DRIP LINE TYPE, PLACEMENT AND WATER

REGIME EFFECTS ON SUGAR CANE GROWTH AND YIELD

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The lack of knowledge on the factors which influence the response of sugar cane to drip irrigation, coupled with limited technical knowledge on the management and operation of a drip system is presently limiting the area under drip irrigation in Mauritius. Some research has been carried out in Hawaii but much of it is not directly applicable to other countries with differring climatic conditions and crop husbandry practices. Among the factors which must be researched are: choice, durability and placement of dripline; amount and frequency of water application; orifice spacing, management of drip irrigated sugar cane with interrow cropping; and methods of irrigation control.

In view of the above, the Mauritius Sugar Industry Research Institute (MSIRI) and the Institute of Hydrology (IH) began a joint study covering most of the above-mentioned factors. The trials laid down not only look into treatment effects but also at the various processes involved. The results on dripline type, placement and water regimes are presented here.

MATERIALS AND METHODS

Data used in this paper comes mainly from one of three trials located at Belle Vue Sugar Estate in the north of Mauritius (20°S; 57°E; altitude 70m). Details on the objectives and layout of the trials have been given in Batchelor et al. (1985). The mean annual rainfall of the area is 1432mm with a wet and warm summer period extending from November to April. The soil is a dark reddish-brown silty clay classified as a tropeptic haplustox in the USDA system (Arlidge and Cheong 1975).

The trial consisted of eight treatments in a randomized block with three replicates. The eight treatments were a factorial combination of two irrigation regimes, two types of dripline and two dripline placements. The two irrigation regimes were defined according to potential cane evapotranspiration, ET_c (Doorenbos and Pruitt 1977), as 1.0 ET_c and 0.5 ET_c. Irrigation was daily except after rainfall, when the irrigation was suspended for a number of days dependent on effective rainfall (Dastane 1974). The two types of dripline were a double-chamber type (orifice spacing - 0.30m, discharge rate - 1.2 l hr^{-1}) and an inline-emitter type (orifice spacing - 0.91m, discharge rate - 3.8 l hr^{-1}). The two dripline placements were at 20cm depth beneath every cane row and at 20cm depth in the alternate narrower interrows. Row spacing was a pineapple spacing (2.26 x 0.97m). Plot size was full field length (100m) by six cane rows wide, with only the inner two rows of each plot being considered as experimental. The sugar cane was Saipan 17, this is a variety which has a high sucrose content with an average cane yield. All the treatments received the same amount of fertilizer, P and K were applied at planting and N was applied through the drip system.

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The cane was planted in April 1983 and harvested in July 1984. Routine data collection was interrupted by an intense tropical cyclone on 25 December 1983 (i.e. 36 weeks after planting). This cyclone caused serious lodging and defiolation of the cane on the trials. The data collected up to the cyclone included tiller density, leaf area index and stalk elongation. Tiller density was recorded at fornightly intervals by counting the number of live tillers along 10m of the two experimental rows. Stalk elongation was also recorded fornightly by measuring the stalk length from soil level to the top most visible leaf collar of 15 stalks on two random spots per plot.

Samplings for cane yield were made after the cyclone and at harvest. The samples taken after the cyclone consisted of all stalks in 5m of the two experimental rows. Stalks were topped as for normal harvest (10 to 15cm below apex) and weighed on a field balance. At harvest, three sub-samples were weighed per plot, each consisting of 10m of the two experimental rows. One sample of 1m row length was cut for laboratory analysis for sucrose content using an automatic Saccharomat.

Table 1. Monthly rainfall and ET at Belle Vue

	Year	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
Rainfall (mm)	1983	-	-	-	48	38	54	78	48	22.	83	42	207
	1984	130	179	68	81	51	60	55	-	-	-	-	-
ET (mm)	1983	-	-	-	84	63	75	93	127	148	186	195	200
	1984	200	168	192	159	115	60	45	-	-	-	-	-

RESULTS

Sucrose yield at harvest ranged from 17.0 t ha^{-1} in the 1.0 ET_c emitter-type dripline in interrow treatment to 14.1 t ha^{-1} in the 0.5 ET_c double-chamber type dripline per row treatment (Table 1). As the treatments did not affect sucrose content (Industrial Recoverable Sucrose % Cane = IRSC) attention may be focussed on the second yield component i.e cane weight. At harvest cane yield in the above treatments were 151.7 t ha^{-1} and 127.3 t ha^{-1} respectively (Table 2).

