COMPARISONS OF MEASURED EVAPOTRANSPIRATION OF SUGARCANE FROM LARGE AND SMALL LYSIMETERS

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Abstract

Evapotranspiration (E_t) was estimated for plant, first ratoon and second ratoon crops in a sugarcane field by means of the water balance in a large plastic-lined lysimeter (405 m^2) and three small weighed lysimeters (each 3,71 m^2). For the first 230 days of the plant crop of the experiment the mean daily estimates of E_t from the large and small lysimeters were 4,14 mm and 4,16 mm respectively. This good agreement was not maintained during the final 80 days of the experiment, when the sugarcane in the large lysimeter was lodged. The consumptive use of water by the crop immediately after lodging was apparently reduced to an extent which could be of practical significance in commercial production. The plant crop results were confirmed by the first and second ratoon data, although the agreement between large and small lysimeters deteriorated progressively. The productivity per unit of water (tons cane per hectare per 100 mm of E_t) remained fairly constant throughout the experiment, but, if Class A pan evaporation is taken as a guide to the yield potential in different crops, then it appears that the yield of sugarcane declined in successive ratoons.

Introduction

The water requirements of sugarcane (E_t) have been measured by means of lysimeters in a number of countries (Thompson[3]). Except in some of the earliest work carried out in Puerto Rico (Fuhriman and Smith[1]), all the lysimeters were surrounded by sugarcane planted at the same time and in the same way as that in the lysimeters.

However, the size and shape of all the tanks was such that sampling errors might have been large, particularly where single lysimeters were placed separately in the field. Any slight initial tendency for the cane in the tanks to grow better than that in the surrounds would have been sustained due to reduced competition for light. This was apparent in the plant crop yield data from the first South African experiments. (Pearson *et al*[2]). The mean yield from nine lysimeters, each having a surface area of 4,05 m^2, was 183 metric tons cane per hectare. The mean yield from plots surrounding the lysimeters, each 50,5 m^2 in extent, was only 132 metric tons cane per hectare.

It was therefore decided that a new experiment at Pongola should include both a large lysimeter (405 m^2) and three small lysimeters (each 3,72 m^2). For the plant crop, the data from only one small lysimeter are reported here. Drainage from the other two lysimeters was interrupted temporarily and this appeared to affect the subsequent performance of the sugarcane in these tanks. The same problem was not experienced in the ratoon crops.

Materials and methods

Description of site

The experiment was conducted at the South African Sugar Association Field Station at Pongola, 27°23'S and 31°37'E, on a Makatini sandy clay soil for which the mechanical analysis and moisture characteristics to a depth of 1,83 m have been described previously (Thompson and Boyce[5]). The experiment covered an area approximately 0,4 hectare in extent (216 m long and 18,3 m wide) and comprised 11 cane rows which were spaced 1,52 m apart, and planted along the length of the block (see Figure 1). The 0,4 hectare blocks on either side of the experiment were planted at the same time as the lysimeter block. Portable irrigation pipes were laid in breaks 3,05 m wide between blocks of cane, and irrigation water was applied by means of 13 sprinklers spaced at 18,3 m intervals on each side of the experiment.

The lysimeters were installed in the positions shown in Figure 1, and the completed installations of the large lysimeter and one small lysimeter, prior to planting, are shown in Figure 2. The large lysimeter was 38,0 m long and 10,64 m (seven rows) wide, with two guard rows on either side. The small lysimeters were each 2,44 m long and 1,52 m (one row) wide.

Daily readings were obtained from a Class A pan which was located in the centre of the meteorological station on the farm. The pan was surrounded by well-watered, frequently mowed lawn grass for a minimum distance of 30 m in all directions.

Construction and operation of lysimeters

Large lysimeter

The soil from the site was segregated in 30 cm strata during excavation so that the profile could be re-assembled approximately in its original condition. The bottom of the pit was sloped from a depth of 1,30 m at the N-W corner to a depth of 1,90 m at the S-E corner. The N-E corner was 1,45 m deep and the S-W corner 1,60 m deep.

