

DRYING OFF SUGARCANE ON SOILS WITH LOW WATER HOLDING CAPACITY

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Abstract

Suspending irrigation at a predetermined time before harvesting was compared with a gradual drying off through reduced irrigation, with the aim of producing guidelines for drying off shallow soils. This communication reports on the pros and cons of each approach.

Keywords: sugarcane, drying off, soils, irrigation, yield, harvesting

Introduction

Irrigated sugarcane is dried off to prepare the field for harvesting and to increase sucrose yield (Singels *et al*, 2000). Donaldson and Bezuidenhout (2000) have suggested that shallow soils be dried off for a period during which potential evapotranspiration (ET) does not exceed the available water capacity (TAM) of the soil by more than a factor of 1.8 (m factor). However, there is a risk that severe stress could develop in crops grown in low TAM soils when completely suspending irrigation for a predetermined period before harvest, because of climate variability. An alternative approach is to achieve a gradual drying off through deficit irrigation (Thompson and Boyce, 1968; Gosnell and Lonsdale, 1974).

Inman-Bamber (2004) linked crop parameters such as plant extension rate (PER) to changes in crop and soil water status and sucrose accumulation. Some of these parameters may be useful criteria for managing the drying off process.

In this study, crop responses to two drying off strategies were tested with the aim of improving drying off recommendations for shallow soils. Plant extension rate was measured to ascertain whether it could be employed in developing drying off strategies.

Methods

Experiment details

The experiment was conducted near Komatipoort (25°37'S; 31°52'E, 187 m a.s.l.), on a shallow sandy clay loam. The gravimetrically determined average TAM was 70 mm. Sugarcane varieties N25 and N32 were planted 1.5 m apart. Standard fertiliser and weed control practices were followed. Drip irrigation was scheduled using the Canesim model (Singels *et al*, 1998) when the calculated deficit reached 10 mm.

Three regimes of water application were compared during the period leading up to harvesting, (i) a slowly increasing soil water deficit (½ Dry) achieved by 50% irrigation, (ii) a rapidly developing soil water deficit (Dry) achieved by suspending irrigation, and (iii) no soil water deficit (Wet) achieved by full irrigation up to seven days before harvest.

Drying off treatments

In the first ratoon crop the drying off period for the Dry treatment was fixed at 62 days before harvest (DBH) (according to Donaldson and Bezuidenhout (2000), for June harvest on a 80 mm TAM soil at Tenbosch), but was unavoidably delayed to 67 DBH. The ½ Dry treatments were started on 10 February 2003 (134 DBH). The crop was harvested at the age of 11.6 months on 24 June 2003.

The second ratoon crop was cut back on 6 November 2003. For both the Dry and ½ Dry treatments, irrigation was suspended 35 DBH (see Donaldson and Bezuidenhout (2000) for a September harvest on an 80 mm TAM soil at Tenbosch). In the ½ Dry treatment, irrigation was resumed when the calculated available soil water content (ASWC) reached 35% of TAM, and thereafter maintaining calculated ASWC between 35% and 55% of TAM. Drying off treatments were started on 2 August 2004 and plots were harvested on 6 September 2004 when the crop was 10 months old.

Crop and soil water measurements

Cane quality and yields were determined (Buchanan and Brokensha, 1974). From the day of imposing dry treatments, PER was measured daily on three marked stalks in the third ratoon crop only. PER of Dry treatments were expressed relative to that of the Wet treatments (RPER). Volumetric soil water content was measured using a neutron water meter calibrated for the soil.

Results and Discussion

Water balance

The *m* factor captures the impact of all the important water balance components (TAM, evapotranspiration (ET) and rainfall) and is a convenient way of expressing the degree of drying off and consequent yield response. The *m* values that were eventually realised were higher than those found by Donaldson and Bezuidenhout (2000), especially for the first ratoon (Table 1). This is a clear indication that the first ratoon was dried off too severely. The main cause was a 55% difference in ET during the drying off period between the trial site and the Tenbosch site, due primarily to a much higher wind speed. The five-day delay in harvesting also contributed somewhat. A similar spatial difference in ET existed for the third ratoon, but the impact was largely negated because actual ET was 16% lower than the long term mean LTM (Table 1). Actual rainfall (and LTM values) was low and did not impact much on the water balance.

This highlights the danger of using a predetermined drying off period based on data from a different site, especially on a shallow soil. The large spatial variation observed here, and inter-annual variation in rainfall and ET could cause huge deviations from the desired *m* value, with consequential loss in yield or quality.

Crop yield and quality

Cane quality, but not cane yield, was affected by treatments in both the first and third ratoons (see Table 1).

Results for the first ratoon were quite variable due to severe lodging. The Dry treatment yielded on average 10% less estimated recoverable crystal (ERC) yield than both the ½ Dry and Wet treatments due to a significant reduction in ERC content (erc%cane). Juice purity was also reduced substantially. ERC yields of Wet and ½ Dry treatments were similar despite 239 mm less irrigation having been applied in the ½ Dry treatment.

ERC content declined in the Wet treatments in the third ratoon over the drying off period in both cultivars, despite a steady increase in stalk dry mass. Erc%cane was increased in a similar way by both dry treatments in both cultivars (Table 1) and ERC yield was increased by 9% (not significant). Unexpectedly high cane yields in the ½ Dry treatment of N32 resulted in the highest increase in ERC yields.

Table 1. The drying off period, growth cycle irrigation, cane yield, estimated recoverable crystal (ERC) content (%cane) and ERC yield (means of two cultivars) at harvest for the different treatments. Totals of rainfall and potential evapotranspiration (ET) during the drying off period of the Dry treatment, and the resultant m value (see table footnote) are also given. Long-term means are given in parentheses. Common superscripts denote insignificant differences.

