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IRRIGATION SCHEDULING USING KANSCHED FOR A RANGE OF WEATHER CONDITIONS

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KanSched[1] is an irrigation scheduling software program developed to allow irrigation managers to use ET or crop water use information to schedule irrigation applications. ET information is available from a number of weather stations throughout Kansas. The ET information can be accessed by a variety of means including the web; such as the website of the Kansas State University Weather Data Library at www.oznet.ksu.edu/wdl.

Irrigation scheduling is a management practice to help irrigators determine when to irrigate and how much water to apply to meet crop water needs without waste of water. The scheduling concept is most often associated with irrigation systems with high irrigation capacities, meaning that water related water stress is unlikely to occur. Therefore, many irrigators discount the utility of irrigation scheduling because declining water levels have resulted in decreased well yield and therefore reduced irrigation capacity.

Irrigation capacity is the depth of water that the field would receive if entire field is watered in one day. It can be calculated as follows:

$$IC = \frac{GPM \times 24}{450\ Acres} \qquad \text{for 24 hour/day pumping}$$

GPM = gallons/minute
Acres = total irrigated acres in the field
450 gpm = 1 acre-inch/hour

As a general guideline, an irrigation capacity of at least 0.25 in/day would be considered high capacity for systems irrigating fields with high water holding capacity soils, like silt loams. Irrigated fields with sandy soils (low water holding capacity) need to have at least 0.30 inch/day to be considered high irrigation

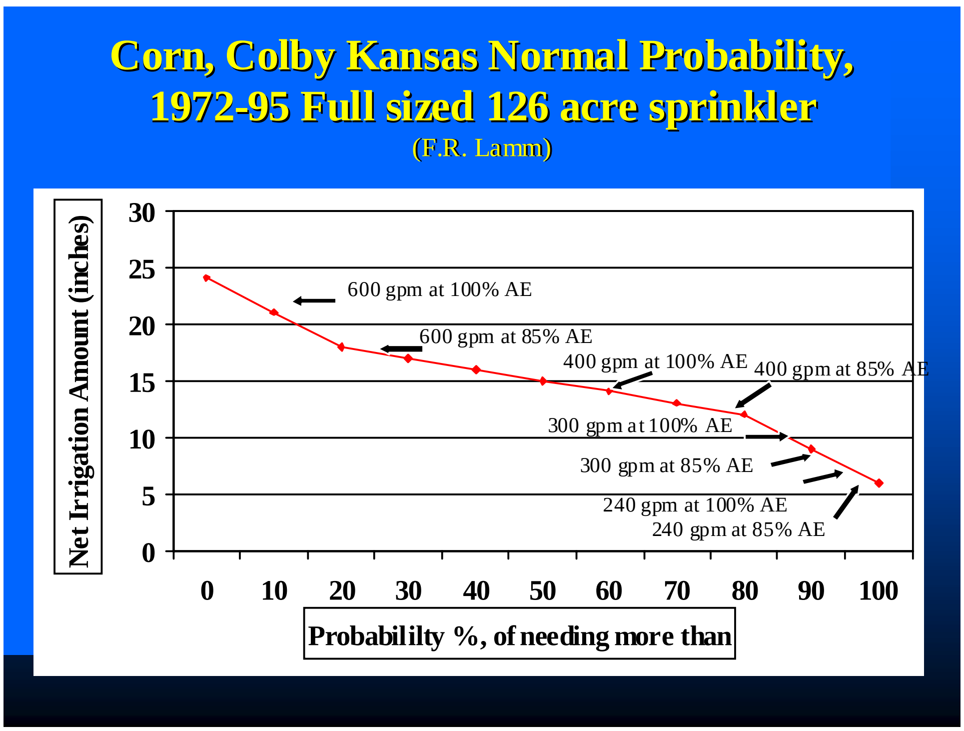
[1] KanSched is available for download for the Mobile Irrigation Lab (MIL) website at www.oznet.ksu.edu/mil or contact the author for a CD. The MIL program is supported in part by State Water Plan Funds through the Kansas Water Office.

capacity. Table 1 show the discharge rate requirement for various field sizes and efficiency values. Figure 1 shows the probability of various system capacities of meeting crop water needs for western Kansas conditions. This probability analysis also indicates lower capacity systems can meet full water needs of crops in some years, so irrigation scheduling could still benefit irrigators in determining when opportunities to save irrigation water occur.