The walls and bottom of the pit were sprayed with dieldrin and Jeyes fluid to discourage soil fauna which might otherwise puncture the plastic liner made of P.V.C., 0,56 mm thick. A 7,5 cm layer of sieved river sand was laid evenly over the bottom of the pit. The plastic liner was then laid carefully on this sand layer and a second 7,5 cm layer of river sand was

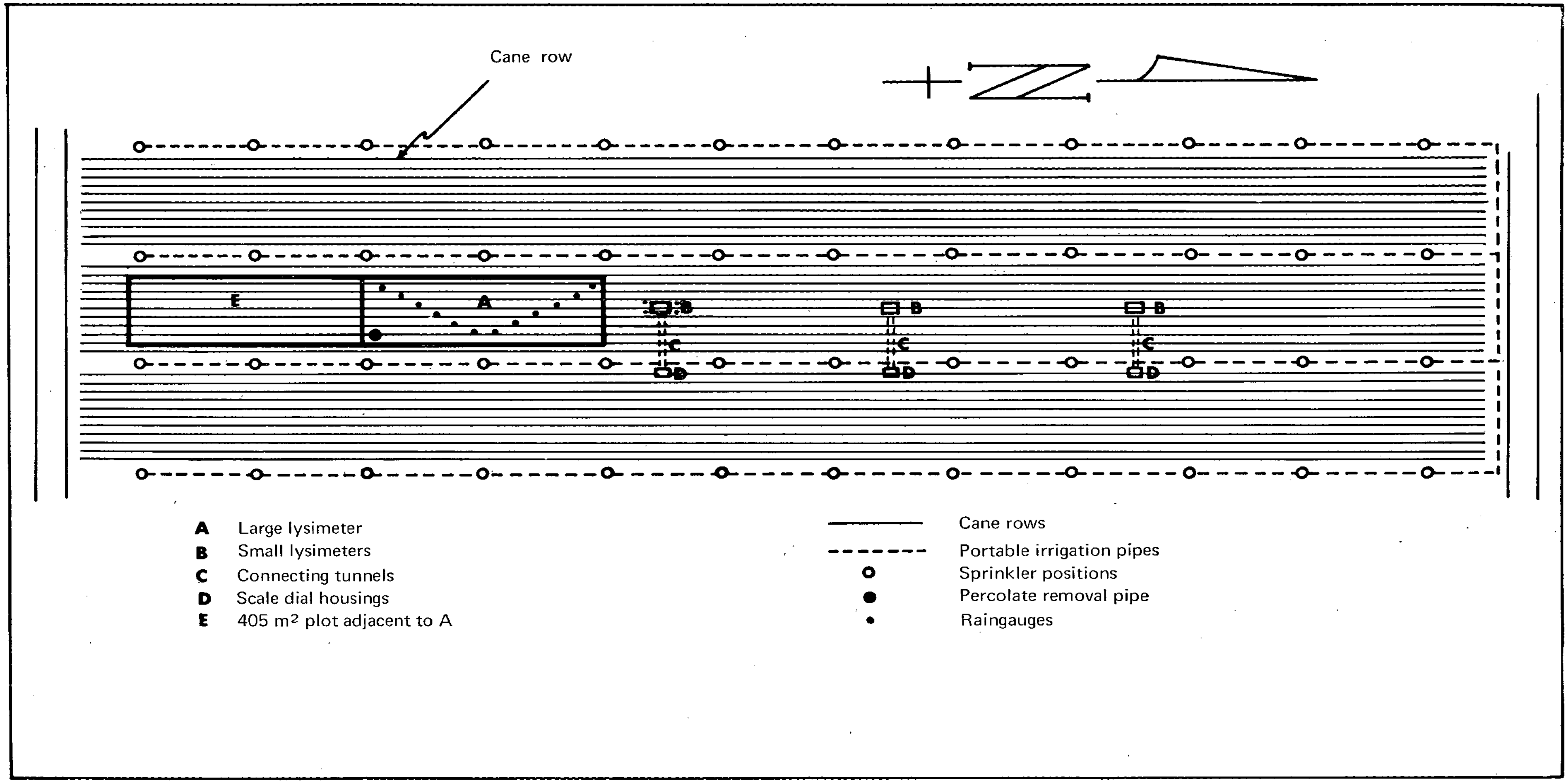

FIGURE 1: Plan of experiment showing locations of lysimeters.

placed on top of the plastic. A layer of 2 cm stone, varying in depth from 5 cm in the N-W corner to 15 cm in the S-E corner, was spread over the sand.

