THE EFFECTS OF DRAINAGE ON CANE YIELDS AS MEASURED BY WATER-TABLE HEIGHTS IN THE MACKNADE MILL AREA

By

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Introduction

Inadequate drainage is recognized as the greatest single factor limiting production in the Macknade mill area.

A recent survey carried out by Macknade mill staff estimated that production could be increased by 135 000 tonnes of cane per annum on present areas by provision of better drainage facilities.

In an endeavour to quantify the severity of the problem, an investigation to measure yield losses that can occur from high water tables was initiated during the 1975-76 growing season.

The objects of this investigation were:

(a) To check fluctuations of water-table levels in the Macknade mill area; and

(b) to determine the magnitude of yield loss caused by the existence of high water tables in poorly drained situations.

Experimental Details

Site Criteria

Sites to be studied were selected as follows:

(a) Each site selected included two drainage categories—adequate and inadequate—within the one cane block. The drainage categories were assessed visually before and after the harvest of the 1975 crop.

(b) One variety, Triton, was chosen since:

(i) It is the major variety, comprising 45.5 per cent of the 1975 crop in the Macknade mill area; and

(ii) it has the reputation of performing better than other varieties in poorly drained situations.

(c) First ratoon blocks only were studied.

(d) All sites must have been harvested during the months of October and November in 1975, since it was assumed that yields of late harvested blocks would be affected to the greatest extent by high water-tables.

Location of the various sites is shown in Fig. 1.

Equipment

Water-table levels were measured using 25 mm diameter PVC tubing with 3 mm diameter holes at regular intervals. The bottom of the tube was covered with a hessian sleeve.

These tubes were inserted 1.65 m into 60 mm diameter auger holes, 1.8 m deep. The tubing was then encased with coarse sand.

Two tubes were installed at each site in case of malfunction of one. Installation was carried out during November, 1975, within two weeks of harvest of any block. The tubes were positioned in the centre of the cane row.

Frequency of Measurement

Water table levels were read twice weekly from the date of installation until harvest of the block. Data given in this report refer to the mean of both measurements at each site. Although 150 mm of the tube remained above ground, data for water table levels refer to the distance of the water table below the soil surface. The total number of days the water table was less than 0.5 m from the surface was determined by noting the trends in water table movement.

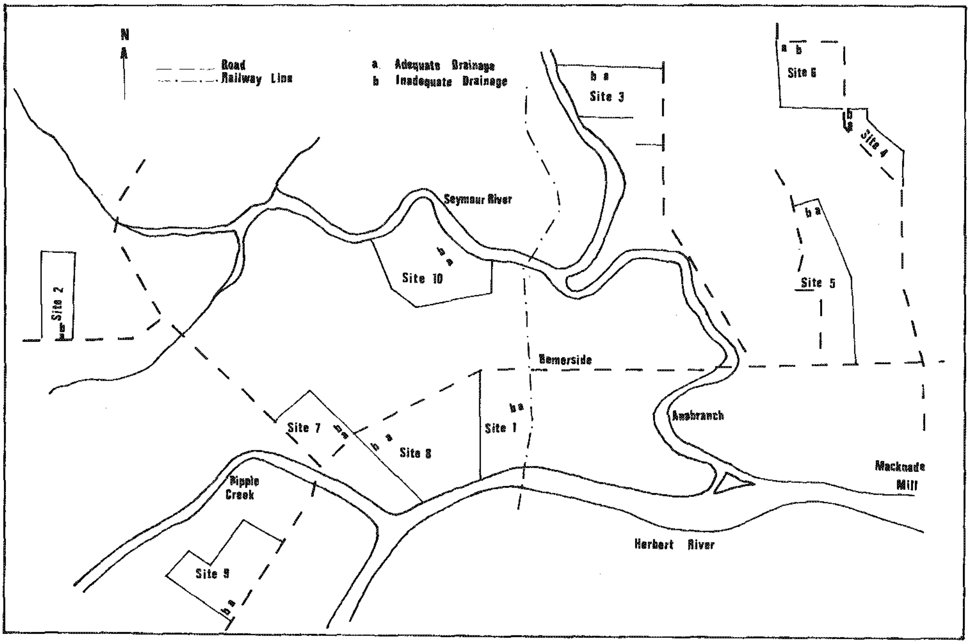

Fig. 1—Location of water-table study sites.

Yield Determination

Yields of plots 10 m × 3 rows at each site were determined at harvest. This was carried out with the normal harvest of blocks over a period from July 29, 1976 to October 4, 1976. No significant rainfall was recorded over this period and water levels remained comparatively low and it is assumed that, due to the cool and dry conditions which prevailed, little growth occurred.