Table 1. System flow rate required for various acreage and system efficiency

Irrigation Capacity	1 acre		125 acre	
	100% Eff	**85% Eff**	**100% Eff**	**85% Eff**
0.25 in/day	4.7 gpm	5.5 gpm	585 gpm	690 gpm
0.30 in/day	5.6 gpm	6.6 gpm	703 gpm	827 gpm

Figure 1. Effect of Irrigation Capacity on Irrigation System Reliablility.



To illustrate the use of ET-based irrigation scheduling, three years of ET and rainfall data were selected to use in KanSched and determine the irrigation schedule for two irrigation capacities (Figures 2-4). The years selected were 2002, representing high ET and low rainfall conditions; 1998, representing average or typical ET and average seasonal rainfall conditions; and 1986, representing low ET and high rainfall conditions. The data was collected at the

NW Research and Extension Center, Colby, KS. The ET and rainfall data were then mixed and matched to develop additional schedules to examine.

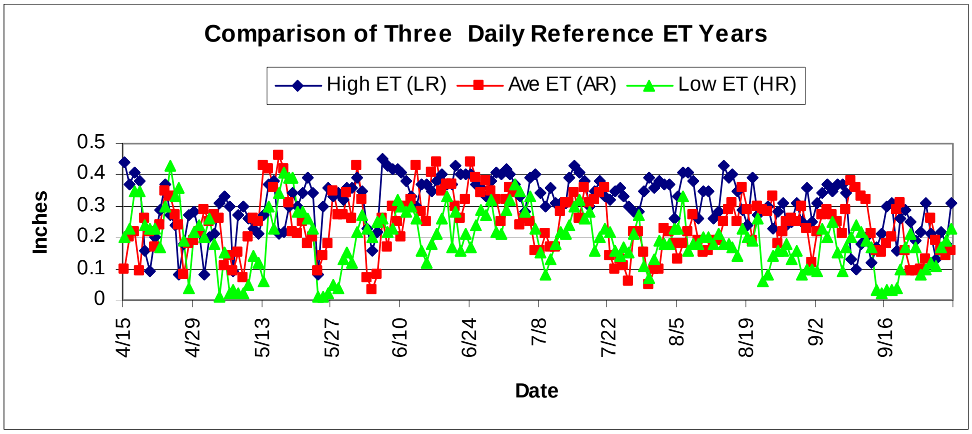


Figure 2. Daily Reference ET values for three example years.

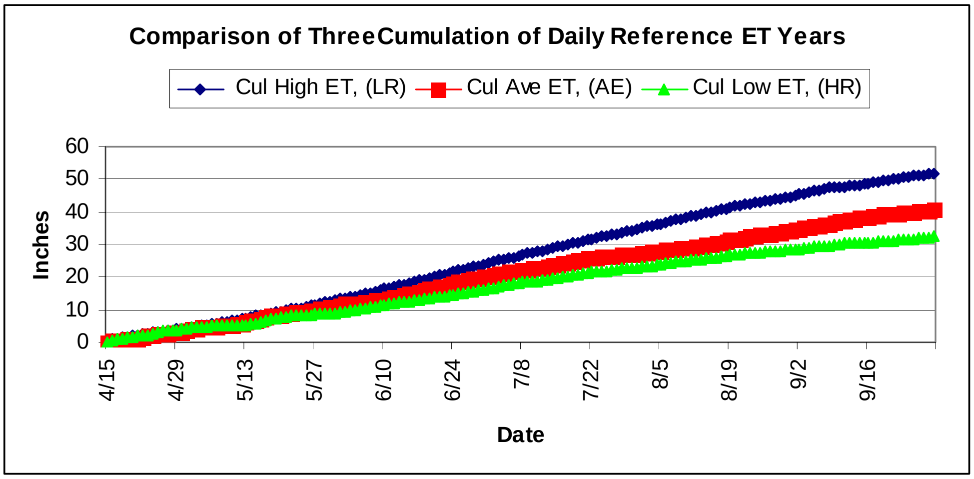


Figure 3. Cumulated Daily Reference ET values for three example years.