At this stage a 20 cm diameter steel pipe was placed in a vertical position, protruding 45 cm above ground level in the S-E corner of the pit and located midway between the first two rows of sugarcane in the lysimeter. The lowest end of the pipe was perforated with 1 cm diameter holes to permit free access of water, and the coarse stone layer was built up in the shape of an inverted cone around the pipe to a height of 75 cm. The entire stone layer in the pit was then covered with an additional 4 cm layer of river sand before the layers of soil were replaced in the correct order, leaving a 90 cm wide gap around the perimeter of the pit so that the plastic walls of the lysimeter could be raised at a later stage.

A wheel tractor was driven over the surface of the soil at several stages of refilling in order to compact the soil as nearly as possible to its original bulk density. After each such operation, the densely compacted surface layer was broken up to minimise stratification. The plastic liner forming the walls of the lysimeter was subsequently raised in the correct position, and sieved soil was compacted simultaneously on both sides of the sheet. The soil level in the lysimeter was raised approximately 5 cm above the surrounding ground level.

The site was then irrigated on two occasions and allowed to settle before the rim of the lysimeter was established. Treated timber boards, 3,7 m long, 23 cm wide and 5 cm thick were used for this purpose. One side of each board was bevelled at an angle of approximately 30° and the boards were placed in the soil to a depth of 15 cm, standing up so that the tall edge of the bevel was on the inside and formed the exact boundary of the 405 m^2 plot. The plastic sheet, protruding from the soil, was then drawn tightly over the bevelled timber rim and firmly secured. Excess plastic sheeting was trimmed away and the completed lysimeter appeared as it is shown in Figure 2. Percolate was removed from the lysimeter by means of a 5 cm semi-rotary hand pump (located next to the 20 cm pipe in the S-E corner), and was delivered to 200-litre measuring drums which stood outside the experiment.

FIGURE 2: Experiment site after completion of the installation of lysimeters, but before planting. Small, weighed lysimeter in foreground; large, plastic-lined lysimeter in background.

Previous work with non-weighing lysimeters (Thompson *et al*[6]) showed that data for periods of less than 28 days tend to be extremely variable, presumably due to relatively large unknown differences in soil profile moisture contents at the beginning and the end of a measuring period. No attempt was made, therefore, to saturate the profile and to remove percolate at definite time intervals. The duration of successive periods was based on the following criteria:

(i) that total evapotranspiration for a period was so large that the error incurred due to differences in profile moisture contents at the beginning and end of a period was proportionately small, and

(ii) that a period began and ended when either rainfall or irrigation water had saturated the soil profile and that all percolate from such precipitation had been removed before additional percolation from subsequent precipitation occurred.

Small lysimeters

Each of the steel tanks for the small direct-weighing lysimeters was 2,44 m long, 1,53 m wide and 1,22 m deep, with a perforated plate 5 cm from the bottom to permit the accumulation of percolate below the soil profile. A 4 cm diameter pipe was located vertically in one corner of each tank, the pipe being held approximately 6 mm clear of the bottom of the tank. A layer of 2 cm stone was spread to a depth of 7,5 cm over the perforated plate, and a 4 cm layer of river sand was placed on top of the stone.

Trenches 0,60 m wide and 1,5 m deep were dug around three monoliths of undisturbed soil on a nearby site. The surface dimensions of the monoliths were exactly 2,44 m × 1,53 m. Strata of soil, 15 cm thick, were cut and removed separately from the monoliths until the seventh stratum was reached. This was transferred directly to a lysimeter tank and re-compacted so that it again formed a layer 15 cm deep. Each additional stratum of soil from one monolith was then placed in the same tank in the correct order and recompacted to the required 15 m depth, care being taken again to avoid stratification. The final soil level was 2,5 cm below the rims of the tanks.

The lysimeters were weighed by means of heavy capacity dial scales. The dial cabinets were located in pits about 8,5 m from the lysimeter pits, with access tunnels 1,2 m below ground level connecting the two pits (see Figure 1). The upper 20 cm of the lysimeters was surrounded by steel frames. The gaps between the frames and the tanks were 1,25 cm wide but below the level of the frames, the brick walls of the lysimeter pits were separated from the tanks by gaps of 7,5 cm.

