THE PLANT CROP RESULTS OF TWO IRRIGATION EXPERIMENTS AT PONGOLA

By G. D. THOMPSON and J. P. BOYCE

South African Sugar Association Experiment Station

Introduction

There are at present 15,600 acres of sugarcane land at Pongola served by a canal which is fed from the Pongola river. The majority of the area is made up of settler farms which vary in size from 58 to 155 acres. The maximum amount of water used during a four-week month over the past three years was 77,728 cusec hours, and this represents an average water duty of 135 acres per cusec. Almost all of the land is furrow-irrigated, the scheme having been laid out exclusively below canal level. The predominant variety is N:Co.310 which has always constituted more than 85 per cent of the crop at Pongola, and in 1966/67 made up 92.7 per cent of the crop.

Sugarcane was first milled at Pongola during the 1954/55 season, when the mean sucrose per cent cane was 14.76, and total production was 17,529 tons of sugar. Sucrose per cent cane reached a peak of 15.58 in 1955/56, but has been considerably lower than this in most of the subsequent seasons, the lowest value being 13.62 in 1965/66. Total production of sugar reached a peak of 89,004 tons in 1967/68.

The mean annual rainfall at Pongola over the past 16 years has been approximately 25 inches. This amount is inadequate for rain-fed sugarcane production and irrigation has always been necessary. However, no information has been available regarding the acreage which irrigation water should serve in this area to produce the maximum amount of cane. When the South African Sugar Association Field Station was established in 1966, therefore, experiments were immediately laid down to study the effects of different amounts of water on crop yields, and also to determine whether or not drying the crop off before harvest was advantageous.

Location and Design of Experiments

The experiments were situated at Pongola on a Makatini sandy clay soil for which the mechanical analyses and moisture characteristics to a depth of 6 ft. are shown in Table 1. All data are the means for two samples taken at each depth. Field capacity at 0.1 bar tension was determined on 4-in. diameter undisturbed soil cores. Wilting point determinations at 15 bars tension and the mechanical analyses were conducted on disturbed soil samples.

Experiments I and II each consisted of six replications of four treatments in randomised block designs. The gross plots consisted of six rows, each 40 ft. long and spaced 5 ft. apart, the rows running in a N.-S. direction. The experiments were planted on 29th November, 1966, with variety N:Co.376. They were harvested 12 months later on 28th November, 1967.

Experimental Methods

Irrigation water was applied to individual whole plots, each 40 ft. × 30 ft., by means of perf-o-rainer pipes. Instead of using individual pipes on the ground in each interrow, operating at a very low pressure as described by de Robillard and Stewart[4], a single 40 ft. length of perf-o-rainer pipe was raised on telescopic masts in the middle interrow of each plot as the crop developed. The irrigation of a single plot is shown diagrammatically in Fig. 1. The masts supporting the perf-o-rainers stood in three specially constructed concrete blocks placed permanently in the centre of the middle interrow of each plot. Perf-o-rainers and masts could thus be moved from plot to plot, eight sets of equipment being used to irrigate the two experiments. By controlling the water pressure in the pipes it was possible to adjust the throw of the water to almost exactly 15 feet on either side of the pipes, but irrigation had to be suspended whenever the wind became more than a slight breeze. This drift was largely avoided by irrigating during the calm, early-morning hours.

TABLE 1
Mechanical analysis and moisture characteristics of Makatini sandy clay at Pongola

Soil depth ft.	Textural Class	Mech. analysis %				Moist., in./ft			Bulk dens. g/cm³
		Clay	Silt	Fine sand	Coarse sand	0.1 bar	15 bars	Total avail.	
0–1	sandy clay	41	10	35	12	3.40	1.45	1.95	1.29
1–2	sandy clay	40	14	36	10	3.78	1.33	2.45	1.31
2–3	sandy clay/clay	47	12	33	8	3.92	1.26	2.66	1.35
3–4	sandy clay	43	12	38	7	3.85	1.39	2.46	1.37
4–5	sandy clay	39	13	40	8	3.73	1.31	2.42	1.40
5–6	sandy clay loam	33	19	37	8	3.80	1.24	2.56	1.38

