SOUTH AFRICAN SUGAR INDUSTRY
AGRONOMISTS' ASSOCIATION

Project No.. 3185
Cat No : 1810

Title: Comparison of mole drains with no drainage.

Particulars of project

This crop	: 3rd ratoon
Site	: La Mercy Site 1 Field 209A
Region	: North Coast
Soil System	: Umzinto Coast Lowlands
Soil form/series	: Rensburg/Phoenix
Design	: Randomised
Variety	: NCo376
Fertilizer (kg/ha):	N 90, P 0, K 90
Date	: 8.3.90

Soil analysis Date: 9.8.90

pH	O.M.%	Clay%	P.D.I.
5,7	-	57	-

ppm

P	K	Ca	Mg	Zn	Al
23	217	1650	350	-	-

Age: 12,2 months **Dates:** 03/08/89-08/08/90
Rainfall: 1171 mm **LTM:** 1081 mm
Irrigation: Nil

Objectives:

a) To establish whether mole drains are able to drain the soil sufficiently without the extensive use of permanent sub-surface drains.

b) To establish the reasons for early mole drain failure if this should happen.

c) To continue selecting important criteria for recommending the uses of mole drainage.

d) To establish whether the mole drains will help increase yield.

Treatments:

a) Control - no mole drainage
b) Mole drainage.

Growth measurements

As with the previous crop the tallest cane was found on plots 5, 6 and 7 (Table 1) which happened to be the least sodic (Table 5).

There was only a small response to moling in terms of population and stalk length respectively. However, the differences in growth were better correlated with the salinity status of the plots than the moling treatments (Tables 1 and 6).

Yield

The third ratoon moled results showed a non significant response of 10,2 tc/ha and 1,0 ts/ha when compared with the control. Although these responses were lower than that of the previous ratoon, the tc/ha and ts/ha of both the control and moled plots was higher than those from the second ratoon. The mean response of the moled plots over the control plots was 12,9 tc/ha and 1,5 ts/ha (see Table 2).

Damage to stools

On the 5.09.90 plots 1, 4, 5 and 7 were re-moled. Currently the rows are running north south and the moles east west. On the 21.11.90 the number of dead stools were determined on lines where the latest moles were drawn (Table 3). All new mole lines were used in this determination (6 per plot) over a distance covering 10 cane rows. The average mortality percentage was 23% per plot and the highest percentage recorded was 35%.

Table 1: Various yield parameters per plot

Treatment	Plot No.	Length (mm)	Cane t/ha	Cane kg/stalk	Sucrose t/ha	Population 1000/ha
Control	2	1610	59,8	0,40	8,9	151
	3	1390	49,5	0,36	6,9	139
	6	1690	59,5	0,39	7,7	151
	8	1570	49,3	0,36	6,5	137
Mean		1570	54,5	0,38	7,5	145
Moled	1	1500	61,3	0,41	8,3	150
	4	1520	60,7	0,40	7,5	151
	5	1610	63,0	0,45	8,8	140
	7	1710	73,7	0,53	9,5	140
Mean		1590	64,7	0,45	8,5	145
Response (%)		1,3	18,7	18,4	13,3	0,0

Table 2: Summary of yield data - La Mercy mole drain (Mean of 4 replicates)

Treatments	Plant crop		1st Ratoon		2nd Ratoon		3rd Ratoon		Cum response	
	tc/ha	ts/ha	tc/ha	ts/ha	tc/ha	ts/ha	tc/ha	ts/ha	tc/ha	ts/ha
Control	90,0	12,6	54,0	7,0	47,3	6,3	54,5	7,5	-	-
Moled	108,0	14,6	63,0	7,8	61,7	8,4	64,7	8,5	51,6	5,9
Mean	99,0	13,6	58,5	7,4	54,5	7,3	59,6	8,0	-	-
Response: (t/ha)	18,0	2,0	9,0	0,8	14,4	2,1	10,2	1,0	-	-
M-C (%)	20,0	16,0	17,0	11,0	31,0	22,0	18,7	13,3	-	-
LSD (5%)	35,0	3,7	7,6	1,4	17,0	2,3	16,5	2,4	-	-

