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Sugarcane Water Use in Semiarid South Texas.

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Sugarcane water use has been established using reference evapotranspiration and crop coefficients developed based on research conducted at various locations throughout the world, as described in Irrigation & Drainage Paper 56 published in 1998 by the Food and Agriculture Organization of the United Nations. Application of this methodology requires that crop growth stages be calibrated for local conditions, and that information be determined for soil moisture holding capacity and rooting depth. Direct soil moisture monitoring over time using capacitance sensors in the semiarid South Texas indicate that sugarcane water use may be substantially less than predicted based on evapotranspiration. While sugarcane is a high water using crop, it may be able to compensate for mild or brief water stress and still be able to produce maximum yields. Optimum soil moisture availability may not be necessary throughout the entire growing period. Water use efficiency by sugarcane as high as 12 t cane/ML of water can be achieved.

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Sugarcane Water Use in Semiarid South Texas

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Introduction

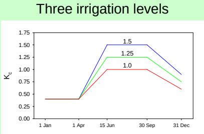
Water availability for agricultural production is becoming increasingly limited everywhere irrigated agriculture is done. Sugarcane is a big water user. This crop is capable of producing 10 t/ha of cane for each 1.0 to 1.2 ML of water used. Based on evapotranspiration rates, sugarcane therefore has the potential to produce up to135 t/ha depending on climate conditions in the Lower Rio Grande Valley, which would require 13.5 to 16.0 ML of water. While many factors including inadequate nutrition, salinity, weeds, insects and diseases can impact sugarcane production, water stress is most often the primary limitation. Sugarcane irrigation in the Lower Rio Grande Valley is usually very inefficient and wasteful. Therefore, substantial improvements are possible. Several efforts have been made to establish sugarcane crop water requirements in South Texas. In order to irrigate sugarcane as efficiently and effectively as possible, it is necessary to have a good understanding of crop water requirements and use in a manner that can be easily related to annual variability in climatic and rainfall conditions.

Objectives

The purpose of this study was to identify optimum water application levels based on evapotranspiration for sugarcane growth, yield and quality.

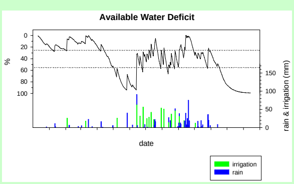
Procedures

Three irrigation levels



Assumptions:

1. Available soil moisture - .16 cm/cm
2. Root depth:
   Initial – 61 cm
   Sep 30 – 152 cm



Study Conditions

Raymondville clay loam soil
Climate:
- Semiarid (630 mm avg. annual rainfall)
- Subtropical (avg. daily high - 29ºC, avg. daily low - 17ºC)

Experimental design

Sugarcane cultivar TCP87-3388
Plots – 125 m^2
Subsurface drip irrigation
Randomized complete block design, 5 reps
4 year study

Parameters measured

Cane Yield
Sugar analysis

Results & Discussion

Sugarcane crop water use determined using the crop coefficient curve based on the low Kc mid =1.0 annually ranged from 10.8 to 13.0 ML depending primarily on the length of the growing season (Table 1). The increase in crop water use when the high Kc mid = 1.5 was applied was 44% higher in the plant crop, and 26 to 27% in the 1st through 3rd ratoon crops.

No significant differences in sugarcane yields occurred due to the irrigation treatments applied in the plant and 1st ratoon crops (Figure 3). Highest yields in the 2nd and 3rd ratoon crops occurred at the low and middle irrigation level, respectively. No differences in juice quality parameters due to the irrigation treatments were found any year. Between the highest and lowest irrigation treatments each year, the level of variation in sugarcane yield was 15% or less, while the difference in the amount of water inputs ranged between 23% and 39%. Therefore, highest water use efficiency each year occurred at the lowest irrigation level and declined with increasing water application (Figure 4).

The first through third ratoon sugarcane crops in this study produced between 9.3 and 11.7 t of cane per ML of water used at the low irrigation treatment. This is in line with the published production potential for sugarcane, and is well above typical production for this region. This suggests that other stress factors were probably not limiting production. The fact that yield gains due to increases in water application were small or nonexistent suggest that the amount of water required by sugarcane in order to produce maximum yields in the Lower Rio Grande Valley of Texas may be lower than the total amount of water used by sugarcane under ideal condition based on the published crop coefficient curves.

Table 1. Crop evapotranspiration (ETc), water inputs, cane yield and water use efficiency defined as cane yield as a function of combined water inputs for the three irrigation treatments based on different crop coefficient curves as indicated by the mid-season crop coefficient (Kc) for four sugarcane crops. Potential crop ET is based on the crop coefficient curve for each treatment, while adjusted crop ET reflects the effect of stress periods which may have occurred.

					ETc‡		rain§			combined		water
year	crop	days	ETo†	Kc_{mid}	potential	adjusted	total	effective	irrigation	water inputs	cane yield¶	use efficiency
			mm		----------	----------	----------	mm	----------	----------	$Mg\ ha^{-1}$	$Mg\ ML^{-1}$
2001	plant	441	1534	1.0	1295	1295	605	279	953	1232	99	8.0
				1.25	1582	1582		305	1168	1471	110	7.5
				1.5	1869	1869		333	1379	1712	102	6.0
2002	first ratoon	371	1389	1.0	1092	1082	587	411	612	1024	96	9.4
				1.25	1323	1267		465	732	1194	97	8.1
				1.5	1565	1361		490	838	1328	102	7.7
2003	second ratoon	401	1491	1.0	1189	1130	752	500	475	973	113	11.6
				1.25	1445	1318		500	602	1100	111	10.1
				1.5	1704	1433		500	699	1196	106	8.9
2004	third ratoon	361	1455	1.0	1166	1133	917	551	427	978	92	9.4
				1.25	1417	1308		747	518	1265	96	7.6
				1.5	1669	1435		747	577	1323	92	7.0

†Penmann-Monteith reference evapotranspiration.
‡Actual crop evapotranspiration may be less than potential crop evapotranspiration because of water stress occasionally encountered when soil water availability fell below the minimum threshold.
§Effective rainfall is less than total rainfall due to various losses before the water becomes available to the crop.
¶No significant differences in cane yield between irrigation levels were found for any crop year.

Figure 3. Cane yield

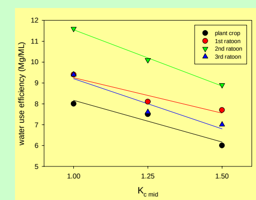


Figure 4. Water use efficiency

Summary & Conclusions

- Optimum irrigation level was not consistent from year to year.
- Between irrigation treatments, yield variability was much lower than difference in amount of water applied.
- Maximum sugarcane yields can be obtained with less water than based on published crop coefficients.

Acknowledgements

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