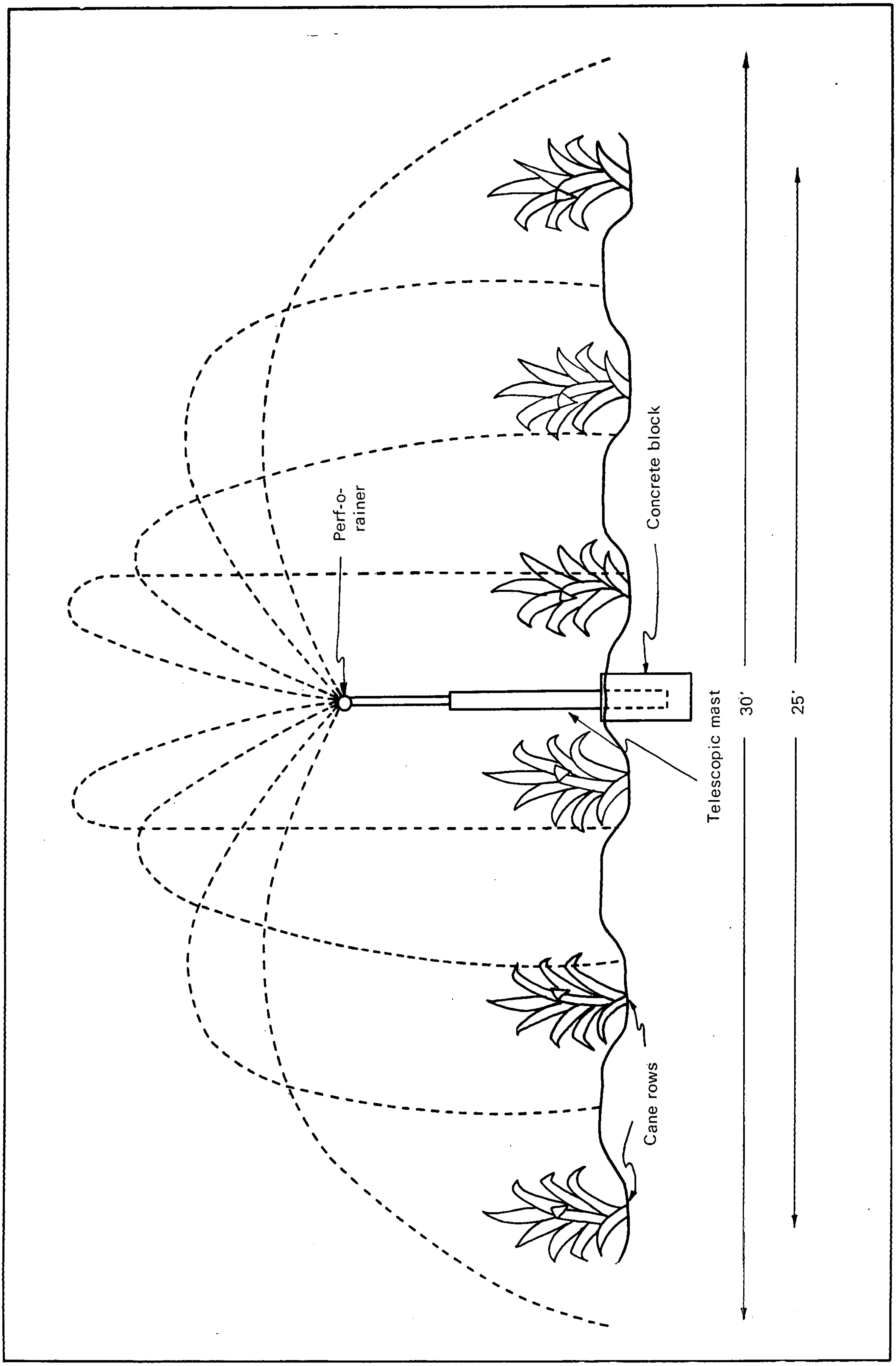

FIGURE 1: Diagram showing the end view of a single plot being irrigated by means of perf-o-rainer pipes mounted on telescopic masts.

Two irrigation applications, each of 2.4 effective inches were applied to the entire experiments by means of sprinklers during the first month after planting, but thereafter exactly two inches of water was applied per application with the perf-o-rainers to each plot by measuring the flow through a meter to the nearest gallon. Run-off did not occur, and since irrigation water was applied only when the soil moisture deficit exceeded two inches, the entire application of water was always assumed to be accounted for in terms of evapotranspiration (Et). The flow rate of water was approximately 7 gpm and the precipitation rate 0.67 inches per hour.

Cylindrical gypsum soil moisture blocks were placed at depths of 6, 18, 30, 42, 66 and 90 inches in each plot of both experiments. The blocks were located mid-way between the centre of the cane row and the centre of the interrow, and readings were taken twice weekly with a Bouyoucos meter. The sensitivity of the blocks was limited to the range from 1 bar to 15 bars soil moisture tension.

During the development of the crop, height measurements were recorded at weekly intervals. The heights of ten selected stalks per plot were measured from the top of a short reference peg placed next to the cane row, to the uppermost visible collar on the stalk. Stalk and shoot populations were counted in 28 ft. of cane row at weekly intervals during summer, but less frequently during winter. Ground cover was estimated on six occasions during the early development of the crop, using the technique described by Cackett[1].

Six feet of end effect was removed from both ends of the centre four rows of each plot in Experiment I before harvesting and weighing the rows individually. In one replication the outer two rows of each plot were also harvested and weighed to provide information on the apparent distribution of water from the perf-o-rainers. Before harvesting the cane all trash and green leaves adhering to the harvestable stalks in the net plots were removed, and the tops were then broken off by hand at the base of the fifth sheaths. The stalks from the centre two rows of each plot were counted, and one stalk in 20 was set aside for length and diameter measurements. A sample of 10 stalks per plot was taken for sucrose determination.

In Experiment II the same harvesting procedures were followed as in Experiment I, except that only the centre two net rows of each plot were harvested and weighed.

Treatments

Experiment I

This experiment was designed to compare the four different water duties which are listed in Table 2. A water duty is conventionally defined as the area in acres to be irrigated with one cusec of water pumped or available at the source. The four treatments were identified in terms of the minimum number of days in which an irrigation cycle could be completed when two inches of water was applied per cycle. Since the entire application of water was considered to be effective, the conversion of cycle times in days to water duties in acres per cusec was carried out for any selected irrigation efficiency and any particular time efficiency that might be pertinent. Thus, if irrigation efficiency were 100 per cent and operations were continuous, a cycle time of five days with a 2 in. application would represent a water duty of water 60 acres per cusec, since one cusec is equivalent to two inches of water on 12 acres in 24 hours. If the irrigation efficiency were only 80 per cent, a five-day cycle would then represent a water duty of 48 acres per cusec. Water duties for three typical sets of conditions are shown for each treatment in Table 2.

