Comparison of Crop Water Consumptive Use of Sorghum, Corn, and Soybeans

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Purpose and Introduction:

The purpose of this study is to compare crop water use amongst sorghum, corn, and soybeans in dryland fields utilizing more efficient and economical technologies available to producers in order to establish baseline numbers for crop water use for these three crops. The plan is to continue this study for three years in two locations to account for weather variation.

This study was proposed to the Nebraska Grain Sorghum Board in June 2008. Two producers, John Dolnicek from the Lawrence area and James Vordestrasse from the Chester area, agreed to participate in this study for the 2009 growing season. Time was spent discussing plans with these producers and experts such as Dr. Ray Ward, Ward Labs; Dr. Charles Wortmann, UNL Extension Soil Fertility Specialist; Dr. Mark Bernards and Lowell Sandell, UNL Extension Weed Scientists; and Dr. Suat Irmak, UNL Extension Irrigation Specialist. The equipment for measuring crop water use was ordered in January 2009.

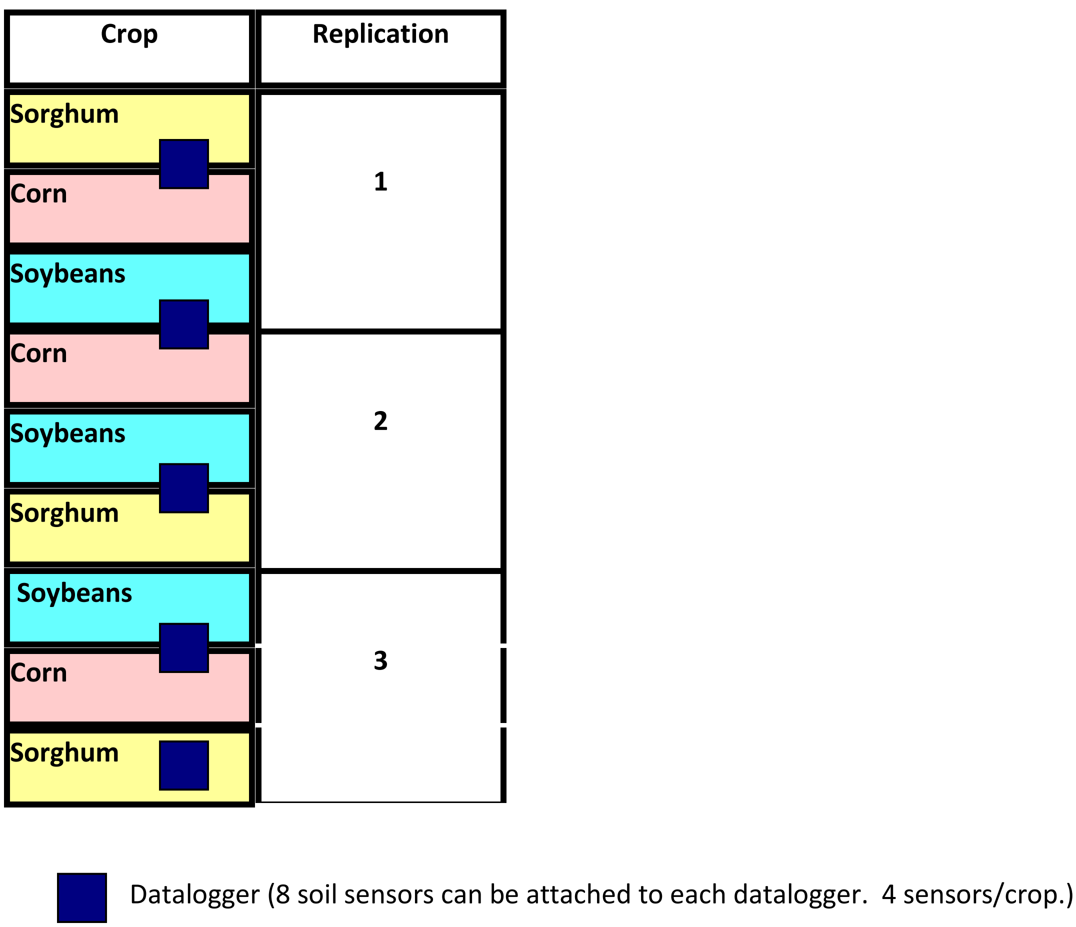
Two tools were used in this experiment to quantify crop water use: watermark sensors and ET gages. Watermark granular matrix sensors are tools to measure the soil matric potential. Soil particles hold moisture and as moisture is depleted from the soil, the soil particles increase their hold on the moisture. Soil matric potential measures the amount of energy it takes to extract the moisture from those soil particles. A handheld meter or a datalogger can be used to read these units of energy. The following publication provides more information in addition to a chart which shows the conversion of soil matric potential to moisture depletion in inches/foot based on soil type.
http://www.ianrpubs.unl.edu/epublic/live/ec783/build/ec783.pdf

