Preliminary review of irrigation needs for sorghum cover crop and native grass establishment on sands.

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Abstract
An analysis using three distinct historical weather years representing a range of high to low irrigation demand years, and the KanSched irrigation scheduling software package suggests sorghum irrigation needs for cover crop with irrigation termination at full cover, amounts would vary from 5 to 9.5 inches. For native grass irrigation needs for first year establishment, amounts would vary from 5 to 13.25 inches.

Three years were selected to examine the irrigation requirements needed for sorghum and native grass establishment on sand soil. The years were selected to represent a range of environmental conditions; from high evapotranspiration demand and low rainfall conditions, normal evapotranspiration and rainfall conditions and low evapotranspiration demand and high rainfall conditions. It is assumed appropriate cultural practices would be used for sorghum and grass.

The KanSched irrigation scheduling program was used to schedule the irrigation events for the three years. Tables 1a and 1b show the results for the three years assuming an emergence date of June 1. In Table 1a, irrigation was scheduled for the entire growing season. In the high ET year, the irrigation capacity was insufficient to meet the sorghum's water needs as indicated by noting that the available water in the soil root dropped below the management allowable deficit (MAD) of 50 per cent available for a total of 13 days during the growing season. For the high ET year, the gross irrigation water requirement was 20.75 inches. For the other two years with average or low ET requirements, no days of water stress were predicted and irrigation requirements dropped to 14.5 and 8.75 inches, respectively. The other assumption needed to complete the field set up pages of KanSched2 are noted below the table.

Table 1b only differs from Table 1a in that irrigation was terminated at one week past the 70-80 per cent cover date used in KanSched2. The rational is that full cover has been attained and grain yield is unimportant. This would achieve the goal of providing residue to protect the sand while the grass is planted and established but save irrigation water. The gross irrigation applications for the high, average and low ET years were 9.5, 6.25, and 5 inches respectively. The two extreme years would establish an expected irrigation range for sorghum cover crop establishment with full cover (5 to 9.5 inches).

Table 1a. Sorghum* irrigation needs for cover crop establishment

Field Name	**Sorg HET LR FI**	**Sorg AET AR FI**	**Sorg LET HR FI**
Ref ET	36.67	28.24	21.9
Crop ET	23.56[1]	18.11	14.25
Gross Rain	8.24	11.94	19.93
Effective Rain[2]	6	5.33	7.3
Gross Irrigation	20.75	14.5	8.75
Days < 50%	13	0	0

*Sorghum crop irrigation need for three crop years (High ET, Average ET, Low ET)
Crop assumptions: Maturity Length = 110 days; Emergence = June 1; 10 % cover = 6/18; 70-80 % cover = 7/17; Initial Maturation = 8/22; End of Season = 9/19.
Soil = sand with root zone beginning at 6 inches and maximum of 30 inches.
System efficiency = 85% Initial depth = 0.5 inches increasing to 0.75 inches with sufficient root zone.
Irrigation initiated with 0.5 inch root zone deficit (or 0.75 inch) or below 75% calculated soil water availability when 0.5 inch application.
Irrigation capacity set at 0.25 inches/day
[1]Note: non-stressed ET = 24.49
[2] Effective rain is the amount of a rainfall event that can be stored in the crop root zone at the time of the rainfall event

Table 1b. Sorghum irrigation needs for cover crop for season with irrigation termination at full cover (Estimated at 1 week past 80% cover date).

Field Name	**Sorg HET LR LI**	**Sorg AET AR LI**	**Sorg LET HR LI**
Ref ET	36.67	28.24	21.9
Crop ET	16.2	12.84	13.04
Gross Rain	8.24	11.94	19.93
Effective Rain	7.25	5.8	9.29
Gross Irrigation	9.5	6.25	5
Days < 50%	51[2]	41[3]	21[4]

*Sorghum crop irrigation need for three crop years (High ET, Average ET, Low ET)
Crop assumptions: Maturity Length = 110 days Emergence = June 1; 10 % cover = 6/18; 70-80 % cover = 7/17; Initial Maturation = 8/22; End of Season = 9/19.
Soil = sand with root zone beginning at 6 inches and maximum of 30 inches.
System efficiency = 85% Initial depth = 0.5 inches increasing to 0.75 inches with sufficient root zone.
Irrigation initiated with 0.5 inch root zone deficit (or 0.75 inch) or below 75% calculated soil water availability when 0.5 inch application.
Irrigation capacity set at 0.25 inches/day
[2]Note: Crop death ~ one week after end of irrigation.
[3]Note: Crop death ~ 4 weeks after end of irrigation.
[4]Note: Crop, though stressed, may have reached maturity.