So that the water duty treatments would simulate recommended field practice, irrigation water was applied only if the soil moisture deficit was such that two inches could be accepted by the soil profile. A continuous estimate of the available soil moisture deficit was made by keeping a daily soil moisture profit and loss account for each treatment, taking rainfall, irrigation and evapotranspiration into account. The total available moisture content of the soil was estimated to be four inches, and soil moisture was assumed to be equally available to the crop between the limits of field capacity and wilting point. As can be seen from Table 1, four inches of available water was held in slightly less than 2 ft. of soil.

All rainfall was credited to the soil moisture profit and loss account up to field capacity (four inches of available water), any excess being regarded as lost due to run-off or deep percolation.

In commercial practice, the same field is likely to be irrigated regularly at the beginning of an irrigation cycle when the soil moisture deficit is low, whilst another field is likely to be irrigated regularly at the end of the cycle when the soil moisture deficit is high. In order for the experimental yields to approximate mean field yields, therefore, the plots

TABLE 2
Minimum cycle times and equivalent water duties for four treatments in Experiment I

Treatment	Minimum cycle time, days	Water duties, ac/cusec		
		80% eff., 168 hrs/week	80% eff., 120 hrs/week	60% eff., 120 hrs/week
W_1	19	182	131	98
W_2	11	106	76	57
W_3	7	67	48	36
W_4	5	48	34	26

in any one treatment were irrigated when it was estimated that half of the cycle had been completed. This was achieved by withholding the first irrigation application for an extra half-cycle after each saturating rain, and thereafter irrigating according to the full-cycle time.

Evapotranspiration for each month of the year at Pongola was predicted as shown in Table 3 for various degrees of green leaf canopy, and for treatment W_4 separately from the other three treatments. The data for treatments W_1, W_2 and W_3 were based on the established 1:1 ratio between evapotranspiration and Class A Pan evaporation in Natal (Thompson[5]), and the data for treatment W_4 on an excessive 1.3 × Class A Pan evaporation. Based on the predicted Et, two inches of effective water every seven days was sufficient to meet the peak water requirements of the crop, which was estimated to be 0.28 inches per day in January. It was therefore necessary for the W_4 treatment to postulate that Et was greater than Class A Pan evaporation in order to justify the application of two inches every five days during the period of maximum evaporative demand. Hence the soil moisture profit and loss account for the W_4 treatment was conducted by using the estimates of Et equal to 1.3 × Class A Pan evaporation shown in Table 3. This table was used to estimate daily Et until September, when actual pan evaporation at Pongola exceeded the 1:1 estimate of Et by 0.06 inches per day. Thereafter actual evaporation data were used. On the average, these exceeded the estimates by about 20 per cent.

Experiment II

The treatments in this experiment were intended to compare the effects of no drying off prior to harvesting with three rates of drying off on the amount and quality of sugarcane produced. The treatments were identified as follows:

A: no drying off, irrigated to potential requirements

B: irrigated to potential requirements for ten months, all irrigation withheld for final two months

C: irrigated to potential requirements for eight months, soil profile moisture depleted by 1.5 inches per month over final four months

D: irrigated to potential requirements for six months, soil profile moisture depleted by one inch per month over final six months.

Potential water requirements were estimated from the data given in Table 3 for treatments W_1, W_2 and W_3 in Experiment I, and irrigation water was applied to the A treatment plots whenever a soil moisture profit and loss account showed that the soil moisture deficit was two inches. Since the total depletion of soil moisture for treatments C and D was six inches, the total available soil moisture content was arbitrarily increased in the profit and loss accounts to eight inches so that negative quantities could be avoided. For convenience, the principle of equal availability of soil moisture was adhered to even when apparent depletion exceeded four inches.

Ten stalks were chosen at random and removed from rows 2 and 5 of the A and D treatment plots at monthly intervals starting at the end of June, 1967. These were used for sucrose, purity and 3–6 sheath moisture determinations. The same procedure was introduced on the C treatment at the end of August, and on the B treatment at the end of October.

Results

The yield results and water use in Experiments I and II are shown in Tables 4 and 5 respectively. Rainfall for the duration of the crops was 27.5 inches. The amounts of effective water used by the crops were calculated from the soil moisture profit and loss accounts, and they represent the summation of daily estimates of Et for all days except those when the entire amount of four inches of available water had been removed from the soil. In Experiment I, the soil in treatments W_2, W_3 and W_4 never reached wilting point and, assuming equal availability, the estimated effective water of 60.6 inches therefore represents potential Et for the duration of the crops. The soil in treatment W_1 was estimated to be at wilting point for short periods during each month from August to November.

TABLE 3

Estimated mean daily evapotranspiration (E_t) for various degrees of green leaf canopy during each month at Pongola

Month	E_t, in/day									
	No canopy		¼ canopy		½ canopy		¾ canopy		Full canopy	
	$W_{1,2,3}$	W_4	$W_{1,2,3}$	W_4	$W_{1,2,3}$	W_4	$W_{1,2,3}$	W_4	$W_{1,2,3}$	W_4
January	0.11	0.15	0.15	0.20	0.20	0.27	0.23	0.31	0.28	0.37
February	0.11	0.15	0.15	0.20	0.19	0.25	0.23	0.31	0.27	0.36
March	0.09	0.12	0.12	0.16	0.16	0.21	0.20	0.27	0.23	0.31
April	0.07	0.09	0.10	0.13	0.13	0.17	0.16	0.21	0.18	0.24
May	0.06	0.08	0.08	0.11	0.10	0.13	0.12	0.16	0.14	0.19
June	0.04	0.05	0.06	0.08	0.07	0.09	0.09	0.12	0.10	0.13
July	0.04	0.05	0.06	0.08	0.08	0.11	0.10	0.13	0.12	0.16
August	0.05	0.07	0.07	0.09	0.09	0.12	0.10	0.13	0.12	0.16
September	0.07	0.09	0.10	0.13	0.12	0.16	0.15	0.20	0.17	0.23
October	0.08	0.11	0.11	0.15	0.14	0.19	0.17	0.23	0.20	0.27
November	0.09	0.12	0.12	0.16	0.16	0.21	0.19	0.25	0.22	0.29
December	0.10	0.13	0.14	0.19	0.17	0.23	0.21	0.28	0.24	0.32