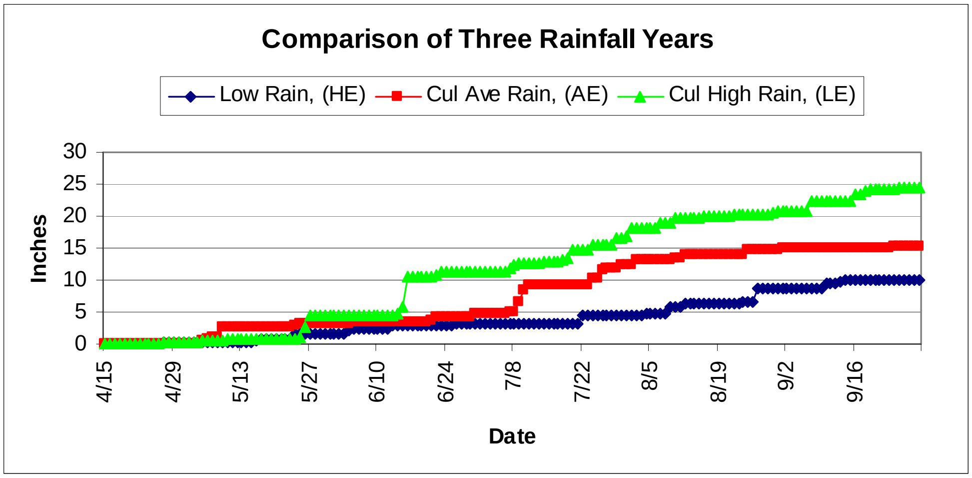


Figure 4. Cumulated rainfall events for three example years.

The test field established was for 118 day corn, emerging on May 1. Silt loam soil with a managed root zone of 42 inches was also used. The system efficiency was set at 85 percent. The irrigation capacity used was high capacity was set at 1 inch every four days (0.25 in/day) and low capacity of 1 inch every six days (0.17 in/day). Irrigation was initiated whenever the calculated root zone deficit reached one inch. Irrigation was terminated whenever the crop could reach physiologic maturity without exceeding the MAD (managed allowable deficit) of 50 percent.

The differences in the three base years are illustrated in Figures 2, 3 and 4. Figure 2 shows the daily ET plot, while Figure 3 shows the reference ET values accumulated for the period of April 15 through September 30. There is approximately 10 inches of difference between each year. Rainfall is shown in Figure 4. The low rainfall year occurred during the high ET year while the high rainfall year occurred during the low ET year.

Figure 5 shows a soil water chart for the average ET and rainfall year. Even though the rainfall for the year is near average for the season, notice the early season was dry while the later part of the season was wet. The high capacity irrigation system was easily able to maintain the soil water of the root zone above the 50 percent MAD level.

