Cotton Irrigation in Kansas

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Abstract: *Kansas is north of the traditional Cotton Belt and considered to be a thermally limited area for cotton; however cotton is being grown as an alternative to corn to stretch declining water resources. Cotton is a non-determinate plant that continues to grow with favorable condition. Irrigation timing is critical to ensure satisfactory crop growth and to achieve boll maturity for favorable lint quality and yield before a killing frost. Both over irrigation or under irrigation may affect yield and quality. Declining water resources make it necessary to conserve water but, at the same time, maintain acceptable revenue. Cotton is a new alternative crop and there is a lack of research based irrigation management information. One year data from a field research on a grower field indicates that 5 inches of irrigation plus rainfall produced a slightly better yield (2.52 bales) compared to an application of 7 inches plus rain (2.31bales). Although the difference is not significant, yet the trend was same for all replications. The treatment receiving only 2.4 inches of water plus the rain produced 1.73 bales, which is significant. Total rainfall during the growing season was 14.31 inches of which 8.81 was considered to be effective rainfall. It was also noticed that the water extraction by roots were mostly within the first 2 feet of root zone; barely reaching to third foot depth. It was also observed that the roots were more laterally distributed rather than deep in depth, although there appeared to be no restricting soil layer.*

Keywords: alternative crop cotton, heat units for cotton,

Introduction: Crop production in western Kansas is dependent on irrigation. The irrigation water source is groundwater from the Ogallala aquifer. The water level of the Ogallala aquifer is declining, causing the depth of pumping to increase. The additional fuel consumption required for greater pumping depths and higher energy costs have resulted in increased pumping costs in recent years. Because of declining water levels and higher pumping costs, the growers are looking for alternative crop that may provide somewhat acceptable revenue at a lower water requirement. Cotton has made some inroads from south moving northward as an alternative crop. Acreage grown in 2006 reached to 110 thousand acres, which has gradually come down due to recent commodity price changes. Most of the crops grown are still in southern counties within Kansas.

Procedures: A producer’s field with center-pivot sprinkler irrigation system was selected for the study. The soil belongs to Richfield series and the texture is silt loam. Three outer spans were selected to establish three replication of the study. Three sets of eight nozzles in each span were fitted with a closing valve to establish three irrigation treatments. The nozzles are five feet apart giving a length forty feet in each set of eight nozzles for individual plots. A width of forty was marked to establish 40 ft by 40 ft individual plots.

The total number plots were nine. Three irrigation treatments in terms of timing and number were randomly scattered in these nine plots. Treatment T1 was set for four irrigation of one inch application depth each time during the growing season. The tentative timing of irrigation was set for July 10, July 20, August 1, and August 10. However, this was changed to meet the field condition and an application of 1.6" inches were applied as pre-irrigation to make the soil water condition suitable for planting and was followed by an application of 0.8" inches after seeding to secure good germination. This was done for all the plots in the trial. Afterwards, T1 received five irrigations starting on June 12 as the first differential treatment (Fig. 1). Total irrigation application amounted to 7" inches for the growing season.