TABLE 4
Harvest data and amounts of water applied on Experiment I

	Treatment				S.E. treatment mean, ±	L.S.D.	
	W_1	W_2	W_3	W_4		P= .05	P = .01
Cycle time days	19	11	7	5	—	—	—
Irrigation applied, in.	32.8	44.8	46.8	64.8	—	—	—
Yield, tons cane/acre	55.2	60.1	56.9	60.9	1.39	4.2	5.8
Sucrose % cane	13.46	12.51	12.62	12.18	0.243	0.73	1.01
Yield, tons sucrose/acre	7.43	7.52	7.17	7.40	0.208	0.63	0.87
Harvested stalks/acre x 10^{-3}	53.3	54.5	54.8	53.3	—	—	—
Mean stalk wt, lb	2.09	2.20	2.08	2.29	—	—	—
Mean stalk length, cm	182	197	194	196	3.3	10.1	13.7
Mean stalk diam, mm	22.4	22.2	22.1	22.4	—	—	—
Effective water, in.	55.2	60.6	60.6	60.6	—	—	—
Rainfall efficiency, %	89.6	72.7	71.8	58.9	—	—	—
Tons cane/in. total water	0.92	0.83	0.77	0.66	—	—	—
Tons cane/in. effective water	1.00	1.00	0.94	1.01	—	—	—

TABLE 5
Harvest data and amounts of water applied on Experiment II

	Treatment				S.E. treatment mean, ±	L.S.D.	
	A	B	C	D		P = .05	P = .01
Irrigation applied, in.	40.3	32.8	34.3	34.8	—	—	—
Yield, tons cane/acre	58.4	60.7	59.0	57.3	1.21	3.6	5.0
Sucrose % cane	12.65	13.84	13.85	13.34	0.182	0.55	0.76
Yield, tons sucrose/acre	7.38	8.40	8.17	7.64	0.161	0.48	0.67
Harvested stalks/acre x 10^{-3}	55.5	56.4	56.5	54.5	—	—	—
Mean stalk weight, lb	2.10	2.16	2.10	2.11	—	—	—
Mean stalk length, cm	192	194	191	191	—	—	—
Mean stalk diam, mm	22.7	22.7	22.4	22.3	—	—	—

Treatment comparisons, responses and S.E.'s:

	Tons cane/ac	Suc. % cane	Tons suc./ac
A vs. mean of B.C.D.	0.6 ± 1.40	-1.02** ± 0.210	-0.69** ± 0.186
B vs. mean of C.D.	2.5 ± 1.48	0.23 ± 0.223	0.49* ± 0.197
C vs. D	1.8 ± 1.71	0.51 ± 0.257	0.53** ± 0.228

Rainfall efficiency was also determined from the the soil moisture profit and loss accounts as that amount of rainfall which was theoretically accepted by the soil without exceeding field capacity, as a percentage of total rainfall. The depletion of soil moisture in treatment W_1 in Experiment I, as shown by gypsum blocks, is depicted in Fig. 2, where rainfall and irrigation applications for this treatment are also shown. Fig. 3 shows the gypsum block data for the final six months of crop life in treatments B, C and D in Experiment II, and the sampling dates for sucrose and sheath moisture determinations. The amounts of irrigation water applied are also shown, rainfall being the same as that shown in Fig. 2. The gypsum block data for treatments W_2, W_3 and W_4 in Experiment I, and for treatment A in Experiment II, were of little interest since the crops in these treatments were always adequately watered.

The development of the crops in all treatments in both experiments was always similar. As an example, the heights, population counts and ground cover measurements are shown in Fig. 4 for treatment W_3 in Experiment I.

The results of the sucrose, juice purity and sheath moisture determinations in Experiment II are shown in Table 6. The sheath data represent moisture expressed as a percentage of green 3–6 sheath weight.

TABLE 6
Sucrose % cane, purity of mixed juice, and moisture % green 3-6 sheath of monthly samples from Experiment II

Date	Crop age, mths	Treat- ment	Suc. % cane	Purity of juice, %	Sheath moist., %
29/6	7	A	7.01	64.4	84.2
		D	7.78	71.3	84.3
26/7	8	A	8.99	74.9	83.5
		D	9.06	75.9	83.1
28/8	9	A	11.63	83.4	84.0
		C	11.09	82.4	83.5
		D	11.18	82.3	83.2
22/9	10	A	12.39	85.5	84.4
		C	12.42	83.6	83.7
		D	12.17	83.4	82.8
2/11	11	A	13.76	88.1	83.3
		B	14.10	88.7	81.5
		C	13.87	87.7	82.6
		D	13.49	87.3	82.6
25/11	12	A	12.65	84.4	—
		B	13.83	83.9	—
		C	13.85	87.4	—
		D	13.34	85.7	—

