate (lbs ai/a) | Appl. Stage | 6/14/99 Ht x no. | %Red. | 7/9/99 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 | 7/9/99 |
|-----------|----------------|-------------|---------|--------|
| 1 Roundup Ultra | 0.75 | LPost | 13.3 | 97.7 |
| 2 Guardsman : Basis Gold+Clarity+COC+28%UAN | 1.25 : 0.79, 0.125, 1.0%, 4.0% | Pre:Post | 0.0 | 95.9 |
| 3 Guardsman : Accent Gold+Clarity+COC+28%UAN | 1.25 : 0.152, 0.125, 1.0% 4.0% | Pre:Post | 0.0 | 91.9 |
| 4 Basis+Atrazine | 0.023, 1.0 | Pre | 0.2 | 71.1 |
| 5 Basis : Basis Gold+Clarity+COC+28%UAN | 0.015 : 0.79, 0.125, 1.0%, 4.0% | Pre:Post | 0.0 | 99.6 |
| 6 Balance : Basis Gold+Clarity+COC+28%UAN | 0.05 : 0.79, 0.125, 1.0%, 4.0% | Pre:Post | 0.0 | 98.2 |
| 7 Axiom : Basis Gold+Clarity+COC+28%UAN | 0.425 : 0.79, 0.125, 1.0%, 4.0% | Pre:Post | 0.0 | 87.7 |
| 8 Basis Gold+Distinct+COC+28%UAN | 0.79, 0.175, 1.0%, 4.0% | Post | 8.8 | 57.2 |
| 9 Harness Xtra : Roundup Ultra+AMS | 1.73 : 0.75, 2.0% | Pre:Post | 0.0 | 93.6 |
| 10 Roundup Ultra+AMS : Roundup Ultra+AMS | 0.75, 2.0% : 0.75, 2.0% | Post:LP | 1.0 | 69.9 |
| 11 Roundup Ultra+AMS | 0.75, 2.0% | Post | 0.0 | 60.5 |
| 12 Bullet : Roundup Ultra+AMS | 2.25 : 0.75, 2.0% | Pre:Post | 0.0 | 86.4 |
| 13 Harness Xtra+Roundup Ultra+AMS | 1.73, 0.75, 2.0% | Post | 0.0 | 92.5 |
| 14 Bullet+Roundup Ultra+AMS | 2.25, 0.75, 2.0% | Post | 2.8 | 80.3 |
| 15 Atrazine+Roundup Ultra+AMS | 1.0, 0.75, 2.0% | Post | 1.3 | 0.0 |
| 16 Dual II Magnum : Marksman | 1.60 : 1.4 | Pre:Post | 0.0 | 100.0 |
| 17 Harness Xtra : Roundup Ultra+AMS | 1.73 : 0.75, 2.0% | Pre:Post | 0.0 | 49.0 |
| 18 Bicep II Magnum : Exceed+Clarity+NIS | 2.2 : 0.028, 0.2, 0.25% | Pre:Post | 0.0 | 82.4 |
| 19 Frontier : Distinct+NIS | 1.17 : 0.263, 0.25% | Pre:Post | 0.0 | 98.3 |
| 20 Guardsman : Basis Gold+NIS+28%UAN | 2.5 : 0.783, 0.25%, 5.0% | Pre:Post | 0.0 | 100.0 |
| 21 Balance+Atrazine | 0.07, 1.5 | Pre | 0.0 | 68.7 |
| 22 Axiom | 0.68 | Pre | 0.0 | 100.0 |
| 23 Aim+Atrazine+NIS | 0.01, 0.75, 0.25% | Post | 4.5 | 47.5 |
| 24 Aim+Atrazine+Banvel+NIS | 0.01, 0.5, 0.25, 0.25% | Post | 0.5 | 78.7 |
| 25 Aim+Tough | 0.01, 0.35 | Post | 16.0 | 82.1 |
| 26 Aim+Tough+NIS | 0.01, 0.35, 0.25% | Post | 16.0 | 69.5 |
| 27 Aim+Roundup+NIS | 0.01, 1.0, 0.25% | Post | 6.3 | 100.0 |
| 28 Bicep II Magnum | 2.2 | Pre | 0.0 | 100.0 |
| 29 Bicep II Magnum : Northstar | 2.2 : 0.137 | Pre:Post | 0.0 | 100.0 |
| 30 Bicep II Magnum : Beacon | 2.2 : 0.036 | Pre:Post | 0.0 | 100.0 |
| 31 Bicep II Magnum : Spirit | 2.2 : 0.036 | Pre:Post | 0.0 | 100.0 |
| 32 Bicep II Magnum : Exceed | 2.2 : 0.036 | Pre:Post | 0.0 | 100.0 |

continued
| 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     | 63.0  |
| 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) =

|       | 6/14/99 | 7/9/99 |
|-------|---------|--------|
|       | 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.

|                      | 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 |
| Roundup              | 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 P₂O₅ 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 | %H₂O | 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 | %H₂O | 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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