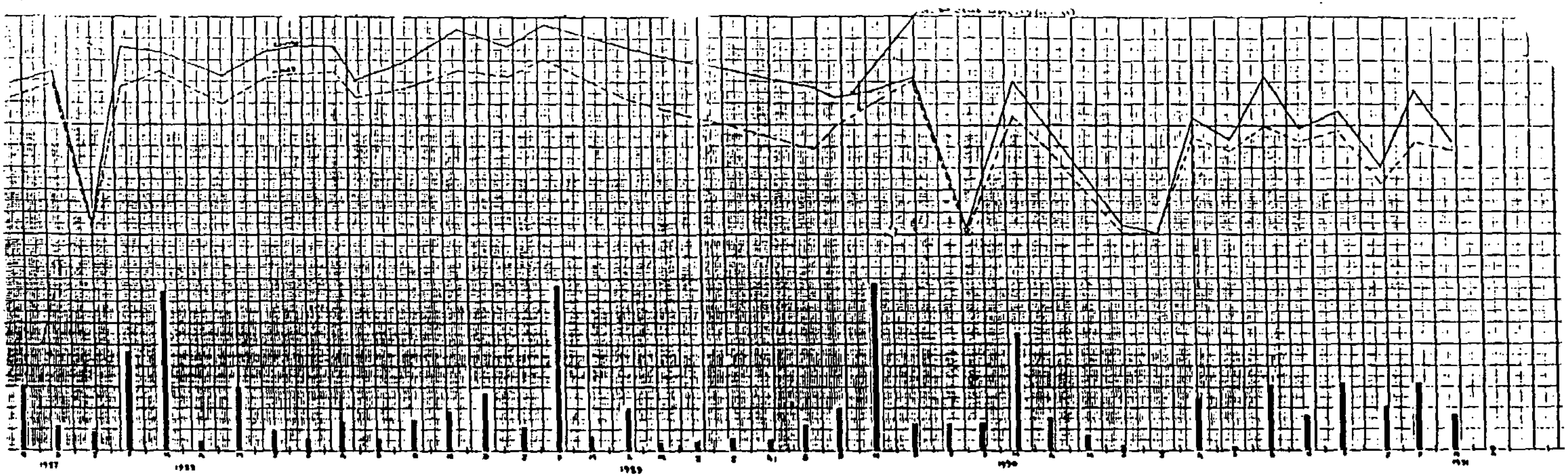


Fig. 1: Mean water table heights in relation to moling - La Mercy.

Table 3: **Stool mortality caused by drawing moles across cane rows. Mole drain trial - La Mercy**

Plot No.	M=Moled C=Control	Stool mortality (10 cane rows and 6 moles per plot)		Visibility of mole lines on the surface covering 10 cane rows	Visibility of mole channels at depth from surface	Growth rating
		No. of stools	%			
1	M	21	35	Yes	Yes	Poor
2	C					Moderate
3	C					Poor
4	M	7	12	Yes	Yes	Moderate
5	M	17	28	Only one mole	Deep not open	Good
6	C					Very good
7	M	11	18	No	No	Moderate to poor
8	C					Poor

Root development

Pits were opened in plots 7 (moled) and 8 (control) and the root washing technique was used to compare root development between treatments (Table 4). In general the roots in the moled plot were deeper, more widely distributed throughout the profile and many more roots were found in the subsoil when compared with the control plot. Forty two percent more roots were counted in the moled plot when compared with control. The greatest effect on root proliferation was found below a depth of 400 mm and laterally the roots were better distributed on the moled plot.

Water table heights

Continuous monitoring of the watertable in 24 newly installed dipwells produced small but consistent differences of the water table heights between moling and control treatments. Changes in mean watertable heights for both treatments are shown in relation to rainfall in figure 1.

Note that the differences between the graphs are relatively small below a depth of 450 mm (the depth of the moles) and that the watertable heights of the moled plots were rarely found within the 450 mm depth mark and then only for a short period.