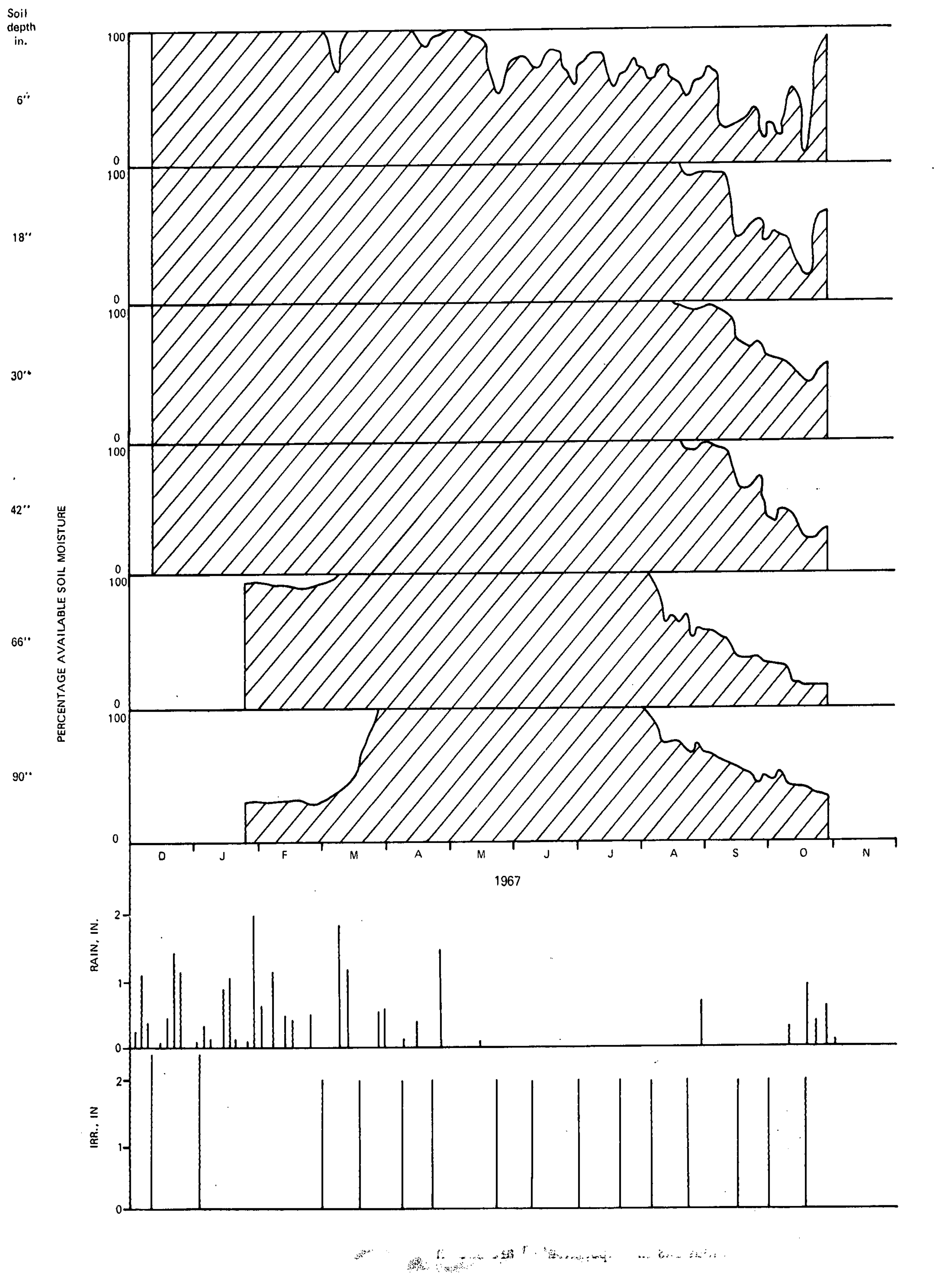

FIGURE 2: Gypsum block, rainfall and irrigation data for the W_1 treatment in Experiment I.