The second tool , the ET gage, estimates reference evapotranspiration (ET) by simulating how ET occurs in the plant canopy. ET is also known as how much water the crop uses through the amount of water evaporated from the crop surface in addition to the amount of water transpired by the plant. Factors which influence ET include wind, temperature, and humidity. To determine actual crop water use, the reference ET is multiplied by a crop coefficient which coincides with every crop growth stage. This way, the reference ET can be used regardless of crop. More information on the ET gage can be found at: http://www.ianrpubs.unl.edu/epublic/pages/publicationD.jsp?publicationId=413. More information about an irrigation scheduling Network using these tools to help producers save water and energy can be found at: http://water.unl.edu/cropswater/nawmdn.

Materials and Methods:

Each producer followed the plot design found in Figure 1 in which the crops were randomized in a complete block design and replicated throughout the producers' fields in order to obtain valid statistical data. The blue square represent the watermark dataloggers. Each watermark datalogger can record data for eight watermark sensors. Each crop contained four watermark sensors installed a few weeks after emergence within the crop row between plants, in increments of one, two, three, and four feet depths. The blue boxes in Figure 1 represent the watermark dataloggers. Each datalogger can hold eight sensors so one datalogger was used for two crops.

Figure 1: Three Crop Plot Design



Detailed production information can be observed in Table 1. At the time of creating this report we did not obtain the full production information from James (due to late notice on our part) but we will provide this information for the field day in September.

Each site was visited weekly to read the ET gage and record data in addition to notes about crop condition and growth stage. Data was not downloaded from each site each week. However, all dataloggers were checked to ensure that the watermark sensors were working properly and that there were no strange readings.

Results:

Based on the ET gages and watermark sensors, ET for the Lawrence site was 8.41 inches for sorghum, 10.20 inches for corn, and 12.92 inches for soybeans from May 23-August 6. ET for the Chester site was 7.07 inches for sorghum, 10.34 inches for corn, and 12.36 inches for soybeans from May 23-August 6. Please see the attached data files for more detailed information.

Table 1: Production Practice Information for Research/Demonstration Sites

Practice Performed	John Dolnicek-Lawrence	James Vordestrasse-Chester
Planted Corn	May 7 at 20,000 seeds/acre	End of April
Planted Soybeans	May 8 at 135,000 seeds/acre	Beginning of May
Planted Sorghum	May 19 at 65,000 seeds/acre	Later in May
Row Spacing and Planted Rows	12 rows, 30" spacing	16 rows, 30" spacing
Previous Crop	Sorghum	Soybeans
Tillage Practice	No-till	No-till
Fertilizer	May 12 using dry blend 90-40 as per soil test for milo using 100 bu/acre yield goal	Normally sidedresses liquid. Did not apply to plot area since equipment already in place.
Equipment Installation	May 22: Corn and Soybeans June 6: ET gage June 12: Sorghum	May 26: Corn and Soybeans June 6: ET gage June 12: Sorghum
Herbicide	May 15 sprayed Dual II Magnum at 1.3 pts. and 1 qt. glyphosate/acre June 13 sprayed beans and corn with glyphosate 1 qt/acre June 27 sprayed milo with paramount 8oz/acre + 1qt atrazine + 1 qt crop oil July 8 sprayed corn and beans with glyphosate	Pre and post Lumax to corn and sorghum. Pre and post Glyphosate-soybeans.