It was determined in advance that the weight of a lysimeter, filled with soil at field capacity, would not exceed 10 000 kg. A counter-balance of 7 250 kg was therefore incorporated in the weighing mechanism and this feature made it possible to read weight changes to the nearest 100 g. The calibration of the scales was checked periodically by means of standard weights placed on the lysimeters.

The evapotranspiration from the weighed lysimeters was determined daily at 8 a.m. by taking precipitation, percolate and the weight changes for the previous 24 hours into account. Percolate was removed from the bottom of each tank by means of a 2,5 cm semi-rotary pump. The drainage water was always removed over a short period in the early morning, and the amounts were accurately determined by recording the weights of the lysimeters before and after pumping.

Measurement of precipitation

Large lysimeter

In order to determine the number of raingauges required and where they should be placed on the large lysimeter, it was arbitrarily decided that precipitation should be measured to within ± 1,3 mm of the mean. The precipitation from the sprinklers surrounding the large lysimeter was estimated on five occasions by means of 144 rain gauges, placed at ground level in a 1,53 m × 1,53 m lattice over the entire area of the lysimeter. On each occasion the mean precipitation was approximately 2,5 cm. Wind direction was either from N-E or S-W, and wind conditions varied from calm to a mean wind speed of 14 k.p.h.

With 12 gauges, located as shown in Figure 1, it was found that total precipitation could be estimated to within 1,0 mm of the mean under a variety of conditions. The 12 raingauges were mounted on telescopic masts so that they could be raised progressively above the developing crop foliage, and the precipitation trapped in the gauges was led through plastic tubing into collecting bottles. No tests were carried out after installation of the raingauges to assess the effects of raising them on the accuracy of the estimates of precipitation.

Small lysimeters

Precipitation onto all of the small lysimeters could be measured accurately in terms of weight gains and all irrigation water applications were therefore made at night, when wind conditions tended to be calm and evaporation losses at a minimum. However, precipitation onto the small lysimeter which lay nearest to the large lysimeter was measured in the plant and first ratoon crops by means of four raingauges located as shown in Figures 1 and 2. It was therefore possible to assess the validity of the raingauge estimates by comparing them with the values obtained from weight changes.

Cultural procedures

The experiment was planted on 12th November, 1967, after all of the lysimeters had been irrigated several times and the soil allowed to settle for more than two months. Superphosphate containing 93 kg P per hectare and urea containing 112 kg N per hectare were banded in the furrow before planting. Single-budded setts of the variety NCo 376 were planted at intervals of 15 cm between buds throughout the 0,4 hectare experiment.

The setts were covered with soil to a depth of 5 cm and before cane emergence the area was sprayed with 4,5 kg diuron per hectare to control weeds. The experiment was top dressed on 20th December, 1968 with urea containing a further 112 kg N per hectare, and muriate of potash containing 56 kg K per hectare. Chemical analyses of third leaf lamina samples, taken in March, 1968, showed that all major nutrient elements had been adequately supplied to the crop.

A heavy application of irrigation water was made after planting and this was followed within a week by 82 mm of rain. The soil profile was thus completely saturated and the operation of the water balance for the large non-weighing lysimeter commenced on 19th November. Percolate equivalent to 73 mm of precipitation was subsequently removed from the lysimeter. Irrigation water was applied to the plant and second ratoon crops whenever the soil moisture deficit, based on measured E_t from the small lysimeters, exceeded 50 mm. In the first ratoon crop the experiment was irrigated whenever percolate no longer accumulated in the lysimeters.

The plant crop of the experiment was harvested on the 9th October, 1968. All stalks were topped by hand at the base of the fifth leaf sheath before cutting at ground level, and yield data were obtained for each of the following areas of cane:

(i) the 405 m^2 large lysimeter
(ii) a similar 405 m^2 area south of, and adjacent to the large lysimeter
(iii) the 2,44 m of cane row constituting the small, weighed lysimeter nearest (i)
(iv) twelve separate sub-plots, each comprising 2,44 m of cane row, within the 405 m^2 large lysimeter (i)
(v) twelve separate sub-plots, each comprising 2,44 m of cane row, within the adjacent 405 m^2 plot (ii)
(vi) four separate sub-plots, each comprising 2,44 m of cane row, in the area surrounding the small lysimeter
(vii) the 2,44 m of cane row on each side of the small lysimeter.