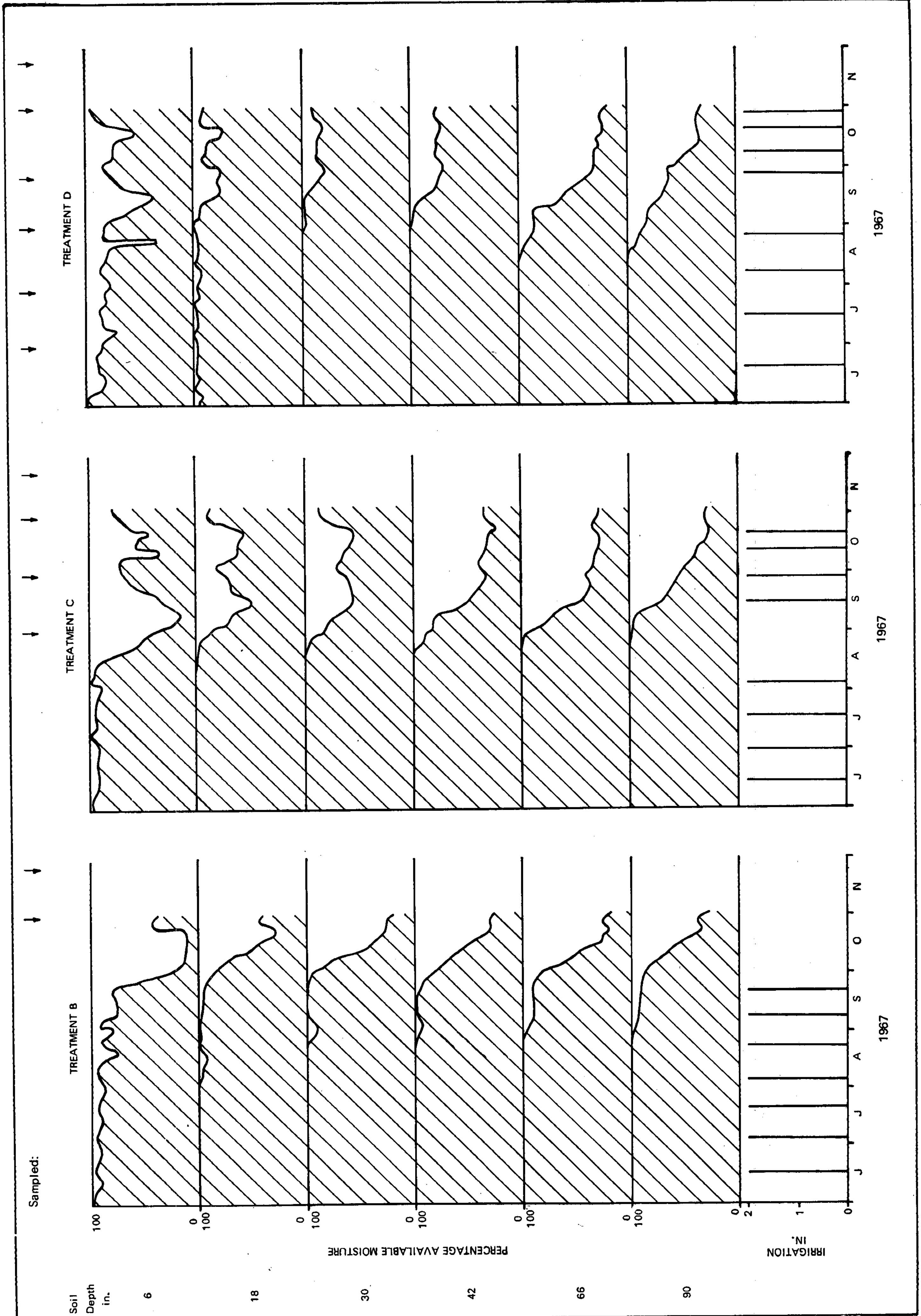

FIGURE 3. Gypsum block and irrigation data for treatments B, C and D in Experiment II during the final six months of the plant crop.