Mole channel ratings

Mole channel ratings were carried out at harvest, and the two highest yielding mole plots (4 and 7) were given the highest ratings (Table 5). Important points from this table are:

- When water was passed through the moles it only re-appeared at the other end in moled plots 4 and 7. When no water had appeared after 28 and 91 minutes respectively in plots 1 and 5 it was assumed that the channels had collapsed totally.

- The best rated moles occurred at the greatest depths.

- The vertical mole diameter was smallest for the fastest flowing channel (plot 7) followed by the second smallest (plot 9) indicating that the moles closest to their original shape were most stable.

EC (mS/m) and SAR

In addition to the regular sampling of the soil profile at depths of 300, 600 and 900 mm at 16 permanent sampling points to monitor changes in EC and SAR levels, the appearance of suspected salts on the surface of the soil in plots 1, 2 and 3 led to further samples being taken at depths of 10, 30, 50 and 100 mm from the surface (Table 6). The results showed that the surface of 0-200 mm layer contained considerably less salts and had lower SAR values than the subsoil horizons (below 300 mm depth).

SAR and EC values are shown in Figure 2 for each plot and for all four crops harvested up to date. Interesting points from this figure are:

- Both EC and SAR values were greater at depths of 600 and 900 mm when compared with those at 300 mm.

- Both EC and SAR values were consistently lower at all depths in plots 6 and 7 when compared with the other plots.

- It does seem as if EC values have been constant over the years in most plots and there might be a slight drop of SAR values for the third ratoon.

In general moling did not appear to have much effect in reducing the level of salinity in the soil profile.

Comments

a) The yield benefit from the moled treatment over that of the control was small and not significant.

b) Moling across rows is not advisable.

c) Moling is beneficial for root development.

d) Moling will result in a lower water table.

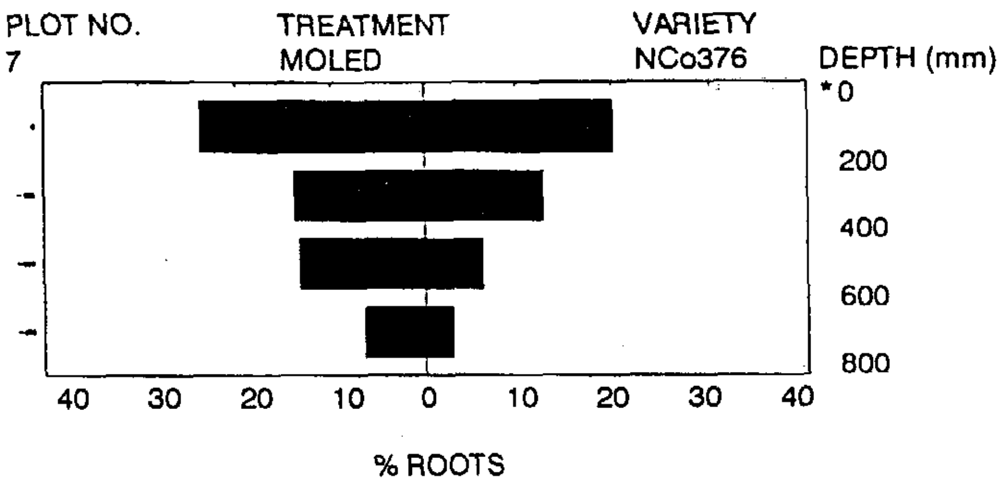
e) A reduction in the salinity/sodicity status of the soil could not be brought about over a four year period with mole drains on this site.

RVA/1b
4 May 1992

Table 4: Root distribution and counts from a moled and unmoled plot (Third ratoon, La Mercy).