Sub-samples, consisting of 25 stalks, were taken from each of the sub-plots and also from the small lysimeter. The lengths and diameters at three points (top, middle, bottom) of each of these stalks were measured. The total number of stalks per sub-plot in the small lysimeter were also counted.

The ratoon crops were top-dressed with fertilizers containing adequate amounts of N, P and K. The first ratoon crop was harvested on 2nd December, 1969 and the second ratoon crop on 17th November, 1970. Harvesting procedures for the ratoons were generally the same as those for the plant crop, but included the yields from all three of the small, weighed lysimeters.

Results

Estimates of precipitation onto the small lysimeter nearest to the large lysimeter, determined from the weight gains of the lysimeter and from the means of the four raingauge measurements, are shown in Table I for the plant and first ratoon crops. The results for the plant crop were grouped into three successive periods during which the relationship between the two estimates remained fairly constant. Approximately the same intervals have been used to classify the first ratoon data.

The comparable data for consumptive use of water by sugarcane in the large lysimeter and one small, weighed lysimeter are given in Table II for a total period of 310 days of the plant crop. The sugarcane in the large lysimeter lodged in July, 1968, whereas that in the small lysimeter and its surrounds was supported in an erect position by means of single-strand barbed wire fences in which the cane was bound. The cane in the small lysimeter

TABLE I

Estimates of irrigation precipitation onto the small lysimeter from the weight gain (A) and the mean of measurements from 4 raingauges (B) in the plant and first ratoon crops

Period	Precipitation, mm		B/A X 100
	From weight gain (A)	Mean of 4 raingauge meas. (B)	
Nov. '67—Feb. '68	449	427	95
Mar. '68—June '68	566	420	74
Jul. '68—Oct. '68	514	424	83
Total, plant crop	1 529	1 271	83
Oct. '68—Feb. '69	1 164	1 062	91
Mar. '69—June '69	1 014	797	79
Jul. '69—Oct. '69	789	743	94
Total, 1st ratoon	2 967	2 602	88

TABLE II

Summary of data for the consumptive use of water by sugarcane in the large and small lysimeters for the plant crop from 19.11.67 to 23.9.68

Period		No. of days	Measured evapotranspiration, E_t			Ratio $\frac{A}{B} \times 100$
From	To		Large lysimeter		Small lysimeter mean mm/day (B)	
			Total mm	Mean mm/day (A)		
19.11.67	7.1.68	45	119	2,64	2,77	95
8.1.68	26.1.68	24	128	5,33	5,46	98
27.1.68	13.2.68	18	119	6,62	6,78	98
14.2.68	12.3.68	28	146	5,21	5,36	97
13.3.68	22.4.68	41	183	4,46	4,34	103
23.4.68	7.6.68	46	170	3,70	3,73	99
8.6.68	5.7.68	28	87	3,11	2,97	105
6.7.68	30.7.68	25	63	2,52	3,00	84
31.7.68	23.9.68	55	204	3,71	4,52	82
19.11.67	5.7.68	230	952	4,14	4,16	99
6.7.68	23.9.68	80	267	3,34	4,04	83
19.11.67	23.9.68	310	1 219	3,94	4,10	96

TABLE III

Summary of data for the consumptive use of water by sugarcane in the large and small lysimeters for the first ratoon crop from 26.10.68 to 29.11.69

Period		No. of days	Measured evapotranspiration, E_t			Ratio $\frac{A}{B} \times 100$
From	To		Large lysimeter		Small lysimeter mean mm/day (B)	
			Total mm	Mean mm/day (A)		
26.10.68	26.12.68	62	194	3,13	4,09	76
27.12.68	7.2.69	43	335	7,79	7,52	103
8.2.69	12.3.69	33	187	5,67	5,89	96
13.3.69	11.5.69	60	188	3,13	3,61	87
12.5.69	8.7.69	58	143	2,47	2,36	104
9.7.69	15.9.69	69	226	3,28	3,61	91
16.9.69	20.10.69	35	133	3,80	5,16	74
21.10.69	29.11.69	40	136	3,40	5,41	63
26.10.68	15.9.69	325	1 273	3,92	4,22	93
16.9.69	29.11.69	75	269	3,59	5,28	68
26.10.68	29.11.69	400	1 542	3,86	4,42	87

TABLE IV

Summary of data for the consumptive use of water by sugarcane in the large and small lysimeters for the second ratoon crop from 9.2.70 to 14.11.70