Table 2 was also generated using KanSched2, although no internal crop growth parameters were used. The parameters used are noted as supplemental information below Table 2. Based on personal observations, a review of warm season grass publications and personal communication with several range grass specialists, the initial Kco was set at 0.20 using alfalfa reference ET, then increased to 0.6 Kco where it remained until ET termination. Warm season grass seeds require soil temperatures of 70^0 F for germination. A review of historical soil temperature data for Garden City indicated the 4 inch soil temperature reached that level around June 1. Data for the 2 inch depth was sooner but the 4 inch depth was used assuming good cover from the sorghum cover crop might keep the temperature cooler. At the end of the growing season, warm season native grass appears to be temperature sensitive and shut down when minimum temperatures reach about 55^0 F on several consecutive days. A visual review of Garden City weather indicated that this often occurs about mid September, so September 15 was selected as the ET termination date. Table 2 shows that in all years, the system was able to keep the root zone soil water above 50 per cent MAD. Early in the season, all irrigation was triggered by a predicted root zone deficit of 75 percent, which could result in the application depth to be in excess of the root zone deficit but was needed to prevent water stress on the emerging grass for the entire area of coverage. The irrigation requirements for the first year grass ranged from 5 to 13.25 inches.

Table 2. Native grass* irrigation for year 1 establishment.

Field Name	**Grass YR 1 HET**	**Grass YR 1 AET**	**Grass YR 1 LET**
Ref ET	35.64	27.26	21.7
Crop ET	15.45	11.63	9.09
Gross Rain	8.22	11.94	17.93
Effective Rain	4.8	3.71	5.25
Gross Irrigation	13.25	9.5	5
Days < 50%	0	0	0

*Native Grass Crop Irrigation Need on Sands for three crop years (High ET, Average ET, Low ET)
Crop assumptions: Growing season June 1-Sept 19. Sand soil with year 1 root zone beginning at 6 inches and maximum of 30 inches
Emergence assumed June 1 (~70 degree 4 inch soil temp); 10% cover date = 6/23; 70-80% cover date = 8/1; Initial Maturation = 8/2; ET termination = (9/15 ~minimum temps of <50 degrees).
System efficiency = 85% initial depth = 0.5 inches increasing to 0.75 inches with sufficient root zone.
Irrigation initiated with 0.5 inch root zone deficit (or 0.75 inch) or below 75% calculated soil water availability when 0.5 inch application.
6/23 = 10% Kco = .2 cover 8/1 = 80% cover Kco = .6; 8/2 = Initial Maturity Kco = .6
9/15 = season end Kco = .6.
Irrigation capacity set at 0.25 inches/day.

Table 3 summaries the year 2 irrigation water requirements for native grass for the three years. In this case, the growing season was assumed to be May 1 with grass green up but still with the mid September grass shut down. The roots were initiated at 30 inches and expanded to 48 inches. Irrigation requirements for the three years ranged from 8.25 inches to 21.75 inches. With irrigation for two years, a good grass crop should be established. With termination of irrigation, the grass will thin as the total water budget will drastically reduce. However irrigation should have allowed grass establishment over the entire field and minimized potential for bare areas that would have high wind blow out potential.

Table 3. Native grass* irrigation for year 2 growth.

Field Name	**Grass YR 2 HET**	**Grass YR 2 AET**	**Grass YR 2 LET**
Ref ET	45.37	26.15	9.63
Crop ET	26.15	20.14	15.56
Gross Rain	9.63	15	23,96
Effective Rain	7.16	6.34	8.5
Gross Irrigation	21.75	15	8.25
Days < 50%	4	0	0

*Native Grass Crop Irrigation need on Sands for three crop years (High ET, Average ET, Low ET).
Crop assumptions: Growing season May 1-Sept 19. Sand soil with year 2 root zone beginning at 30 inches and maximum of 48 inches.
Emergence and/or green up assumed May 1; 10% (begin rapid growth) = May 15; 80% (max ET and Roots) = June 15; Initial Maturation = August 15.
System efficiency = 85%. Irrigation depth = 0.75 inches irrigate if root zone deficit > 0.75 inches.
May 1 Kco = 0.2; June 15 Kco = 0.7; ending Kco = 0.4.
Irrigation capacity set at 0.25 inches/day.