PLOT NO. 7 | TREATMENT MOLED | VARIETY NCo376 | DATE 90/08/23 | AREA LA MERCY

DEPTH (mm)	GRID NO	1	2	3	4	5	TOTAL	%
0–200	A	12	18	34	16	7	87	44
200–400	B	8	11	17	13	4	53	27
400–600	C	7	15	9	3	5	39	20
600–800	D	5	8	0	3	3	19	10
TOTAL							198	100



PLOT NO. 8 | TREATMENT CONTROL | VARIETY NCo376 | DATE 90/08/23 | AREA LA MERCY

DEPTH (mm)	GRID NO	1	2	3	4	5	TOTAL	%
0–200	A	0	22	45	13	3	83	60
200–400	B	0	5	31	6	0	42	30
400–600	C	0	0	10	4	0	14	10
600–800	D						0	0
TOTAL							139	100

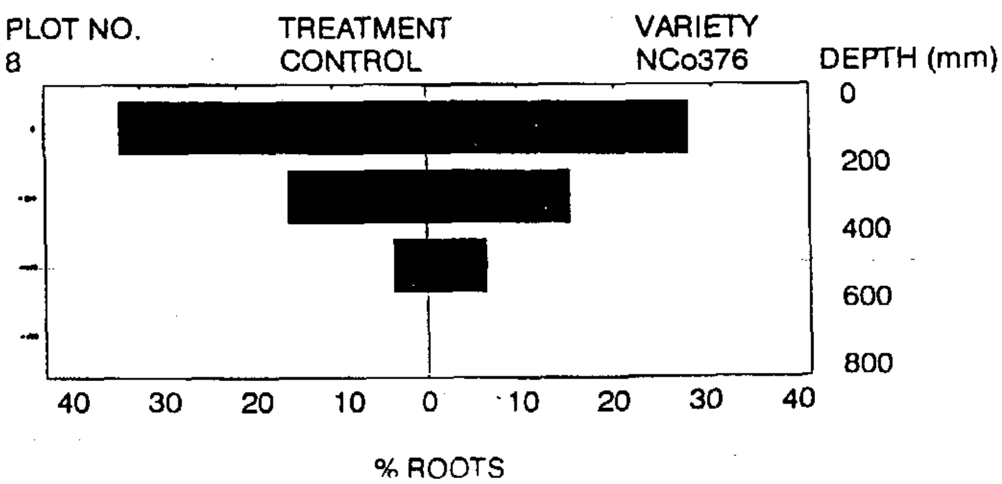


Table 5: Mole channel ratings - La Mercy mole drainage trial

Plot	Inspection profile number	Distance between top and bottom pit	Rating	Remarks	Water entering mole channel	Water flowing out of channel	Time to fill 500 ml beaker	Height from mole to surface	Height from bottom to mole	Depth of pit	Vertical diameter of mole	Engine rev (1000/min)	Time to fill bucket (sec)
1	1		6	Channel completely collapsed								9	29
	2		5	2nd stage of collapse	4.19 min		No flow	20 cm	19 cm	46 cm	7 cm		
	3	10,4 m	5	The channel moved above the original position and removing is necessary		28,00 min		25 cm	14 cm	48 cm	9 cm		
	4		5					30 cm					
	AVG		5					25 cm			8 cm		
4	1		3	Mole channel intact - signs of cracking within channel walls and also roots								9	33
	2		2/3		2,29 min		9 sec to 250 ml	40 cm	15 cm	60 cm	5 cm		
	3	10,6 m	3			13,29 min		30 cm	15 cm	53 cm	8 cm		
	4		3					30 cm					
	AVG		3					33,3 cm			6,5 cm		
5	1		4	1st stage of collapse								17	36
	2	10,5 m	4	Particles of clay or silt on channel bottom	5,37 min		No flow	20 cm	20 cm	47 cm	7 cm		
	3		4	Channel moved up		91,00 min		30 cm	17 cm	58 cm	11 cm		
	4		4					26 cm					
	AVG		4					25,3 cm			9 cm		
7	1		4	1st stage of callapse								17	38
	2		3	Signs of cracking	2,12 min		7 sec to 500 ml	33 cm	16 cm	53 cm	4 cm		
	3	11,3 m	4	1st stage of collapse Particles of clay or silt on channel bottom		7,23 min		33 cm	52 cm	90 cm	5 cm		
	4		4					34 cm					
	AVG		4					33,3 cm			4,5 cm		

N.B. An old sub surface drain between plot 3 and 4 was flowing at a rate of 600 ml per sec after about 36 and 44 mm of rain fell over 2 days.

