2013 Progress Report

Effects of Irrigation Management on Safflower Production and Alternaria Leaf Spot

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In 2013, research was conducted to provide growers information about irrigation management and fungicide treatment impacts on yield and Alternaria Leaf Spot disease. The research showed that yield was significantly impacted by irrigation. However, due to the exceptionally dry summer the Alternaria Leaf Spot disease did not appear until very late in the season when yields were determined. While, there were some differences in seed quality with more dark ends in seeds from plots that were not treated with fungicide treated the overall impact was minor. A growing season with normal or high precipitation is needed to determine the typical impact of irrigation and fungicide treatments on yield and seed quality. The 2013 research provided results that help answer the questions of 1) when and how often should safflower be irrigated, and 2) at what growth stage should irrigation be terminated? However the question concerning irrigation impact on Alternaria leaf spot was not adequately answered.

Experimentation Treatments and Layout

The 2013 research evaluated irrigation management impacts on yields and Alternaria leaf spot disease. Approximately 11 acres on the UAES Greenville Farm in North Logan, Utah were planted to safflower as part of a rotation with irrigated wheat. The treatment plots were sprinkler irrigated by hand lines to be typical of irrigation of many growers. The climatic conditions that very each year have an influence on the presence and degree of Alternaria leaf spot disease infestation. The following treatments were used.

Irrigation Treatments (about 3 inches per irrigation):

- No Irrigation as a control
- Irrigation at elongation (one irrigation)
- Irrigation at elongation and branching (two irrigations)
- Irrigation at elongation, branching, and early flowering (three irrigations)

Fungicide Application

- No pesticide application
- One fungicide application

The experimental design was a randomized block split-plot with irrigation as the whole plot factor and fungicide as the sub-plot factor. Treatments were replicated six times (24 plots and 48 sub-plots). The treatment plots were 210 feet by 50 feet. Field segments perpendicular to the irrigation lines were used for the different fungicide application treatments. Figure 1 is a false color aerial photograph taken on August 3, 2013 showing the layout of the plots and irrigation treatments. Figure 2 is a photo taken of July 18, 2013 showing stages of growth.
Figure 1 – False Color Aerial Photograph of the Safflower Irrigation Research Site taken on August 3, 2013 (the numbering is the number of irrigations).

Figure 2 – Image of field take July 18, 2013 showing different maturity of irrigation treatments.
Data Collection

The following data was collected:

- Climate data – Temperatures, solar radiation, humidity, wind, and precipitation (hourly, daily maximum, minimum)
- Crop management – Herbicide application, fertilization, planting rate, crop development stage and date, and harvest date.
- Irrigation – Amount, time and date, and crop development stage.
- Soil moisture monitoring for irrigation scheduling and estimate crop water use.
- Alternaria leaf spot disease - Evaluate the Alternaria leaf spot disease by photographing and monitoring the progress of disease spots on leaves.
- Air temperature - The air temperature was monitored because it is also thought have an impact on the Alternaria leaf spot disease.
- Yield sampling for each irrigation and fungicide treatment.

The cropping information for 2013 season is listed below:

- Pre-plant fertilizer application of 70 lbs N per acre.
- April 22: Treated with Sonalan for weed control (2 pints per acre).
- April 25: planted, Seeding rate of 20 lbs per acre, variety is S-208.
- June 11-14: 1st irrigation at elongation (2.96 inches net average).
- June 28 – July 2: 2nd irrigation at branching (3.27 inches net average).
- July 18-19: 3rd irrigation at early flowering (3.27 inches net average).
- August 3: Obtained multi-spectral imagery of field.
- August 9: Fungicide application on half of each plot (Quadris Flowable) at 12 oz. per acre and (Exit Activator Adjuvant) at about 6 oz. per acre.
- Oct 9: Harvested 9 of 48 sub-plots (a portion of the east side), the combine broke and then it rained to delay the harvest.
- Oct 21: Harvested remainder of plots.
- Total yield of field (all buffers and plots) was 38,000 lbs or about 2,990 lbs. per acre.

RESULTS AND DISCUSSION

The research provided information concerning irrigation of safflower that is being shared with producers to increase profitability and maximize the use of available irrigation water. At the research site there was a total of 2.02 inches of precipitation from May 1 to August 31, with 1.77 inches occurring during May. Irrigations occurred June 11-14 (2.96 inches net average), June 28 – July 2 (3.27 inches net average) and July 18-19 (3.27 inches net average).

Yields

The resulting yields are shown in Figure 2. There was a significant difference (99.9 percent confidence level) in the yield for the irrigation treatments. However, there was not a significant yield difference between 2 and 3 irrigation levels. The greatest average yield increase occurred between 1 and 2 irrigation. There were 6 plots with yields over 3,900 pounds per acre, 3 from
irrigation level 2 and 3 from irrigation level 2. The average yields for the irrigation treatments were 1540, 2455, 3481, and 3,538 pounds per acre for no irrigation, one irrigation, two irrigations, and three irrigations, respectively.

Figure 2 – Safflower Yield v. Number and Amount of Irrigations.

