Crop Evapotranspiration of Corn, Soybean, and Sorghum under Dryland Conditions as Quantified Using Soil Water Balance

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Extension Educator, Clay County
University of Nebraska-Lincoln Extension
Do you have:

1. Irrigated Crops
2. Dryland Crops
3. Both
Proposal/Objectives:

- Compare water use of 3 crops in 2 dryland fields.
- Utilize tools such as ET gage and Watermark sensors.
- Summer field day.
- Present research findings.
Know how. Know **now**.

Sensor collar

Hand-held meter

Sensor collar

Stainless steel sleeve

Electrodes

Hand-held meter
#54 alfalfa canvas cover

Bird spike

Sight tube and scale

300 mm (11.8 in) capacity water reservoir

Bellani plate (ceramic evaporation surface)

Rubber stopper

Suction tube
Field Experimental Design

- Datalogger (8 soil sensors/datalogger)
- 4 sensors/crop
- Soil matric potential measured every ft. up to 4 ft.
- Matric potential converted to soil water in inch/ft using soil water retention curve.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Replication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum</td>
<td>1</td>
</tr>
<tr>
<td>Corn</td>
<td></td>
</tr>
<tr>
<td>Soybeans</td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>2</td>
</tr>
<tr>
<td>Soybeans</td>
<td></td>
</tr>
<tr>
<td>Sorghum</td>
<td></td>
</tr>
<tr>
<td>Soybeans</td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>3</td>
</tr>
<tr>
<td>Sorghum</td>
<td></td>
</tr>
</tbody>
</table>
Field Pics

John in field
Know how. Know now.
## Management Practices

<table>
<thead>
<tr>
<th>Parameter</th>
<th>LAWRENCE</th>
<th>CHESTER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Corn</td>
<td>Soybean</td>
</tr>
<tr>
<td>Planting date</td>
<td>May 7</td>
<td>May 8</td>
</tr>
<tr>
<td>Emergence date</td>
<td>May 16</td>
<td>May 16</td>
</tr>
<tr>
<td>Maturity day/group</td>
<td>113-day</td>
<td>2.6</td>
</tr>
<tr>
<td>Planting population (ppa)</td>
<td>20,000</td>
<td>135,000</td>
</tr>
<tr>
<td>Hybrid/variety</td>
<td>33T57</td>
<td>92M61</td>
</tr>
<tr>
<td>Row spacing/planted rows</td>
<td>30”/12</td>
<td>30”/12 r</td>
</tr>
</tbody>
</table>
Rainfall - Lawrence

Know how. Know now.
Know how. Know now.

Rainfall - Chester

Date
16-May-09
21-May-09
26-May-09
31-May-09
5-Jun-09
10-Jun-09
15-Jun-09
20-Jun-09
25-Jun-09
30-Jun-09
5-Jul-09
10-Jul-09
15-Jul-09
20-Jul-09
25-Jul-09
30-Jul-09
4-Aug-09
9-Aug-09
14-Aug-09
19-Aug-09
24-Aug-09
29-Aug-09
3-Sep-09
8-Sep-09
13-Sep-09
18-Sep-09
23-Sep-09
28-Sep-09
3-Oct-09
8-Oct-09

Daily rainfall (in)
Cumulative rainfall (in)
Distribution of daily average soil matric potential Lawrence - CORN
Distribution of daily average soil matric potential Chester - CORN

- Chester-CORN

- Distribution of daily average soil matric potential

- Dates and soil matric potential values are shown for various depths.
Distribution of daily average soil matric potential Lawrence-Soybean

- 1 ft
- 2 ft
- 3 ft
- 4 ft

Date

Daily average soil matric potential (kPa)

Lawrence-SOYBEAN
Distribution of daily average soil matric potential Chester-SOYBEAN

- Daily average soil matric potential (kPa)
- Dates range from 7-May-09 to 14-Oct-09
- Depths: 1 ft, 2 ft, 3 ft, 4 ft
Distribution of daily average soil matric potential Lawrence - SORGHUM
Distribution of daily average soil matric potential Chester - SORGHUM
Trend of daily total soil water in the top 4 ft - Lawrence