At 36 weeks after planting the cyclone which passed near Mauritius caused damage particularly to cane in the more advanced plots. Some stalk deterioration susbsequently took place due to lodging. It has been shown in the past that the effect of a cyclone may be negligible on very young or less developed cane crops (Soopramanien 1979). Deterioration of lodged cane and those stalks which were broken at the base could be responsible for the anomalous results for treatments 1 and 5 (Table 2). Hence treatment differences are best illustrated by using the January sampling results.

Table 2. Cane yield for January sampling and yield components at harvest.

Treatment	Dripline type	Dripline placement	Irr. Regime	January Estimates	Yield at harvest		
			ET_c	Cane (t ha^{-1})	Cane (t ha^{-1})	IRSC	Sugar (t ha^{-1})
1	Double-Chamber	Row	1.0	137.7	130.1	11.5	15.0
2	Emitter	Row	1.0	128.2	142.7	10.7	15.3
3	Double-Chamber	Row	0.5	88.2	127.3	11.1	14.1
4	Emitter	Row	0.5	111.2	123.8	11.6	14.2
5	Double-Chamber	Interrow	1.0	143.0	139.3	11.4	15.9
6	Emitter	Interrow	1.0	142.5	151.7	11.2	17.0
7	Double-Chamber	Interrow	0.5	92.8	131.7	12.5	16.5
8	Emitter	Interrow	0.5	91.5	132.4	12.4	16.4
	L.S.D.$_{0.05}$			28.0	8.0	0.6	3.6

Treatment main effects indicate a significant cane yield difference (of the order of 12 t ha -1) between 1.0 and 0.5 ET_c water regimes irrespective of dripline type or placement. It is worthwhile pointing out that at the time of the cyclone highest cane yields were recorded with the higher water regime applied in interrow irrespective of dripline type. The January estimates did not indicate significant differences attributable to dripline type or placement.

The above results may be explained further by means of the two sub-components of cane yield viz: tiller (millable stalk or shoot) density and mean fresh weight per tiller. Tiller density in January was slightly higher for the wetter regime irrespective of dripline type or placement.

Data on tiller density evolution from planting time did not indicate any significant difference in duration of tillering between the water regimes. However there is an indication of a higher rate of tiller production in treatments with the dripline beneath each cane row as opposed to those with interrow placement irrespective of water regime (Fig. 1). A stable tiller population was achieved about 20 to 22 weeks after planting. During this tillering sub-phase irrespective of placement or dripline type, a higher tiller density prevailed in the wetter regime (1.0 ET_c), thus contributing partly to the higher cane yield mentioned earlier. A higher average stalk fresh weight was recorded for the same regime. This may be expained via differences in elongation growth rates as illustrated in Fig. 2. A close correlation is observed between the stalk weight results and the elongation rates. It is worth pointing out the slightly higher rate of elongation observed with emitter type dripline as opposed to a double chamber one, both supplying 0.5 ET_c water regime underneath each cane row.