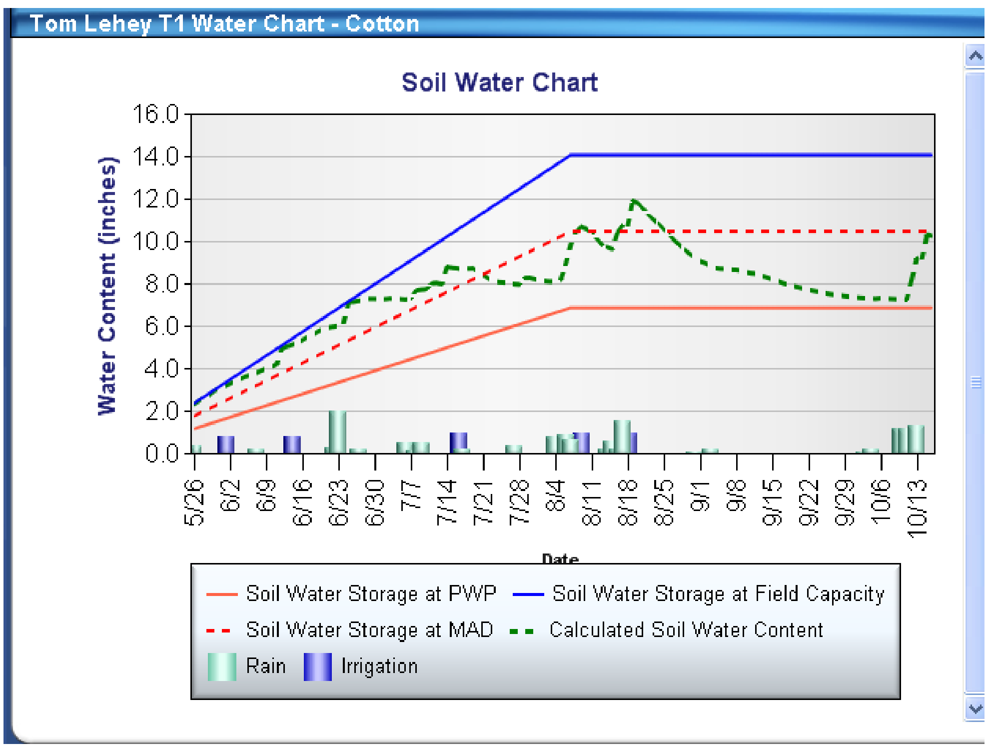

Fig. 1 showing soil water chart for T1 treatment with irrigation and rainfall events.

Treatment T2 was set for two irrigation of same depth of application as T1 each time and the timings were set for July 10 and August 1. However, as mentioned above for treatment T1, the treatment T2 also received pre and post irrigation amounting to 2.4" inches prior to treatment differential application. The first differential application was provided on June 12 followed by one application on July 14. Total irrigation application amounted to 5" inches (Fig. 2). Treatment T3 was set for no irrigation during the growing season except for what was applied to the field as pre-plant and post seeding for germination. Gypsum blocks were placed at one foot depth interval to a depth of four feet to monitor soil water status.

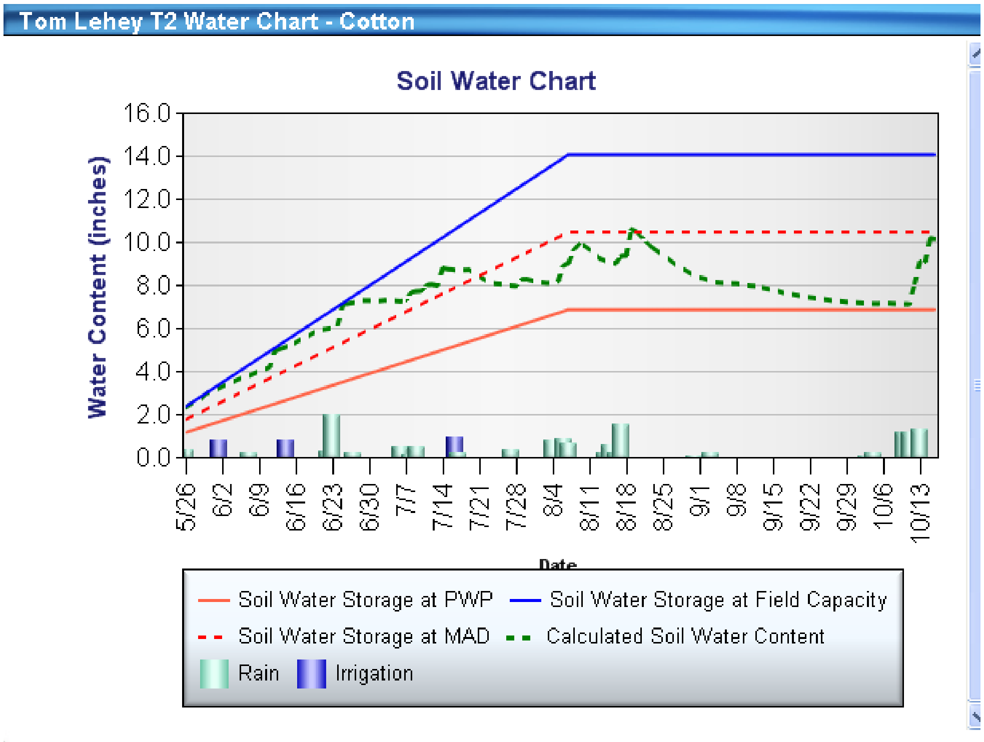

Fig. 2 showing soil water chart for T2 treatment with irrigation and rainfall events

Paymaster 2141, a stripper cotton variety, was planted on May 19, 2008. Plants started to emerge by May 26, 2008. Cotton was harvested on October 28, 2008 by hand to record yield. This was done after the freeze on October 23, 2008, when all mature bolls were open.

Weather data from Garden City experiment station was used for ET data and to calculate cotton growing degree days. Alfalfa based reference ET was used in KanSched irrigation scheduling software to obtain crop ET for cotton under different irrigation treatments.

Results and Discussion**:** One year study results for 2008 indicate that cotton grown in Kansas for a growing period of 140 days used about 16 inches of water as crop ET (Fig. 3); out of this amount 7” inches were provided by irrigation and 8.8 inches were provided by effective rainfall. Seasonal ET of 14.22” inches for treatment T2 was made up from 5” inches of irrigation, 8.8” inches from effective, and less than one half of an inch from soil water. T3 received only pre and post seeding watering amounting to 2.4” inches. Soil water use as shown in figure 3 is based on 100 percent application efficiency of irrigation. At 85 percent application efficiency of water, which is more likely for a center pivot irrigation system the amount of soil water use will probably be a little higher than shown.