Table 6: Yield (tc/ha and ts/ha), EC (mS/m), SAR and pH per plot for the third ratoon

La Mercy mole drain

	R3 Control				R3 Moled			
Plot No.	2	3	6	8	1	4	5	7
tc/ha	59,8	49,5	59,5	49,3	61,3	60,7	63,0	73,7
ts/ha	8,9	6,9	7,7	6,5	8,3	7,5	8,8	9,5
Depth (mm)	EC mS/m							
10	47	58	61	110	86	88	51	52
30	43	48	55	150	90	85	50	46
50	45	40	57	145	82	85	48	44
100	78	53	55	160	41	87	43	44
300	223	248	85	145	188	188	78	82
600	355	310	83	108	440	215	105	75
900	360	255	80	124	355	192	128	72
MEAN	164	144	68	135	185	134	72	59
	SAR							
10	2,2	2,0	1,5	3,3	1,6	1,5	1,0	2,8
30	1,6	2,0	1,7	2,4	1,6	2,1	1,2	2,6
50	2,0	1,8	2,0	4,1	1,9	2,1	1,8	2,3
100	1,8	2,3	1,8	3,2	2,1	2,2	1,1	2,0
300	5,4	5,7	3,2	3,9	5,1	4,0	2,9	2,7
600	7,5	7,6	3,2	4,0	8,8	5,5	4,4	3,0
900	8,7	6,8	4,4	3,9	8,0	6,9	5,3	3,1
MEAN	4,2	4,0	2,5	3,5	4,2	3,5	2,5	2,6
	pH							
10	5,60	6,10	5,55	5,35	5,55	5,35	6,05	5,75
30	6,05	6,10	5,55	5,15	5,45	5,40	5,60	5,65
50	6,15	6,20	5,75	5,15	5,60	5,70	5,70	5,80
100	5,75	6,35	6,15	5,50	6,25	5,95	5,55	5,90
300	6,62	6,65	6,00	5,47	6,67	6,30	6,22	5,82
600	7,17	7,07	6,07	5,55	7,27	6,82	6,62	5,87
900	7,10	7,07	5,92	5,57	7,27	6,77	6,65	5,87