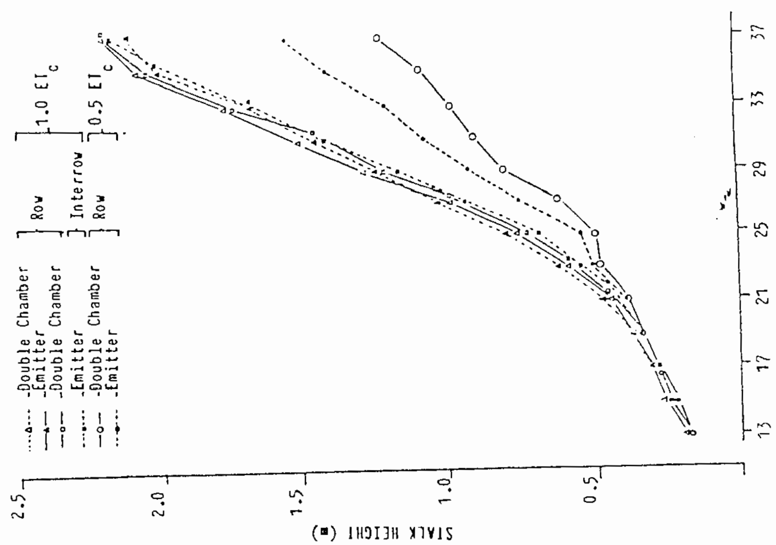

Fig. 2. Effect of Dripline Type and Placement on Stalk Height

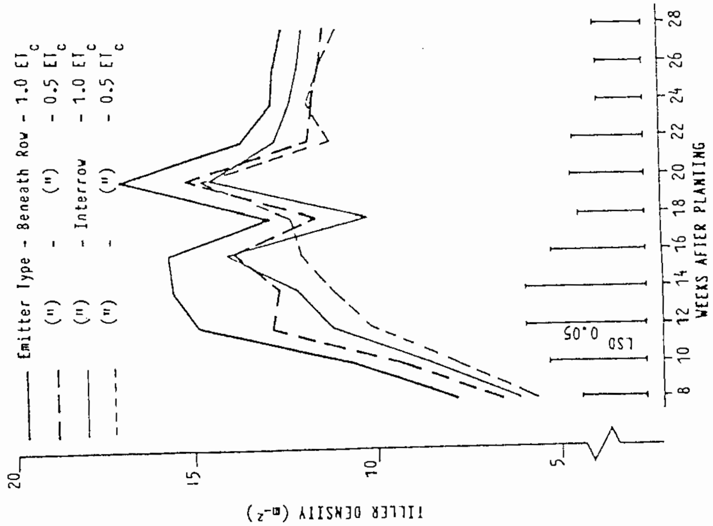

Fig. 1. Evolution of Tiller Density

DISCUSSION

Of the three factors examined in the trial, water regime had the most pronounced effect on cane growth and development. There is an indication that under drip irrigation 0.5 ET_c water application may be sufficient for the tillering phase of sugar cane. This is more or less in agreement with results obtained for overhead irrigation (Hardy 1967). As regards dripline placement, it is known that for cotton a lower but still profitable yield is obtained with one dripline per pair of rows (Benami and Offen 1983). The results here support the view that one dripline may be used to irrigate a pair of cane rows.

The results of cane yield estimate in January did not indicate a difference between the two types of dripline. A difference might have been expected to have arisen from the different instantaneous discharge rates and distance between the orifices or emitters. The instantaneous discharge rate of the emitters was three times that of the double-chamber dripline orifices. This could have influenced the partition between lateral diffusion of water and deep drainage; drainage would be expected to be greater in the case of emitters resulting in less water being available to the crop. Clearly the unsaturated hydraulic conductivity of the soil is an important factor in deciding emitter spacing and discharge rate. In the soil of this trial these factors appear to have been of only marginal importance. In other soils greater differences might have been expected.

A large difference was found between the durability of the two types of dripline. Although there was not any clogging observed with either type, the double chamber driplines were damaged in a few spots by ants. This was in spite of insecticide (Chlorpyrifos) being passed through the system every three to four months. Ant damage to double-chamber driplines has also been recorded on other schemes in Mauritius and is of concern in Hawaii (Chang et al. 1980). It should be mentioned that due to the relative success of biological control of pests, insecticides are not recommended for use in sugar cane fields in Mauritius.

Due to risk from fire and damage during harvest, driplines are usually buried in cane fields. A survey after harvest revealed that many of the double-chamber driplines were blocked by being pinched either between two shoots below ground level or by the whole stool pressing on the tube. This was more frequent in places where the dripline was at less that 20cm below ground level. In Hawaii, driplines are placed at shallow depth and are replaced after each harvest, whilst in Mauritius the driplines are expected to last for a complete crop cycle of one plant cane and eight ratoons ($\sim$ 10 years). Although the results of the plant cane crop do not show a difference in cane yield attributable to dripline type, the observations made on the trial site and elsewhere in Mauritius suggest that the double chamber driplines will not last a complete crop cycle.

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