Period		No. of days	Measured evapotranspiration, E_t			Ratio $\frac{A}{B} \times 100$
			Large lysimeter		Small lysimeter mean mm/day (B)	
From	To		Total mm	Mean mm/day (A)		
9.2.70	19.3.70	39	233	5,97	6,45	93
20.3.70	22.4.70	34	157	4,62	5,05	91
23.4.70	12.5.70	20	55	2,75	3,66	75
13.5.70	17.6.70	36	64	1,78	2,77	64
18.6.70	24.7.70	37	104	2,81	2,44	115
25.7.70	27.8.70	34	102	3,00	3,18	94
28.8.70	30.8.70	34	121	3,56	4,52	79
1.10.70	14.11.70	45	176	3,91	5,38	73
9.2.70	27.8.70	200	715	3,58	3,96	90
28.8.70	14.11.70	79	297	3,76	5,00	75
9.2.70	14.11.70	279	1 012	3,63	4,27	85

was supported independently of that in the surrounds. It appears that the consumptive use of water by the lodged cane was appreciably lower than that of the standing cane. The mean data have therefore been given separately for the major period prior to lodging (230 days), the period after lodging (80 days), and the entire duration of the experiment (310 days).

Similar data, comparing the results from the large lysimeter with the means of those from all three small lysimeters are given in Table III and IV for the first and second ratoon crops respectively. As in the plant crop data, a marked divergence of results for large and small lysimeters only occurred when the cane in the large lysimeter lodged. This happened in mid-September in the first ratoon crop and at the end of August in the second ratoon crop. The mean results have therefore been tabulated separately again for the periods prior to lodging and after lodging, and for the entire duration of the crops.

The yield results for all three crops are given in Table V. The harvested crop characteristics for the plant crop only are given in Table VI. Differences between mean sub-plot data and the results from the small lysimeter were tested for statistical significance, and where this was shown to exist, the level of significance has been indicated by means of asterisks in the table.

TABLE V

Yield data in metric tons of cane per hectare for the plant (11 months) first ratoon (14 months) and second ratoon (11,5 months) crops

Source	Plant	1st ratoon	2nd ratoon
(i) Large lysimeter	151	183	148
(ii) Adjacent 405 m² area	136	179	149
(iii) Small lysimeter(s)	166	226	165
(iv) Mean of 12 sub-plots in (i)	161	181	—
(v) Mean of 12 sub-plots in (ii)	146	181	—
(vi) Mean of 4 sub-plots near (iii)	152	149	169
(vii) 2,44 m of cane row W of (iii)	149	163	163
(viii) 2,44 m of cane row E of (iii)	130	137	140

TABLE VI

Summary of harvested crop characteristics for the plant crop

Source	Stalks/ha $\times 10^{-3}$	Stalk length, cm	Mean stalk diam., mm
(i) Small lysimeter	208	184	21,8
(ii) Mean of 12 sub-plots in large lysimeter	194	218**	21,7
SE of mean ±	4,0	1,83	0,196
(iii) Mean of 12 sub-plots in adjacent 405 m² area	177	202*	21,6
SE of mean ±	6,1	1,65	0,152
(iv) Mean of 3 sub-plots near (i)	177	206	21,5
SE of mean ±	7,9	3,70	0,292
(v) 2,44 m of cane row W of (i)	162	214	21,9
(vi) 2,44 m of cane row E of (i)	167	191	23,3

Asterisks indicate significance of differences between sub-plots and values for the small lysimeter at the 5% (*) and 1% (**) levels.

Discussion

Estimation of precipitation

The data in Table I, showing estimates of precipitation on to the small lysimeter, are of interest mainly as an indication of the possible errors incurred in earlier lysimetry (Thompson *et al*[6]; Thompson and Boyce[4]) where four raingauges per lysimeter were used to estimate irrigation precipitation. By using the mean of the four raingauges instead of the lysimeter weight-gain, actual precipitation during the plant crop would have been underestimated by 5% in the first four months, 26% in the following four months, and 17% in the final four months. The increase in the error after the first four months was probably associated with the increasing height of the raingauges in relation to that of the sprinklers, which were always mounted on risers 3 m above ground level. The discrepancies observed in the first ratoon crop data were similar to those in the plant crop, although smaller on the average. The underestimation of the actual precipitation was probably also associated with the location of the four raingauges near the extremity of the throw of each of the surrounding four sprinklers. Similar effects on the data from the large lysimeter seem less likely to have occurred because the 12 raingauges sampled precipitation at various points along the radius of throw of the sprinklers.