Rainfall

Rainfall data were obtained from the recording station at Macknade mill, and are considered representative of the area in which the trials were performed.

Soil Type

All soils in the study area are of alluvial origin with varying degrees of profile development. Surface soils are all similar and in texture consist of a silt to clay loam to a depth of from 20 to 40 cm. Lower horizons vary greatly from block to block and within blocks, and sand drifts are common through the profiles.

Method of Analysis

Paired "t" tests were conducted for drainage categories A and B using the following variables:

(i) Yield;
(ii) water-table level; and
(iii) total number of days the water table was less than 0.5 m from the surface.

Regression analysis was used to determine the line of best fit for:

(i) Yield on mean water-table level; and
(ii) yield on the number of days when the water table was less than 0.5 metres from the surface.

Results and Discussion

Water-table Heights

Figs. 2, 3 and 4 are indicative of the rapid rise of water-table levels caused by the commencement of heavy rain during December (Figure 5). These high levels were maintained until May, when a rainfall pattern of lesser intensity allowed levels to fall away in a gradual decline.

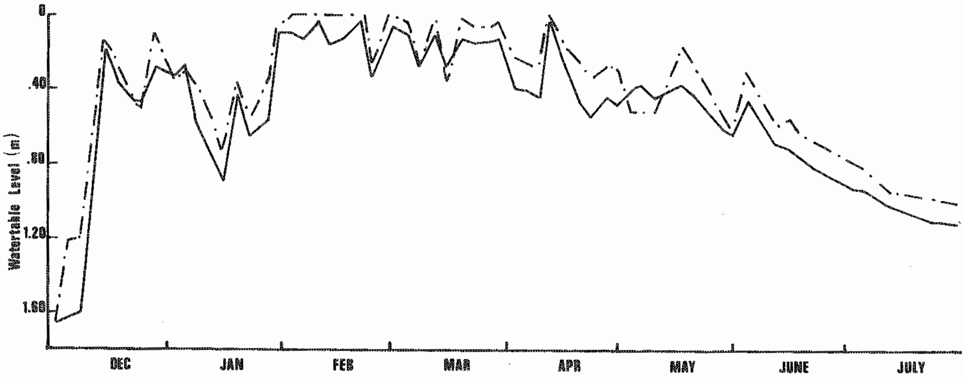

Fig. 2—Bi-weekly readings of water-table levels—site 1.

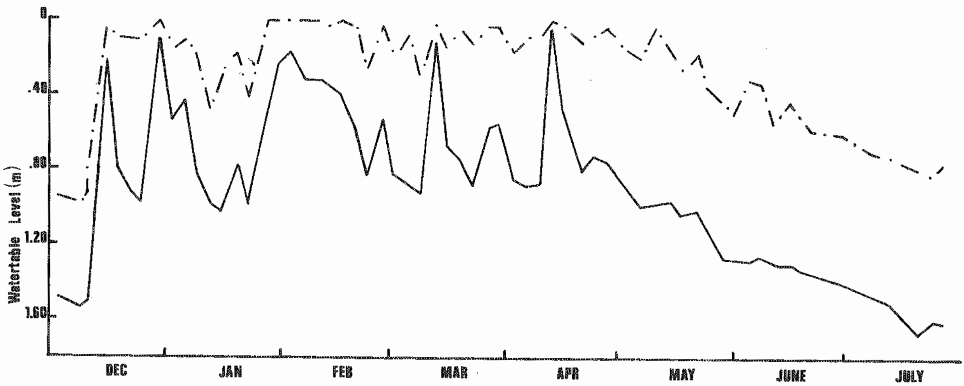

Fig. 3—Bi-weekly readings of water-table levels—site 3.