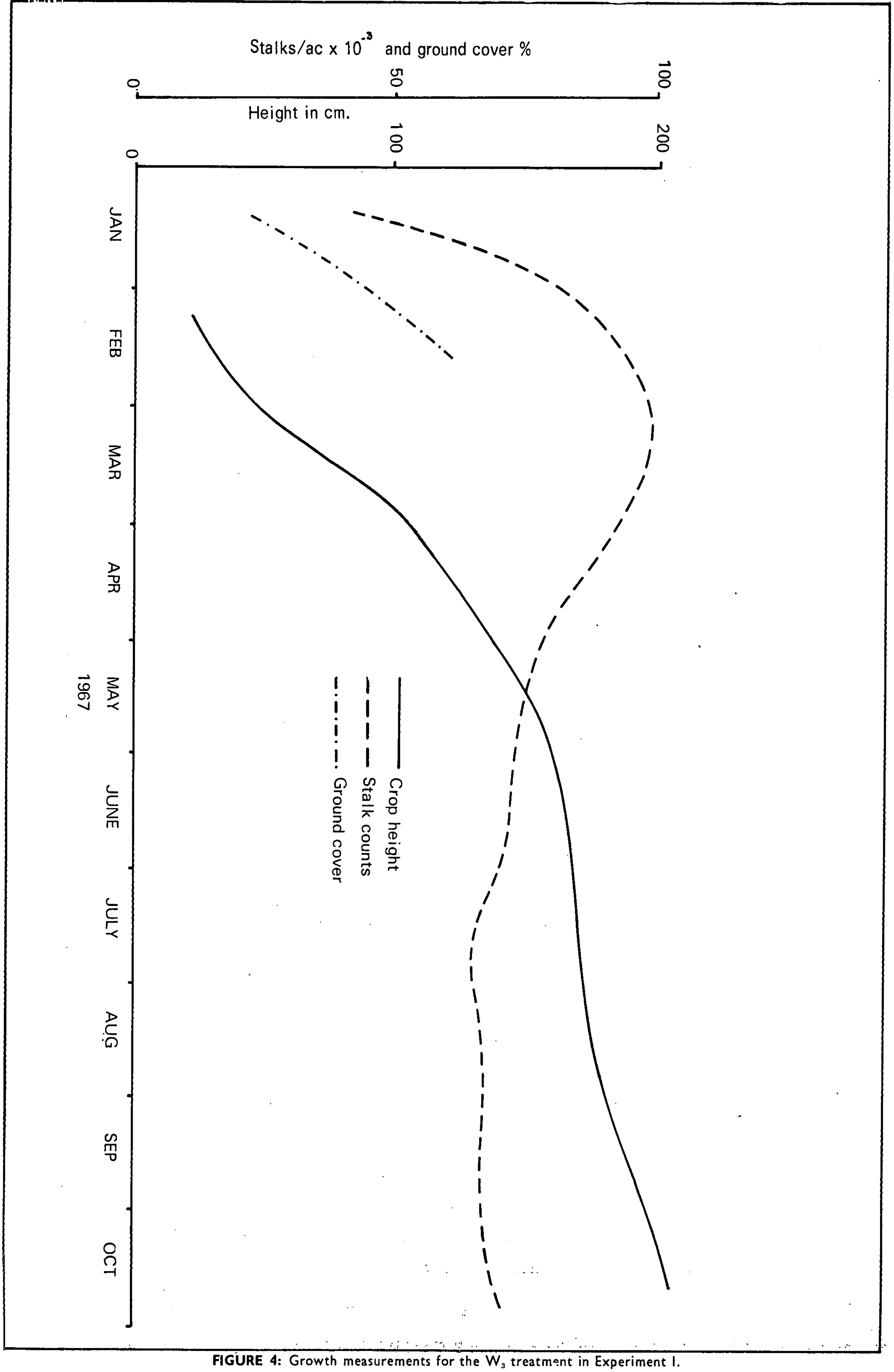

FIGURE 4: Growth measurements for the W_3 treatment in Experiment I.

Discussion

Irrigation Method

The distribution of water from the perf-o-rainers over the plots in Experiment I appears to have been satisfactory. There was no evidence of any differences between estimates of treatment comparisons using the data for rows (3 + 4), (2 + 5) and (2 + 3 + 4 + 5). However, differences between treatments were small and the conclusion may not be valid for larger differences. In this instance, even the outer two rows, 1 and 6, showed little evidence of not being representative of the treatment, as shown by the following mean weights for the four treatments in Replication VI:

Row 1 — 364 lb.
Row 2 — 372 lb.
Row 3 — 337 lb.
Row 4 — 349 lb.
Row 5 — 343 lb.
Row 6 — 363 lb.

Experiment I

The yield results for the different treatments in this experiment were similar. However, since severe moisture stress was shown by the soil moisture profit and loss accounts to have occurred only in treatment W_1, and then to a limited extent, no large differences in mean treatment yields were to be expected. Nevertheless there was statistically significant evidence of a small increase in yield per inch of water applied, amounting to 0.170 ± 0.061 tons of cane per acre. Regarding treatment W_1, an apparently real reduction of yield in terms of tons cane per acre (accounted for by shorter stalks rather than any effect on stalk diameter or the number of stalks) was more than offset by a relatively high sucrose content.

For the climatic conditions encountered during the 12 months of this experiment, it is thus evident that farmers in the Pongola region, able to obtain water for 120 hours per week and applying it by furrow irrigation at 60 per cent efficiency, could have realised maximum yields even with a water duty of about 100 acres per cusec. Although rainfall only exceeded the mean by 2.5 inches, distribution tended to be good, and it remains to be seen whether or not large water duties would be as remunerative in poorer rainfall years. The further implications are that the usefulness of water in the Pongola area could be increased dramatically by increasing operating time and water application efficiencies, as shown by the data in Table 2.

The gypsum block results given in Fig. 2 for treatment W_1 show that the soil profile at depths below 4 ft. was saturated with water held at tensions below 1 bar only after two cycles of irrigation and more than three inches of rain in March. Of considerable interest is the apparent exploitation of moisture from considerable depths from August onwards, a feature which only developed in the 2, 3 and 4 ft. depths in September. It would appear that fairly regular applications of irrigation water kept the shallower strata supplied with water held at tensions below 1 bar, but did not reach greater depths where measurable deficits therefore developed at an earlier stage. The apparent depletion of water at all depths from August onwards confirms the observation made from the soil moisture profit and loss account that this treatment was at wilting point for short periods during August and the succeeding three months. The rather large extent of the depletion, however, may well have been due to the fact that Class A Pan evaporation, and therefore actual Et, exceeded the predicted Et for September by 0.06 inches per day.

The total available moisture content of the soil was estimated to be four inches, which was held in less than 2 ft. of soil according to the data given in Table 1. The gypsum block data, however, confirm earlier results obtained in Natal (Thompson *et al*[6]), where it was shown that water was removed by the crop from considerable depths in a deep soil profile. These results serve to emphasise the need for direct measurements of freely available water from the soil, to substitute for conventional estimates of total available water made from soil moisture characteristics and the ill-defined "effective rooting depth". It is also essential that some measurement of relative crop performance be associated with each stage of soil moisture depletion.

The yield of cane in the various treatments was remarkably consistent and close to one ton per inch of estimated effective water. This is similar to a mean ratio of 1.05 obtained in three experiments in Natal (Thompson and de Robillard[7]), and to a mean ratio of 1.08 tons cane per inch of effective water, calculated from data given by Chang *et al*[2] for adequately irrigated sugarcane in Hawaii. Whilst a regression equation could be used to obtain a more precise estimate of yield from the amount of effective water used by a crop, the ratio appears to be sufficiently consistent for irrigated cane yields to be estimated roughly.

Since Class A Pan evaporation and predicted Et were known to have differed appreciably at times, the soil moisture profit and loss account was repeated for treatment W_3, using actual Class A Pan results throughout. There was not a significant change in the cumulative estimate of effective water, and the ratio of tons cane per inch of effective water remained at 0.94 for this treatment.

As expected, rainfall efficiency decreased sharply with the increasing amounts of irrigation water applied. The efficiency of almost 90 per cent for treatment W_1 is considerably higher than the figure of 70 per cent sometimes used as an average estimate of rainfall efficiency under rain-fed conditions. However, the estimate depends upon the assumption that run-off did not occur until the estimated soil moisture deficit had been entirely replenished. With the high-intensity rains sometimes experienced at Pongola, this assumption obviously may not have been generally applicable.