Size of lysimeter and water use efficiency

The results shown in Table II for the first 230 days of the plant crop of the experiment indicate that the size of the lysimeter had a relatively small effect on the estimate of evapotranspiration. For practical purposes, the difference of 0,02 mm per day between the means, or 8,1 mm cumulatively over the entire period, can be regarded as negligible. However, the difference increased in the first ratoon crop to 0,30 mm per day, and in the second ratoon crop to 0,38 mm per day for the periods prior to lodging of the cane (see Tables III and IV). To facilitate an assessment of the trend of events during the entire experiment, a number of ratios are shown in Table VII. It can be seen that for the period of full canopy, the plant cane in the small lysimeter used water at the same rate as that at which evaporation took place from a Class A pan ($E_t/E_o=0,99$). Previous results have shown that this is approximately the maximum rate of water use by sugarcane. The plant cane in the large lysimeter also used water at this rate prior to the time at which lodging took place ($E_t/E_o=1,01$). After lodging, however, the rate of water use declined sharply ($E_tE_o=0,78$). The efficiency of water use (expressed in terms of tons cane per hectare per 100 mm of evapotranspiration) was slightly higher in the small lysimeter than in the large lysimeter.

In the first ratoon crop, the rate of water use by the sugarcane, relative to Class A pan evaporation, was reduced in the small lysimeters ($E_t/E_o=0,94$), but also to a much greater extent in the large lysimeter ($E_t/E_o=0,89$) prior to lodging. There was also a decline in the rate of water loss from the large lysimeter after the first ratoon crop had lodged ($E_t/E_o=0,67$). The increase in productivity per 100 mm of evapotranspiration which occurred between the plant and first ratoon crops could have been predicted, at least to some extent, on the grounds that the ratoon crop had a trash layer covering the soil surface. Also, the ratoon crop tended to canopy more quickly than the plant crop, thus further reducing the proportion of losses due to evaporation.

A further decline in the rate of water use relative to Class A pan evaporation took place in the second ratoon crop, the effect again being more pronounced in the large lysimeter than in the small lysimeters. The efficiency of water use was not appreciably affected, and the indications therefore are that water use and yield declined concurrently as the experiment progressed, but that the effects were more marked in the large lysimeter than they were in the small lysimeters.

Effects of lodging

The most important implication of the results of of this experiment is that water use by sugarcane declines sharply when lodging takes place and remains low for at least 2½ to 3 months thereafter. Tables II, III and IV show that evapotranspiration was reduced, after the cane in the large lysimeter lodged, by amounts of 0,70 mm, 1,69 mm and 1,24 mm per day in the plant, first ratoon and second ratoon crops respectively, when compared with the water use of the erect cane in the small lysimeters. This represents an average reduction of about 30% in evapotranspiration following lodging, an effect which must have considerable significance in commercial practice. Not only should irrigation water applications be reduced accordingly, but a grower can anticipate that his productivity per unit of time will also be reduced by a similar amount.

Comparisons of yields

Reference to Table V shows that the yields of cane from the large lysimeter and the adjacent 405 m^2 were very similar, particularly from the ratoon crops. This indicates that the extra soil disturbance in the lysimeter did not apparently consti-

TABLE VII

Evapotranspiration/pan evaporation ratios and yield/evapotranspiration ratios for the large and small lysimeters

Crop	E_t/E_o (pan) ratios			Yield/E_t ratios (entire crop periods), tc ha/100 mm E_t	
	Large lysimeter		Small lysimeters (full canopy)		
	full canopy, pre-lodging	post lodging		Large lysimeter	Small lysimeter
Plant	1,01	0,78	0,99	11,2	11,7
1st Ratoon	0,89	0,67	0,94	11,3	12,3
2nd Ratoon	0,80	0,65	0,88	11,5	11,3
Mean	0,88	0,69	0,93	11,3	11,8

tute a marked advantage. However, the rows next to the small lysimeter which lay closest to the large lysimeter gave yields which were appreciably lower than the yield of the crop in the lysimeter itself. This could well explain the generally higher yields from the small lysimeters, but not necessarily the relatively slower decline in consumptive use of water in successive ratoons, when compared with the large lysimeter.