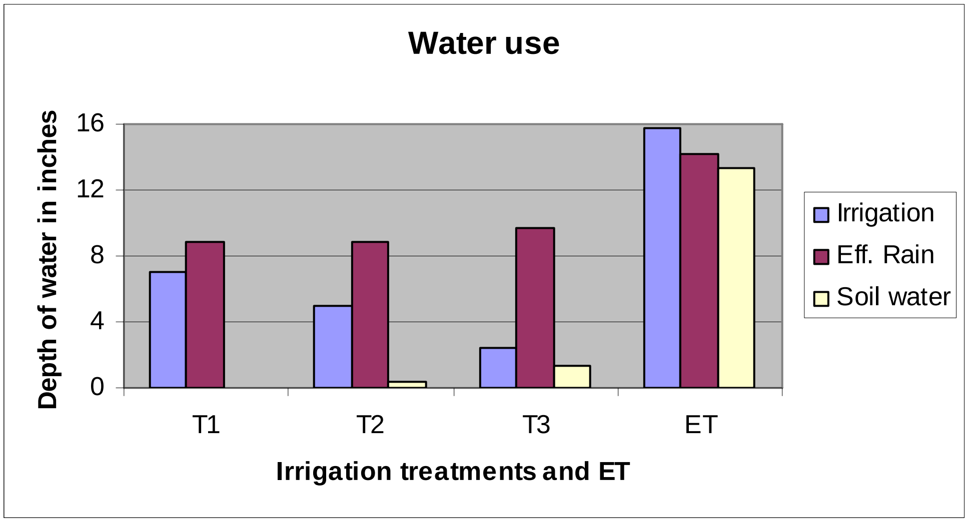

Figure 3 showing seasonal water uses by cotton crop of 2008 in southwest Kansas.

Cotton yield in bales per acre is shown in figure 4. Cotton yield for all three replications were higher for irrigation treatment of 5" inches at an average yield of 2.52 bales per acre. An ET difference of less than an inch between the treatments T2 and T3 has made a yield difference of 400 lbs. per acre. The timing of irrigation to remove water stress is important for cotton crop. It is also critical to avoid high soil water condition for cotton quality and yield.

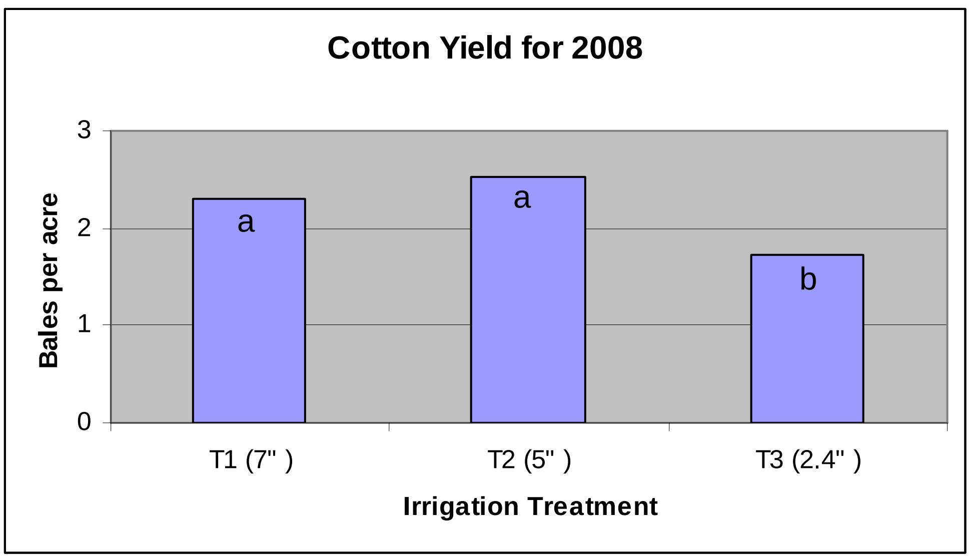

Figure 4 showing cotton yield for different irrigation treatment in 2008.

The harvested samples were sent out to USDA cotton classing office in Abilene, TX, for classification. The salient results are presented in table 1.

Table 1 showing cotton classing results.

Treatment	Color	Mike	Length	Strength
T1	24.3	2.80	1.14	27.20
T2	27.7	2.87	1.13	27.57
T3	31	2.97	1.10	27.23

It appears that the color and mike are inversly related to increased irrigation contributing to prolonged growth. This is probably due to having some late maturing bolls contributing to the production. The length of staple appears to improve with irrigation, but strength of fiber may be sensitive to balanced water management.