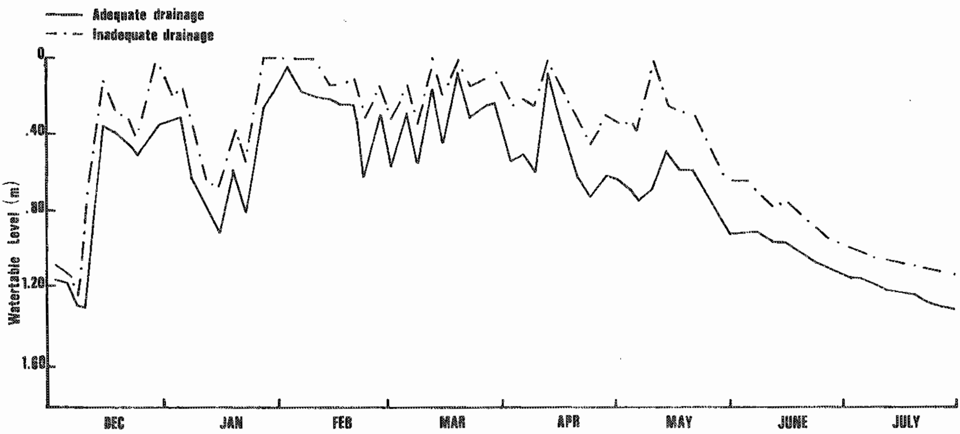

Fig. 4—Bi-weekly readings of water-table levels—site 4.

TABLE I—Yield results and water table information

Site No.	Number of days per month when water-tables < 0.5 m from the surface									Mean water-table level (m)	Yield tonnes cane/ha
	Category	Dec.	Jan.	Feb.	March	April	May	June	July	Total		
1	A	16	31	29	31	30	23	3	0	163	.43	32.0
	B	17	30	29	31	30	19	8	0	164	.36	31.2
2	A	8	9	29	14	26	6	11	0	103	.62	54.5
	B	19	27	29	26	30	31	24	0	186	.36	26.6
3	A	6	9	18	4	5	0	0	0	42	.90	91.7
	B	18	31	29	31	30	31	15	0	185	.29	13.1
4	A	14	12	26	28	9	1	0	0	90	.65	92.5
	B	18	22	29	31	30	26	0	0	156	.43	38.8
5	A	14	12	27	24	16	0	0	0	93	.64	67.2
	B	21	27	29	31	30	31	9	0	178	.36	34.2
6	A	19	20	29	31	27	14	0	0	140	.52	67.8
	B	20	31	29	31	30	31	15	0	187	.31	24.9
7	A	4	8	24	19	8	0	0	0	63	.89	72.5
	B	18	19	29	31	30	6	0	0	133	.51	53.9
8	A	17	12	28	31	27	0	0	0	115	.59	56.1
	B	17	21	28	31	29	0	0	0	126	.57	46.3
9	A	7	14	26	21	30	21	0	0	119	.58	43.3
	B	18	26	29	31	30	31	19	0	184	.34	16.9
10	A	8	19	28	20	29	7	0	0	111	.55	70.4
	B	17	23	29	31	30	31	9	0	170	.44	57.4
Mean	A									104	.64	64.8
	B									167	.40	34.3
Mean diff, $\bar{d}$										63	.24	30.5
S.E. of Diff, $s_{\bar{d}}$										11.3	.048	6.6
$t = \bar{d}/s_{\bar{d}}$										5.55**	4.99**	4.62**

** $P < 0.01$ A = ADEQUATELY DRAINED B = INADEQUATELY DRAINED

Relatively low falls of rain (10 mm) had a marked effect on water tables from December to May, reflecting the waterlogged conditions of the surface soil. The extent of this waterlogging can be seen from Table I which shows the long periods of time when water tables were less than 0.5 m from the soil surface.