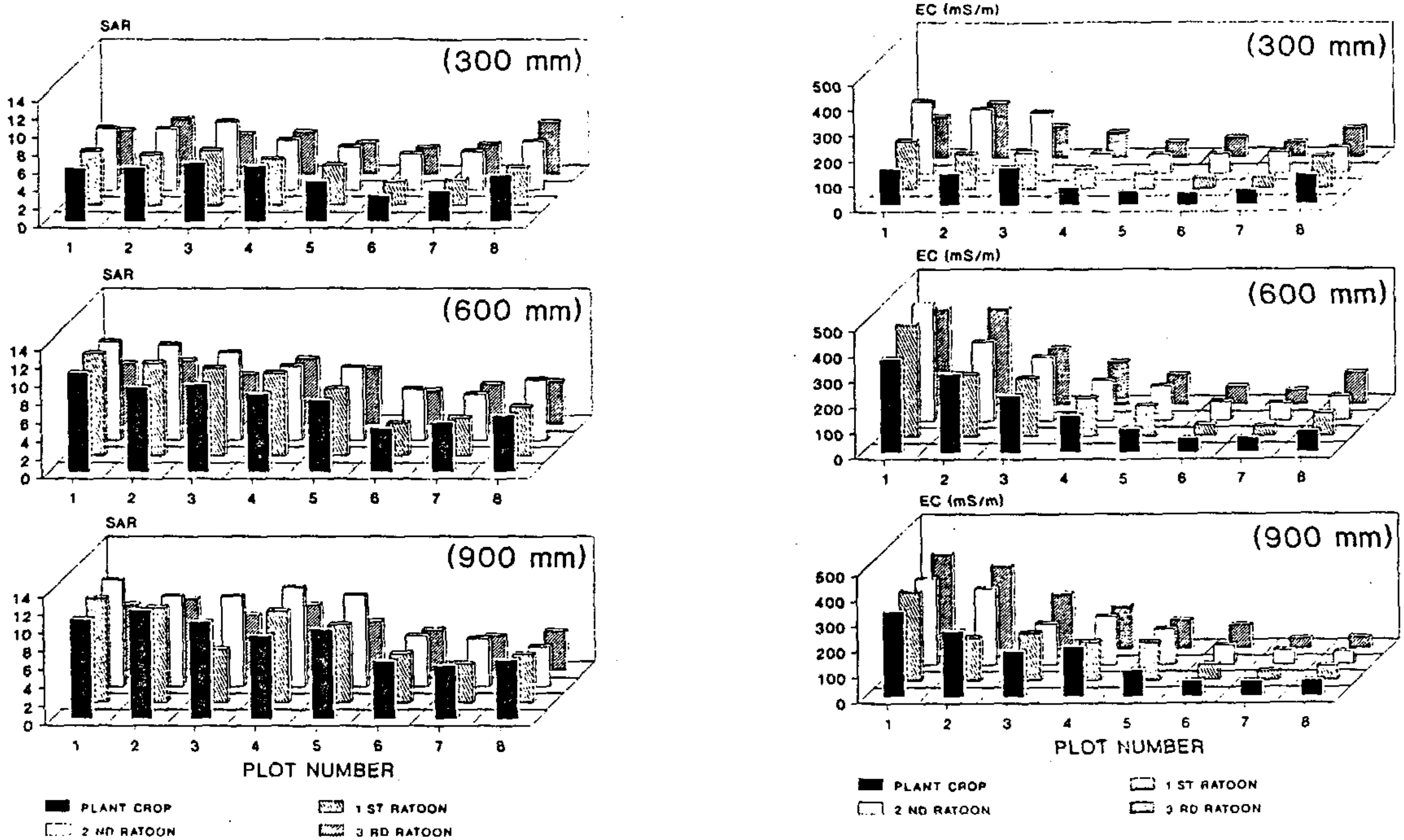


Fig. 2: SAR and EC values from three depths and four crops of each plot - La Mercy mole drain trial.

RvA/cvp
28 April 1992

**SOUTH AFRICAN SUGAR INDUSTRY
AGRONOMISTS' ASSOCIATION**

Cat. No. : 1810
Project No. : 3185
Code No. : MD/85/2

Title: Comparison of mole drains with no drainage.

1. Particulars of project:

This crop	: 4th ratoon	**Soil analysis**	**Date:** 15/8/91				
Site	: La Mercy, Site 1 Field 209A	**pH**	**OM%**	**Clay%**	**PDI**		
		6,00	-	57	-		
Region	: North Coast			ppm			
Soil System	: Umzinto Coast Lowlands	**P**	**K**	**Ca**	**Mg**	**Zn**	**Al**
Soil form / series	: Rensburg/Phoenix	65	255	1483	350	-	-
Design	: Randomised	Age	: 12.2 months				
Variety	: NCo376	Dates	: 08/08/90 - 15/08/91				
Fertiliser/ ameliorants	: 2:0:3 (38)	Rainfall	: 1137,7 mm				
		LTM	: 1081,2 mm				
Kg/ha	: 600	Irrigation	: Nil				
Date	: 23/08/90						

2. Objectives

(a) To establish whether mole drains are able to drain the soil sufficiently without the extensive use of permanent sub-surface drains.

(b) To establish the reasons for early mole drain failure if this should happen.

(c) To continue selecting important criteria for recommending the uses of mole drainage.

(d) To establish whether the mole drains will help increase yield.