This data shows a slightly greater ET use in sorghum and soybeans for Lawrence than for Chester. Most likely this is due to the reduced rainfall amount the Lawrence site received vs. Chester. The corn ET at Chester was slightly higher than Lawrence, but the corn was planted earlier and was further in maturity, thus it used slightly more water than the Lawrence site up to this time.

The two locations varied a great deal due to precipitation differences. Please see Table 2 for the rainfall totals for this season. Because of receiving more rain, the Chester site had more disease pressure-particularly gray leaf spot approaching the ear leaf and common rust above the ear leaf at the time this report was prepared. In contrast, the Lawrence site had minimal gray leaf spot pressure located on the lower plant leaves which are now burned up due to the combination of nitrogen deficiency and lack of moisture. Both sites had nitrogen deficiency beginning to show in July. It's interesting to note that the Chester site did not receive any fertilizer and that the site overall does not show severe nitrogen deficiency so it must be utilizing the residual nitrogen from last year's soybean crop.

In spite of the rainfall amounts, both sites have weathered the lack of moisture quite well. This most likely is due to the combination of better hybrids and varieties better able to withstand stress in addition to the cooler summer on average and higher humidity.

Table 2: Rainfall Totals for Lawrence and Chester area (Provided by NE Rain and local Lawrence producer)

Month	Lawrence Rainfall Amount (inches)	Chester Rainfall Amount (inches)
April	2.77	1.78
May	0.55	2.16
June	2.53	6.60
July	2.60	2.92
August	0.43	0.57
Total as of 8/14/09	**8.88**	**14.03**

Table 3 provides a snapshot of what the soil moisture status of both sites was on August 6, 2009. From this table, it is apparent that the Chester site has more moisture than Lawrence. It is also apparent how the crop roots of sorghum, corn, and soybeans have been utilizing moisture from the fourth foot at Lawrence. Sorghum roots at Chester are just beginning to utilize the third foot and corn and soybeans at Chester are beginning to utilize the fourth foot. Viewing the weekly data (attached graphs), it is interesting to note how soybeans utilize a great deal of moisture from the second and third feet whereas corn and sorghum utilize it more from the top two feet. The Soybean ET was also the highest of all three crops at each site. This may be due to the evaporation from the soil surface and the canopy not closing as quickly as it did for corn and sorghum. These sites are both no-till fields, but the soybean canopy still did not close as quickly as the other two crops.

Table 3: Average Watermark Sensor Readings per Foot Depth for Lawrence and Chester (8/6/2009)

Location & Crop	1 Foot	2 Foot	3 Foot	4 Foot	Avg.	% Moisture depleted from profile*
Lawrence Sorghum	**112**	**109**	**77**	**43**	**85**	**33%**
Chester Sorghum	**63**	**44**	**38**	**38**	**46**	**11%**
Lawrence Corn	**182**	**120**	**88**	**52**	**111**	**38%**
Chester Corn	**45**	**56**	**42**	**36**	**45**	**11%**
Lawrence Soybeans	**151**	**148**	**106**	**96**	**125**	**42%**
Chester Soybeans	**62**	**100**	**54**	**37**	**63**	**23%**

*% Soil Moisture based on 2.2 in/ft. available in silty clay loam soils. % depletion as of 8/6/2009.

Conclusions: It's still too early to form any conclusions. Yield data will be taken and analyzed this fall in addition to the full season of ET data. For this snapshot in time, soybeans have used the most moisture followed by corn then sorghum. Part of this is due to the soybeans not closing canopy as early and sorghum being planted later than corn and soybeans. The end of year data will provide the full story regarding total ET use for each crop at each location.