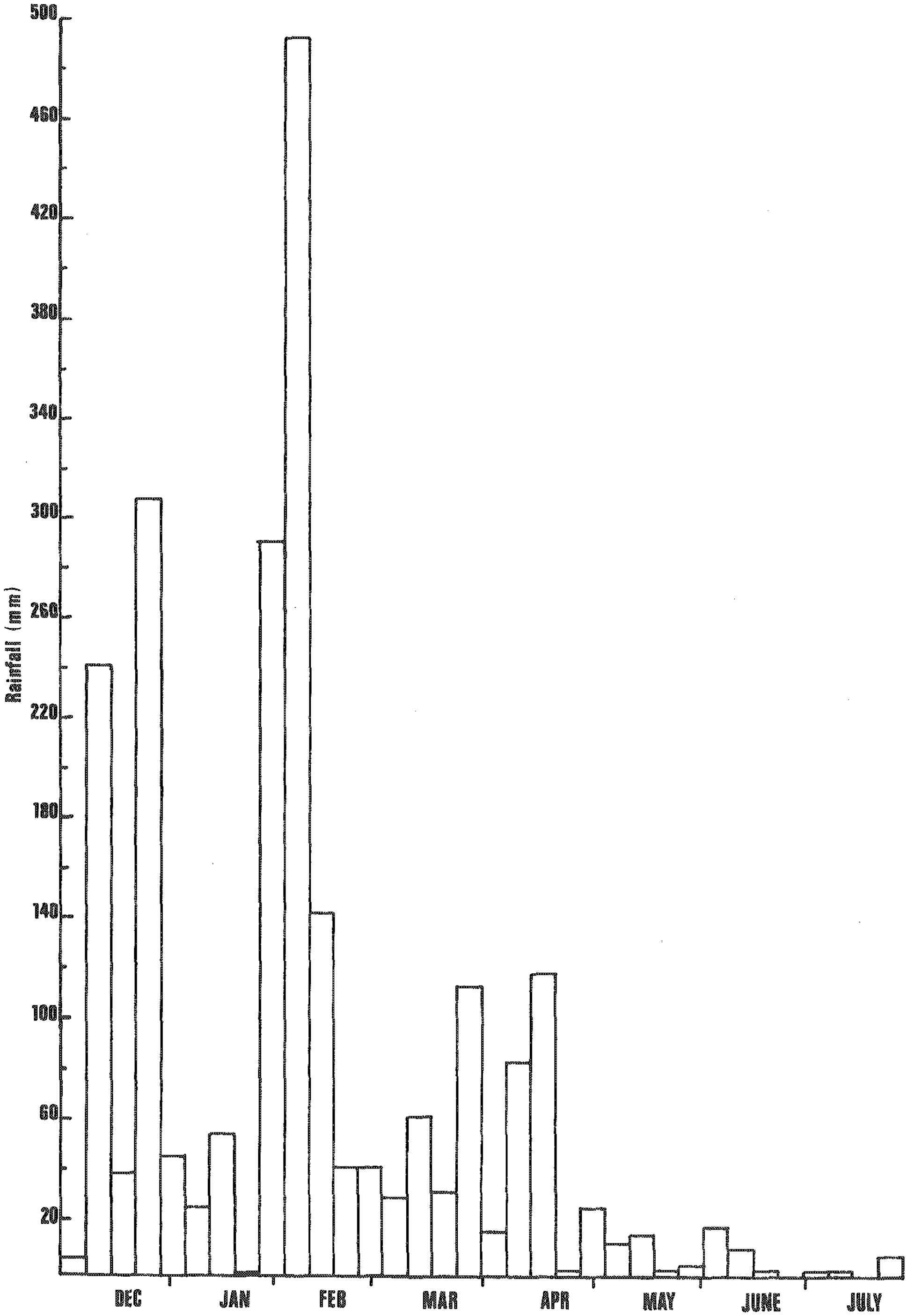

Fig. 5—Weekly rainfall registrations—Macknade Mill, December, 1975 to July, 1976

While the above-average rainfall during December caused a rapid and early rise in water tables, it could be reasonably expected that in a year of average rainfall water-table levels would be maintained at or near ground level from January to May, since rainfall during this period in 1975-76 was below the 50-year average.

Yield Data

Yield differences in category A were consistently higher than in the corresponding category B (Table I). At site 1, there was negligible yield difference between drainage categories and this is reflected in the similar behaviour of the water-table levels. It became obvious after heavy rain that even category A plots would benefit in yield response from improved drainage.

Mean water-table levels and yield differences were most pronounced at site 3 where category A was regarded as the best drained plot in the trial. The yield in this plot was exceeded only by that of the same treatment in site 4 which had the advantage of being harvested in early October, 1975. This allowed the cane to be better established before the onset of the heavy rain.

There was a good relationship between yield and mean water-table level (Fig. 6). This clearly demonstrates the impact of a lower water table between December, 1975 and June, 1976 on improved cane yield.