Ratoon	Treatment	Drying off period (days)	Irrigation (mm)	Cane yield (t/ha)	ERC % cane *	ERC (t/ha)	Rainfall (mm)	ET (mm)	m **
First	Wet	7	1447	183 ^a	10.6 ^b	19.4 ^a			
	½ Dry	134	1208	181 ^a	11.0 ^b	19.9 ^a			
	Dry	67	1225	189 ^a	9.3 ^a	17.6 ^a	24 (22)	247 (239)	2.78 (1.8)
Third	Wet	7	876	113 ^x	11.1 ^x	12.5 ^x			
	½ Dry	35	844	117 ^x	12.0 ^{xy}	14.0 ^x			
	Dry	35	760	111 ^x	12.4 ^y	13.8 ^x	19 (9)	164 (194)	1.81 (1.6)

*Erc%cane = 0.978 sucrose%cane – 0.539 non-sucrose%cane – 0.019 fibre%cane

**m = sum of (ET – Rainfall) over drying off period, divided by a TAM of 80 mm

Plant extension rate and available soil water content

The water balance and RPER of N25 during the drying off period are illustrated in Figure 1. ASWC dropped rapidly to 50% on day 4 of the drying off period. During this period there was a slight decline in RPER for both dry treatments. Thereafter, ASWC for the ½ Dry treatment was maintained at 40-60% of TAM, and RPER remained above 80%. The objective of maintaining ASWC between 35 and 55%, proposed by Singels *et al.* (2000), was not achieved fully, because the Canesim model over-estimated actual irrigation requirements. This highlights the difficulty of using the model approach in practise, especially on shallow soils.

ASWC of the Dry treatment declined further after day 4 at a slower rate than initially. This was accompanied by a significant decline in RPER to about 50% at ASWC values of 20-30% of TAM.

The progression of RPER for N32 was similar to that of N25, although N32 appeared to extract less water initially.

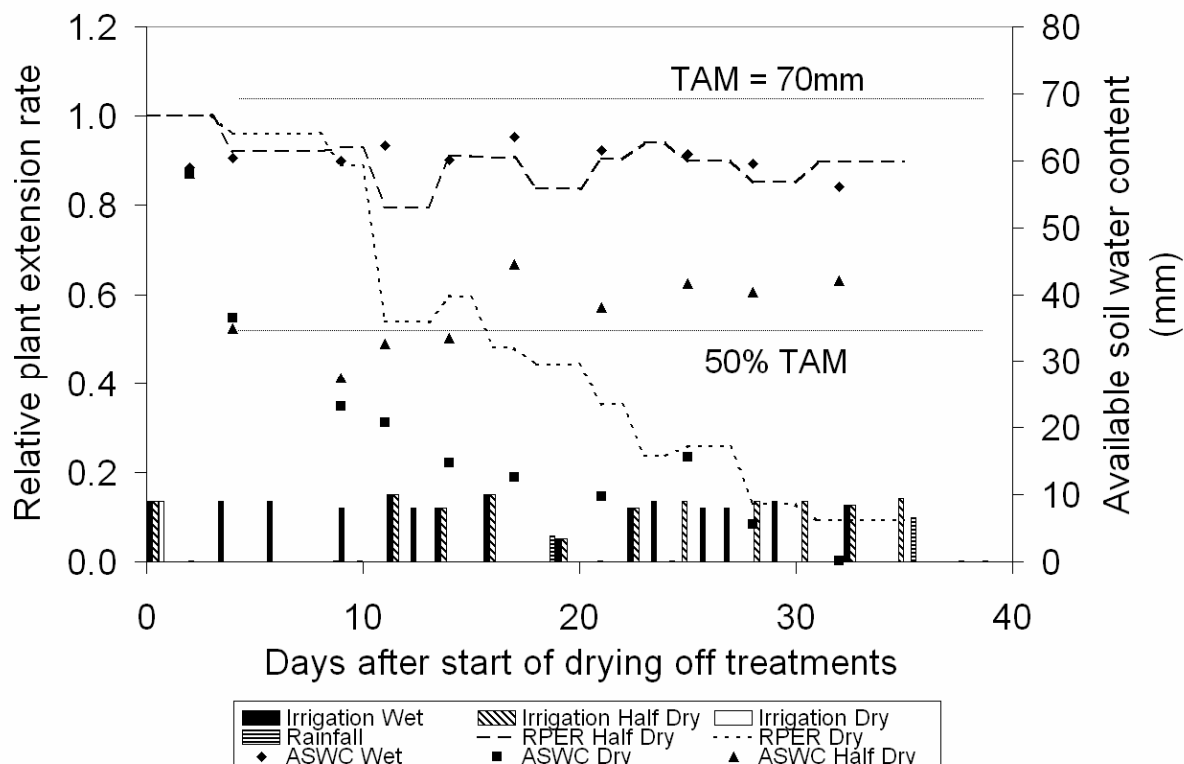


Figure 1. Relative plant extension rates of ½ Dry and Dry treatments (broken lines), available soil water content (symbols) of Wet, ½ Dry and Dry treatments during drying off for N25. Vertical bars indicate rainfall and irrigation amounts.

Conclusions

The study illustrated the difficulty of drying off sugarcane on shallow soils for a predetermined period because of inter-annual climate variation. Spatial variation in ET also limits the relevance of recommendations based on data from specific sites. A gradual drying off through reduced irrigation holds much promise to increase yields and quality.

The results of the third ratoon crop confirm that PER has the potential of being a good measure of crop water status. However, further research is required to develop a practical technique using this parameter (Smit *et al*, 2005).

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