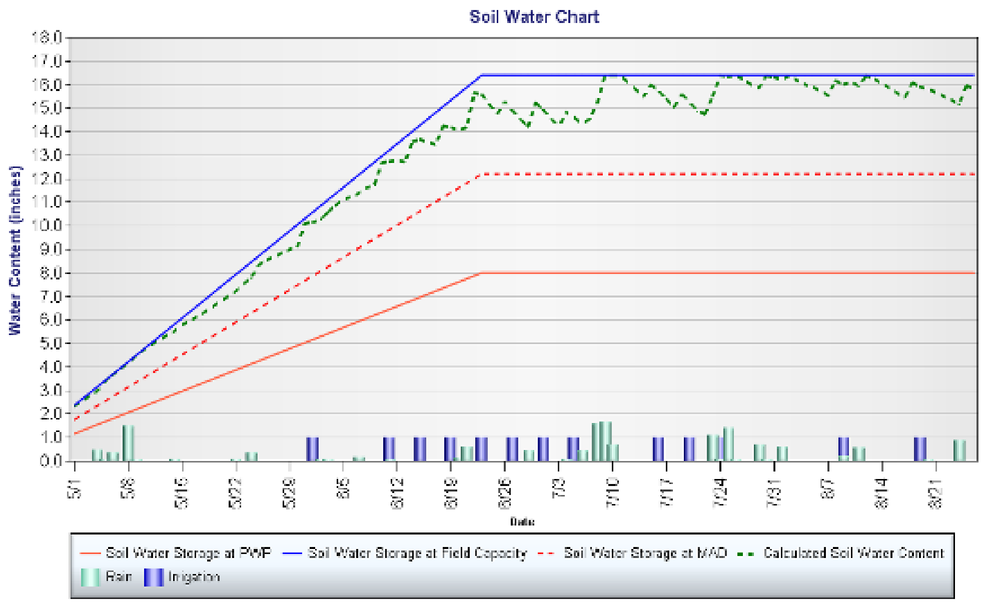


Figure 5. KanSched soil water chart for average ET and Rainfall (Field AR-AR-HC)

Tables 2, 3 and 4 show the results for the various ET years for the three rainfall years and low and high irrigation capacity.

For the high ET year (Table 2) with low rainfall, the high capacity system (Field HE-LR-HC) could not keep the root zone soil water above 50 percent MAD. For the low capacity irrigate rate, 57 days were below MAD. Many systems in western Kansas had water limiting yield stress when this year actually occurred. Notice that when high ET and high capacity were matched with average or high rainfall, no days below MAD were experienced, although the lower capacity system had some days below MAD. When the available soil water drops below MAD, crop ET begins to be suppressed and yield limited. Non crop water stress ET for the high ET year is 28.69 inches while the most stressed field (HE-LR-LC) had an ET of 23.47 inches.

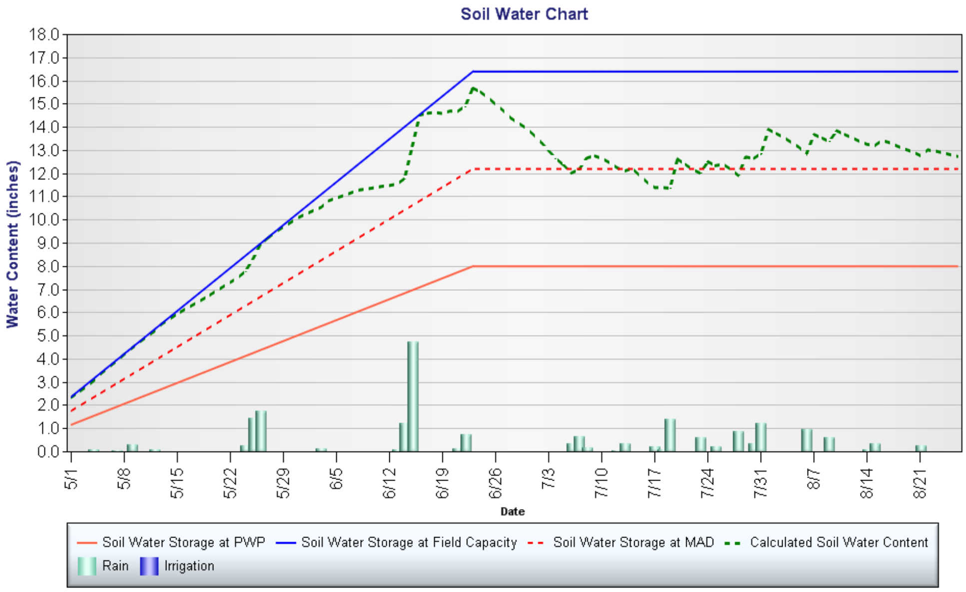


Figure 6. KanSched soil water chart for Low ET and High Rainfall with no irrigation. (Field LE-HR-NI)

Table 2. Summary of crop ET, effective rainfall, irrigation, and number of days when root zone soil water fell below 50 percent remaining for a high ET year.