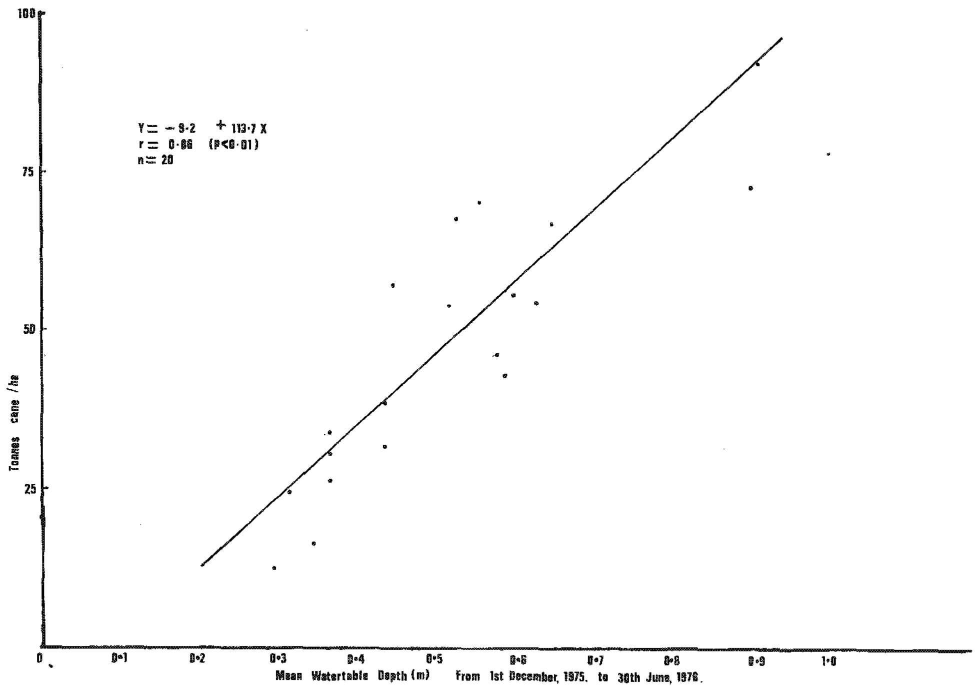

Fig. 6—The relationship between yield and mean water-table level.

In Fig. 7 the model shows the inverse relationship between yield and the total number of days the water table was less than 0.5 m from the surface between December, 1975 and June, 1976. This relationship indicates that for the sites studied, a reduction in yield of the order of 0.46 tonnes per hectare could be expected for every day the water table was less than 0.5 m from the soil surface.

The adoption of this method to investigate the behaviour pattern of water-table depths and its effect on yield represents an initial step to evaluate the importance of improved drainage in the Macknade mill area. A significantly larger number of sites would have to be sampled to better assess the total losses for the mill area.

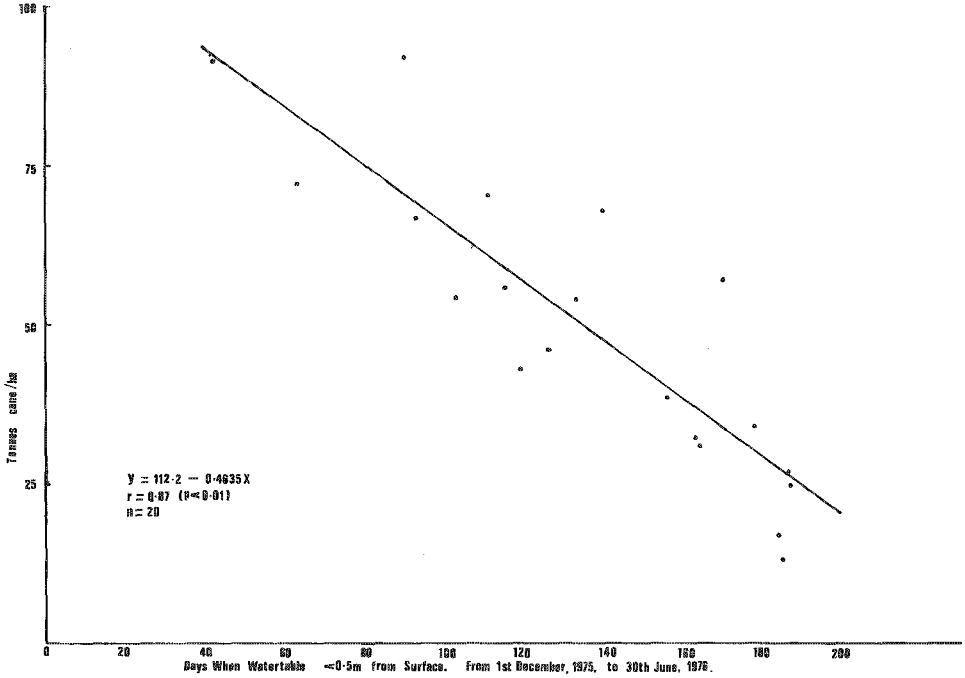

Fig. 7—The relationship between yield and number of days when water-table was less than 0.5 m from the surface.

Conclusions

1—There are large potential yield benefits to be gained by improving farm layout and drainage design.

2—Yields of late cut ratoons are greatly reduced by high water tables.

3—To improve yields, drainage systems should be designed to allow free drainage of the soil to a depth of at least 0.5 m from the surface.

4—Drainage throughout the area of study is inadequate to cope with the high rainfall during the main growing period.

5—Mole drains would be of limited use due to the prevalence of sandy layers through the profile of the majority of soils in the Macknade mill area.