Whilst the mean yields from the 12 sub-plots in the larger lysimeter, and also the adjacent 405 m^2, compared well with the yields from the whole plots (Table V), it should be noted that the yields from individual 2,44 m lengths of row in the large lysimeter varied from 138 to 178 tons per hectare. This confirms the necessity for replication in this type of work. The point is illustrated further when the mean first ratoon crop yield from the small lysimeters (226 tc ha) is compared with the mean yield from four surrounding sub-plots (149 tc ha).

The harvested crop characteristic data in Table VI indicate that the cane in the small lysimeter tended to be taller than any other cane, and particularly taller than the cane in the adjacent rows. Compensation occurred in terms of stalk numbers, however, and in some instances in terms of stalk diameter, so that yields were not as different as the stalk height data alone would indicate.

Conclusions

1. The results indicate that erect sugarcane in a small lysimeter and a large lysimeter required almost exactly the same amount of water in the plant crop, but the subsequent results showed that a difference of 10% had developed in the second ratoon.
2. The data indicate clearly that evapotranspiration is reduced very markedly due to lodging in all crops. The average reduction in consumptive use is about 30%, and it is sustained for at least 2½ months after lodging.
3. It can be inferred that productivity per unit of time is reduced by approximately 30% after lodging, since the yield of cane per 100 mm of evapotranspiration was similar for both lodged and erect crops.
4. If Class A pan evaporation can be accepted as an approximate indication of the yield potential of fully canopied cane in an area, then it would appear that the yields of cane declined in successive crops. The relative data for the small lysimeter were 99, 94 and 88 units of yield in the plant, first ratoon and second ratoon crops respectively, and 101, 89 and 80 units of yield for the same crops in the large lysimeter before lodging took place.

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Discussion

Professor Sumner: The yield of cane in a lysimeter is better than in the surrounding area. Is this not because a lysimeter retains water in much the same way as does an asphalt barrier?

Dr. Thompson: This may be so and if we repeated the experiment we would put artificial suction into the bottom of lysimeters.

Dr. Gosnell: I think a very interesting point that is brought out is the reduction of evapotranspiration in succeeding ratoons. Is Dr. Thompson prepared to recommend irrigation practice on the basis of this finding?

Dr. Thompson: If we can predict that the yields of succeeding crops in the field are going to decline, then I think that a reduction in the amount of irrigation water to be applied may well be warranted. This is because we have so consistently found a constant relationship between yield and water use by sugarcane.

We considered the four factors that may contribute to declining yields. These were weeds, populations of cane stalks, disease and soil compaction. In the experiment weeds were never allowed to grow and stalk populations were maintained. Disease may have been a factor but I think that progressive soil compaction is more likely to have been the trouble, and if the plant is unable to get water because of compaction it should not be applied, as evapotranspiration will then no longer be equal to Class A pan evaporation.

Mr. Rostron: Is the reduction in the ratio E_t to E_o different to what would normally be obtained?

Dr. Thompson: We have data from Chaka's Kraal for our plant and first ratoon crops which could be compared.

Dr. Dick: If RSD was present in the cane it would surely explain everything.

Dr. Thompson: It is apparent from Table VII that there was a severer decline in the large lysimeter than in the small lysimeter, so it is possible that the RSD spread more progressively in the large lysimeter if it was actually present.

Mr. du Toit: Regarding measurements of precipitation, what was the discrepancy between the actual water measured and the raingauge measurements at Chaka's Kraal.

Dr. Thompson: We cannot say because at Chaka's Kraal we had hydraulic lysimeters and were therefore not able to measure weight changes very precisely.

Mr. Halse: Was any comparison made between raingauge measurements of rain and weight gains due to rain?

Dr. Thompson: To do this we would have had to weigh immediately before and after rain, but unfortunately this was not done.

Mr. Truen: What exactly is happening to the E_t/E_o ratio in lodged cane?

Dr. Thompson: When cane lodges you can see sunshine on the trash so you predict that consumptive use will decline. Energy which would have been used before lodging for transpiration is now falling on non-transpiring surfaces. Why this persists for so long, and even increases, is somewhat surprising and possibly points to a physiological factor being involved.