Field	ET	Eff Rain	Gross Irr	Days < 50%
HE-LR-LC	23.47	8.36	14	57
HE-LR-HC	27.2	8.33	20	33
HE-AR-LC	28.35	12.71	14	8
HE-AR-HC	28.69	12.71	18	0
HE-HR-LC	28.55	13.29	14	6
HE-HR-HC	28.69	12.81	17	0

Table 3. Summary of crop ET, effective rainfall, irrigation, and number of days of root zone soil water fell below 50 percent remaining for an average ET year.

Field	ET	Eff Rain	Gross Irr	Days < 50%
AE-LR-LC	20.55	7.94	13	14
AE-LR-HC	21.13	6.62	17	0
AE-AR-LC	21.13	11.9	10	0
AE-AR-HC	21.13	8.5	14	0
AE-HR-LC	21.13	11.37	9	0
AE-HR-HC	21.13	10.52	10	0
AE-HR-LC	21.13	11.37	9	0

Table 4. Summary of crop ET, effective rainfall, irrigation, and number of days of root zone soil water fell below 50 percent remaining for a low ET year.

Field	ET	Eff Rain	Gross Irr	Days < 50%
LE-LR-LC	17.4	7.16	12	0
LE-LR-HC	17.4	7.16	12	0
LE-AR-LC	17.4	9.35	9	0
LE-AR-HC	17.4	8.08	10	0
LE-HR-LC	17.4	9.36	8	0
LE-HR-HC	17.4	8.51	9	0
LE-HR-NI	17.2	13.43	0	11

Table 3 shows the results of schedules for the average ET year. Only for the low capacity, low rainfall year did the available soil water drop below MAD. For the actual year of average ET and average rain, both high and low irrigation capacity met crop water needs.

For the low ET year, both high and low capacity was able to meet crop water needs for all rainfall years. The low ET, high rainfall year soil water chart is shown in Figure 3 and indicates that rainfall alone was nearly able to maintain MAD. Table 4 and Figure 6 show the results for field LE-HR-NI (NI = No irrigation) and indicates only 11 days below MAD occurred for the year with rainfall only. The full ET for the low ET year is 17.4 inches, only slight stress occurred with the rainfall only as the ET was 17.2 inches.

Table 5 shows the results of the three ET years combined with each rainfall year for high capacity irrigation. In this case, irrigation was to be initiated when 75 percent available soil water was reached, instead of the one inch depletion criteria. This would allow more room for rainfall storage in the soil root zone. In two cases, the strategy increased the number of days below MAD. For field HE-LR-HC, the days increased from 33 to 38; ET changed from 27.2 to 26.81 inches. The other is AE-LR-HC where two days of below MAD occurred with the improved strategy, however, ET only dropped from 21.13 to 21.11 inches. However, in all cases, gross irrigation was reduced from 1 to 4 inches. Effective rainfall, the amount of rain that could be stored in the root zone, increased in all cases except one.

Table 5. Summary of crop ET, effective rainfall, irrigation, and number of days when root zone soil water fell below 50 percent remaining for a high ET year when irrigation is initiated at a 75 percent root zone soil water contact.

Field	ET	Eff Rain	Gross Irr	Days < 50%
HE-LR-HC-I	26.81	8.36	19	38
HE-AR-HC-I	28.69	12.71	16	0
HE-HR-HC-I	28.69	14.14	14	0
AE-LR-HC-I	21.11	8.19	14	2
AE-AR-HC-I	21.13	14.78	10	0
AE-HR-HC-I	21.13	13.07	7	0
LE-LR-HC-I	17.4	7.87	11	0
LE-AR-HC-I	17.4	9.78	7	0
LE-HR-HC-I	17.4	11.85	5	0

Summary

ET-based irrigation scheduling has been effectively used by many irrigation managers, although some producers with low irrigation capacity systems feel its utility is limited. However, the examples in this presentation, illustrates that even low capacity systems can use ET-based scheduling to determine the irrigation application timing, including when to begin irrigation (sufficient root zone deficient to hold the applied depth) and when to end irrigation. In the selected years used for this analysis, rainfall at times can be sufficient to meet crop water needs without irrigation, indicating ET-based scheduling can be used effectively even for systems with limited irrigation capacity.