The gypsum block readings showing soil water extraction according to gypsum block readings for T1 and T3 are shown in Figure 5-6.

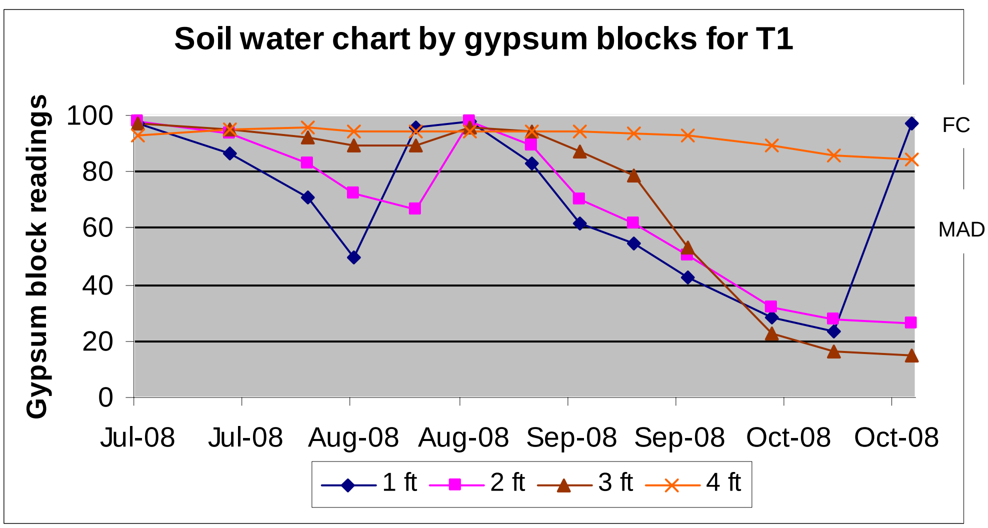

Fig. 5 shows soil water chart according to readings obtained by gypsum blocks.

The soil water status corresponds to what was observed in soil water charts developed by KanSched irrigation scheduling software. The soil water increased back to about field capacity (FC), after a rainfall of 2.6" inches that was spread over three days from August 17 to 19, 2008. Soil water status fell to management allowable depletion level (MAD at gypsum block reading of 60) for T1 treatment by the end of the first week of September. However, no further irrigation was provided to encourage plants to go for life cycle completion.

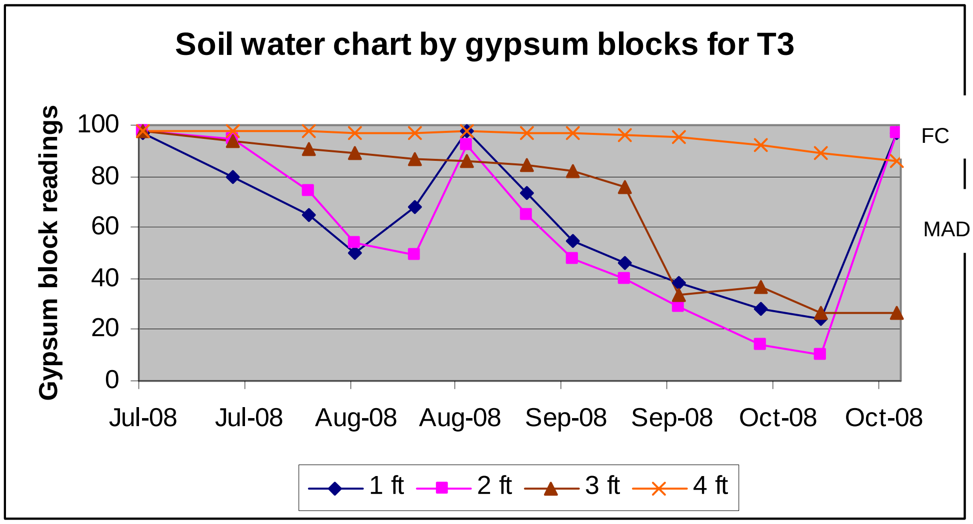

Fig. 6 shows soil water chart from readings obtained by gypsum blocks.

In figure 6 it is visible that the soil water status for first two feet of soil profile, where the roots were most active in early season fell below management allowable depletion by first week of August, and stayed that way until 2.6” inches of rain of third week of August.

Concluding Remarks:

The results presented are from one year study only. The crop of 2009 was completely destroyed by hail storm. The study needs to be repeated for making any conclusive remark. However, it is evident that in a thermally limited area like Kansas, it is critical to manage water for optimum maturity. The yield of cotton may also be limited due to limited growing season and cotton GDD (growing degree days) needed for full maturity of a crop. The cotton GDD from May 26 to October 10 was 1,690 units only and no further increase occurred until freeze on October 23, 2008.

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