**Water Use**

Soil moisture measurements were taken at 6 locations at two week intervals to estimate crop evapotranspiration and for irrigation scheduling. Soil samples were taken in 1-foot depth increments with a 0.75 inch diameter soil probe within about a 5-feet radius of the staked location. Soil samples were bagged, weighted, oven dried and then weighted again to determine the soil moisture. Measured seasonal ET ranged from 8.68 to 18.96 inches, although there may have been additional ET from soil moisture deeper than five feet. The soil water depletion in the top five feet ranged from 6.27 inches to 9.79 inches. Some of the soils water depletion differences are accounted for because of differences in soil moisture at the beginning of the season. The crop water use and yield for 2 and 3 irrigations were similar, but more soil moisture was extracted from the soil for plots irrigated twice. In all cases the soil moisture depletion was not replaced by irrigation.

**Table 1 – Summary of Soil Water Depletion, ET, and yield for Soil Moisture Monitoring Sites.**

<table>
<thead>
<tr>
<th>Location</th>
<th>No. Irrigations</th>
<th>Irrigation and Precipitation (inches)</th>
<th>Soil Water Depletion (inches)</th>
<th>ET (inches)</th>
<th>Yield (lbs/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - E</td>
<td>3</td>
<td>12.41</td>
<td>6.27</td>
<td>18.68</td>
<td>3,978</td>
</tr>
<tr>
<td>2 - E</td>
<td>1</td>
<td>5.05</td>
<td>7.89</td>
<td>12.94</td>
<td>1,724</td>
</tr>
<tr>
<td>3 - E</td>
<td>0</td>
<td>2.02</td>
<td>6.65</td>
<td>8.68</td>
<td>1,705</td>
</tr>
<tr>
<td>4 - W</td>
<td>2</td>
<td>8.26</td>
<td>9.71</td>
<td>17.97</td>
<td>3,300</td>
</tr>
<tr>
<td>5 - W</td>
<td>1</td>
<td>6.16</td>
<td>8.85</td>
<td>15.01</td>
<td>2,422</td>
</tr>
<tr>
<td>6 - W</td>
<td>2</td>
<td>9.17</td>
<td>9.79</td>
<td>18.96</td>
<td>3,919</td>
</tr>
</tbody>
</table>
Seed Quality

The seeds were analyzed and/or graded for oil content (%), moisture content (%), bushel weight (lbs/bushel), color score (1=whitest and 10 being a tan/brown color), dark ends, papus, immature seed, sprouted seeds, and slight yellowing. The analyses of oil content, moisture content, and bushel weight were conducted by commercial laboratory. The visual quality analyses (color score, dark ends, etc.) were made by a safflower buyer. In both cases the treatments were not provided with the sampling labels. Analyses of variances were conducted using R software. The following summarizes the significant impacts.

**Oil Content** – The oil content is higher for the non-irrigated plots without fungicide treatment (95% significance level). The average percent oil ranged from 39.05 percent for no irrigation to 34.87 percent for two irrigations for plots without fungicide treatment. There was no significant difference resulting from irrigation level in oil content for fungicide treated plots with an average of 38.02 percent oil. The fungicide treated plots had higher average oil content (38.02 percent) than the non-treated plots (35.20 percent).

**Color Score** – There is a difference (99% significance level) in irrigation levels with higher colors scores (darker seeds) for 2 and 3 irrigations. The color scores ranged from an average of 1.04 for no irrigation to 2.0 for three irrigations (scale of 1 to 10, best to worst). There were no significant differences in color scores between fungicide treatments (average for non-treated was 1.55 and average for treated was 1.53).

**Dark Ends** – There were more occurrences of dark ends from plots with 2 and 3 irrigations that were not treated with a fungicide (99% significance level). The dark end score ranged from an average of 0.17 for no irrigation 2.43 for three irrigations (scale of 0 to 3, best to worst) for plots that were not treated with a fungicide. There are no significant differences in dark ends with irrigation levels for fungicide treated plots.

**Papus** – Papus is hairy tuff on the end of the safflower seed. There were more occurrences of papus from non-irrigated plots that were not treated with a fungicide (95% significance). The average ranges from 1.5 for no irrigation to 0.4 for three irrigations (scale of 0 to 3, best to worst).

**Slight Yellowing** – The occurrence of slight yellowing was increased by irrigation level for fungicide treated plots (95% significance level). The average slight yellowing scores ranged from 0 for no irrigations to 2.0 (scale of 0 to 3, best to worst) for three irrigations for the fungicide treated plots. There were no significant differences for the plots that were not treated with a fungicide.

**SUMMARY**

The number and amount of irrigation significantly affects the yields. Adequate soil moisture, either provided by rain or irrigation, through branching and early flowering is important for high yields (up to 4,000 pounds per acre). Safflower can produce high yields without late water if there is adequate soil moisture during elongation, branching, and early flowering. Irrigations of about 3 inches occurred at elongation (first), branching (second), and early flowering (third). There was no significant difference in yields between 2 and 3 irrigations; however the ending soil moisture
was less for 2 irrigations than 3 irrigations. Measured ET ranged from 8.68 to 18.96 inches and soil water depletion ranged from 6.55 to 9.79 inches (top five feet). In 2013 the Alternaria leaf spot disease was not a significant factor in the yield because it occurred in the late season. The fungicide treatment increased oil content, reduced dark ends, and increased slight yellowing. There was very little rain during May through August in 2013 and as a result the Alternaria did not occur until very late in the season. The results could change during a year with higher precipitation.