The growth patterns of the cane in the W_3 treatment, shown in Fig. 4, are generally typical. It is interesting to note that growth was severely checked during the three winter months from June to August, even in the warmer climate at Pongola.

Experiment II

The results given in Table 5 show that no loss of yield was incurred due to drying off despite the reduction of six or eight inches of irrigation water applied to the B, C and D treatments. The gypsum block data gave clear evidence that soil moisture was severely depleted where drying off was practised, and particularly so in the B treatment which was not irrigated during the final two months. There was, in fact, a highly significant increase both in sucrose per cent cane and tons of sucrose per acre, due to drying off compared with no drying off, and a significantly higher yield of sucrose per acre from the B treatment compared with treatments C and D.

On the basis of these observations alone it would be logical to prefer the B treatment to any other, but it seems likely that the irrigation of the C and D treatments during October tended to suppress sucrose accumulation in the stalks. In Table 6 it can be seen that the highest sucrose per cent cane and juice purity, and the lowest sheath moisture values were obtained in the B treatment at the beginning of November when the crop was 11 months old. The gypsum block data in Fig. 3 show that at this time the soil moisture content of the surface 2 ft. of the soil in the B treatment was at its lowest level. If the moisture from the surface 2 ft. of soil in the C and D treatments had been similarly depleted towards the end of the crop, even higher sucrose contents may have been obtained from these treatments than the 14.1 per cent recorded for the B treatment.

At 11 months of age the sucrose content of the cane in the A treatment (13.76 per cent) compared favourably with those in the C and D treatment crops, but at harvest, only a month later, it was lower by a highly significant amount. This may well have been due to the fact that only the A treatment received irrigation water during the final month before harvest.

The drying off treatments did not affect harvested crop characteristics, stalk length, stalk diameter and weight per stalk being similar for all treatments, as was the number of harvested stalks per acre.

There was a normal seasonal increase in sucrose per cent cane and juice purity from June until the beginning of November, followed by a decline over the final month of the crop. There was a significant negative correlation ($r = -0.60$) between sucrose per cent cane and sheath moisture content in all the monthly samples, but the sheath moisture contents never fell below 80 per cent. Clements[3] in Hawaii found that maximum sucrose content was obtained when sugarcane was dried off gradually until sheath moisture fell to approximately 73 per cent at harvest time. If treatments C and D had not been irrigated during October, it is possible that sheath moisture contents may have fallen to this level, and that the sucrose contents of the stalks would have increased accordingly.

In any event, successful drying off must clearly become hazardous once the spring rains begin, so that cane harvested during the July to October period would probably respond most reliably. However, more severe soil moisture depletion would be necessary than was achieved in any of the treatments in this experiment for sheath moisture levels to fall below 80 per cent, and since the maximum laboratory sucrose determination (14.10 per cent) is well below the mid-season peak known to be obtainable, higher values may well be feasible following more severe drying off procedures than were practised in this experiment.

Conclusions

The application of two inches of effective water every 19 days on the deep Makatini series soil at Pongola is sufficient in a year of well-distributed rainfall to produce potential yields. This treatment represents a water duty of 98 acres per cusec where water is available for 120 hours per week and is used with an efficiency of 60 per cent. By increasing the efficiency to 80 per cent and operating continuously, however, this water duty could almost be doubled to 182 acres per cusec.

The production of approximately one ton of cane per inch of effective water at Pongola is similar to the productivity obtained in experiments in Natal and in Hawaii.

Sugarcane exploits soil moisture to at least a depth of 8 ft. on the deep Makatini series soil, the exploitation proceeding at all depths once the surface foot has been dried out fairly thoroughly.

Drying off the sugarcane crop at Pongola is warranted in terms of increased sucrose production under the conditions of these experiments. Although the complete suspension of irrigation for the final two months before harvest gave the best results, more gradual drying off procedures may yet prove to be superior if water applications near the end of the crop are avoided.

Acknowledgements

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Discussion

Mr. Gosnell: We are carrying out experiments of this nature in Rhodesia in a similar climatic cycle. In one experiment we had two drying off treatments, one equivalent to treatment A here and the other equivalent to treatment B. Our results were completely different in that we lost in both tons cane and tons sucrose due to the excessive desiccation in the last two months.

To what extent did the cane in plots B, C and D show visual symptoms of stress and what is the reason for the difference in yield between A and B?

Mr. Boyce: There was not much difference between the plots and the cane was certainly not scorched and white as occurred in Rhodesia.

Dr. Thompson: We assume that the difference in yield between plots A and B lies within the limits of experimental variability.

Mr. Gosnell: What you are saying is that in the last two months of growth of a twelve-month crop, during the period of maximum evapotranspiration, there was no difference between treatments in the increase in cane yield.

Dr. Thompson: The evaporative demand during the period of drying off and the nature of the soil profile are going to affect the type of drying off procedures that are going to be followed. I don't think this will ever be reduced to a rule of thumb method.

Mr. du Toit: This trial was carried out under a peculiar set of conditions so I think the results must be treated with caution.

There was no significant difference in yield of cane per acre between plots A, B, C and D, and B, C and D showed no difference in sucrose. A showed a lower sucrose but only at the time of harvest and this might have been the result of not only irrigation but also rainfall.

We are dealing here with a deep soil and there are certainly dangers of over-desiccation when we deal with high evaporation and shallow soils.

Dr. Cleasby: There is no doubt that the type of soil at Pongola went a long way towards determining the results that were obtained.