- Corn
- Soybean
- Sorghum

Date:
- 7-May-09
- 27-May-09
- 16-Jun-09
- 6-Jul-09
- 26-Jul-09
- 15-Aug-09
- 4-Sep-09
- 24-Sep-09
- 14-Oct-09
- 3-Nov-09
Trend of daily total soil water in the top 4 ft - Chester
Calculation of Crop Evapotranspiration

- General soil water balance equation was used to quantify crop evapotranspiration as a function of water input and output to and from the field:

\[ ET_c = (TSWi - TSWe) + \text{rainfall} - RO - DP \]

where:

- \( ET_c \): crop evapotranspiration (in)
- \( TSWi \): initial available soil water at the beginning of season (in)
- \( TSWe \): available soil water at the full maturity (in)
- \( RO \): Runoff (assumed zero)
- \( DP \): Deep percolation (assumed zero)
### Crop Evapotranspiration for Each Site

**Lawrence**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Rainfall (in)</th>
<th>TSWi (in)</th>
<th>TSWe (in)</th>
<th>ETc (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>9.21</td>
<td>10.5</td>
<td>5.2</td>
<td>14.51</td>
</tr>
<tr>
<td>Soybean</td>
<td>8.84</td>
<td>10.6</td>
<td>5.4</td>
<td>14.04</td>
</tr>
<tr>
<td>Sorghum</td>
<td>9.96</td>
<td>10.4</td>
<td>6.8</td>
<td>13.56</td>
</tr>
</tbody>
</table>

**Chester**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Rainfall (in)</th>
<th>TSWi (in)</th>
<th>TSWe (in)</th>
<th>ETc (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>15.75</td>
<td>10.5</td>
<td>8.4</td>
<td>17.85</td>
</tr>
<tr>
<td>Soybean</td>
<td>15.05</td>
<td>10.4</td>
<td>8.6</td>
<td>16.85</td>
</tr>
<tr>
<td>Sorghum</td>
<td>13.59</td>
<td>10.3</td>
<td>7.7</td>
<td>16.19</td>
</tr>
</tbody>
</table>

Lower ETc rates in Lawrence site is most likely due to water stress.
Crop evapotranspiration - Lawrence

- **Corn**: 14.5 in
- **Soybean**: 14.0 in
- **Sorghum**: 13.7 in
Crop evapotranspiration - Chester

<table>
<thead>
<tr>
<th>Crop</th>
<th>Seasonal crop evapotranspiration (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>17.9</td>
</tr>
<tr>
<td>Soybean</td>
<td>16.9</td>
</tr>
<tr>
<td>Sorghum</td>
<td>16.2</td>
</tr>
</tbody>
</table>
### Yield Data

<table>
<thead>
<tr>
<th>Location</th>
<th>Corn</th>
<th>Sorghum</th>
<th>Soybeans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lawrence</td>
<td>97.5 bu/A</td>
<td>77.4 bu/A</td>
<td>33.4 bu/A</td>
</tr>
<tr>
<td>Chester</td>
<td>113.1 bu/A</td>
<td>98.7 bu/A</td>
<td>33.3 bu/A</td>
</tr>
</tbody>
</table>
Evapotranspiration means:

1. Evaporation from crop and transpiration from soil
2. Evaporation from soil and transpiration from crop
3. I’m not sure
Are you interested in participating in NAWMDN (irrigation scheduling)?

1. Yes
2. No
3. Already am involved
This study found greatest ET use in which crops?

<table>
<thead>
<tr>
<th>25%</th>
<th>1. Corn &gt; Soybean &gt; Sorghum</th>
</tr>
</thead>
<tbody>
<tr>
<td>25%</td>
<td>2. Sorghum &gt; Soybean &gt; Corn</td>
</tr>
<tr>
<td>25%</td>
<td>3. Soybean &gt; Corn &gt; Sorghum</td>
</tr>
<tr>
<td>25%</td>
<td>4. Soybean &gt; Sorghum &gt; Corn</td>
</tr>
</tbody>
</table>
Thank You!

- John Dolnicek and James Vorderstrasse
- Nebraska Grain Sorghum Board
- Little Blue NRD-Daryl Andersen
- Dr. Suat Irmak-UNL Extension Irrigation Specialist
- Dr. Charlie Wortmann-UNL Extension Soils Specialist
- Dr. Mark Bernards-UNL Extension Weed Scientist
- Lowell Sandell-UNL Extension Weed Scientist
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