3. Treatments

(a) Control - no mole drainage

(b) Mole drainage

La Mercy mole drain trial

Table 1: Summary of yield data - La Mercy mole drain (mean of 4 replicas)

	Plant crop		1st ratoon		2nd ratoon		3rd ratoon		4th ratoon		Mean response	
Treatments	tc/ha	ts/ha	tc/ha	ts/ha	tc/ha	ts/ha	tc/ha	ts/ha	tc/ha	ts/ha	tc/ha	ts/ha
Control	90,0	12,6	54,0	7,0	47,3	6,3	54,5	7,5	51,0	7,2	-	-
Moled	108,0	14,6	63,0	7,8	61,7	8,4	64,7	8,5	64,5	9,3	13,0	1,6
Mean	99,0	13,6	58,5	7,4	54,5	7,3	59,6	8,0	57,8	8,2	-	-
Response: (t/ha)	18,0	2,0	9,0	0,8	14,4	2,1	10,2	1,0	13,5	2,1	13,0	1,6
: M-C (%)	20,0	16,0	17,0	11,0	30,4	22,0	18,7	13,3	26,5	29,2	22,5	18,3
LSD (5%)	35,0	3,7	7,6	1,4	17,0	2,3	16,5	2,4	21,7	3,1	-	-

4. Growth measurements

The mean stalk height of the moled plots was on 1 740 mm, 130 mm taller than those from the control plots. This difference was, however, not significant. As with previous crops the tallest cane was found on plots 5, 6 and 7 which happened to be the least sodiced plots.

Although the mean stalk population of the moled plots (144 000/ha) was about 8 000/ha more than that of the control plots the difference was not significant.

5. Yield measurements

The mean response of the moled plots over the control plots for the fourth ratoon was 13,5 tc/ha and 2,1 ts/ha. Although these differences were not significant they were consistent with responses obtained to moling since the plant crop. The mean response over five crops was 22,5% and 18,3% in terms of tc/ha and ts/ha respectively (see Table 1).

6. Root counts

Root distribution of plots 5 (moled) and 6 (control) were studied with the root washing technique. The total amount of roots counted on the moled plot was a little bit more than those counted for the control plot. The most noticeable difference between treatments was the higher percentage of roots occurring in the top soil and the lower percentage of the moled plot. These differences were, however, not significant.

Pits were opened along the rows and in the case of plot 5 across the moles. The old (1990) and new (1991) moles were located in grid positions C5 and C3 respectively (see Table 2) and could be the reason for the relatively high counts in that area. This point becomes clearer when the root counts in the 400 to 600 mm soil layer of the moled plot are compared with that from the control plot. Also noted was the higher degree of branching in the vicinity of the moles when compared with the immediate surroundings and with the control.

7. Water table

Results were calculated from three dip wells installed in each plot. These indicated that the water level on the moled plots was always lower than those of the control plots, also below the depth to which the moles were drawn. However, below the depth of the moles (450 mm) the difference in water table height between treatments was small, but large above the level of the moles (figure 1).

Leaf growth rate (LGR) was monitored by the Agronomy Department to determine how it is affected by water table height. These measurements were done on plots 7 (moled) and 8 (control). Figures 2 and 3 represents leaf growth rate in reaction to water table height of the control and moled plots respectively. By comparing these two figures it does seem as if the LGR reaches a maximum every time that the water table was closest to the surface. However, three reasons are suggested to explain the apparent erratic leaf extension rate of the plant:

(a) LGR is low in a dry soil and high in a wet soil.

(b) Young leaves grow at a rate of about 20 mm/day which could change to 2 mm/day within four days with ageing of the leaf.

(c) The change in measuring a slow growing leaf to that of a fast growing young leaf.

(d) The most likely reason for the lack of a reduction in growth rate under waterlogging is thought to be due to the water not being close to the surface for longer than four days.

The mean difference in LGR between the moled and control treatments was only 0,3 mm/day in favour of the moled plot.

8. Comments

(a) The yield benefit from the mole treatment over that of the control was small and not significant with the exception of the second crop.

(b) Moling is beneficial to root development as it results in a lower water table and improved aeration.

(c) It was difficult to quantify the effect of waterlogging on the rate of cane growth as conditions were not sufficiently wet for any length of time. However, it may be inferred from the available measurements that waterlogged conditions of up to four days is unlikely to cause a reduction in leaf growth rate.

9. Future work

It is suggested to terminate the trial because it failed to produce any significant yield response within five crops and to replace it with a trial to compare the yield benefits from cambered beds.

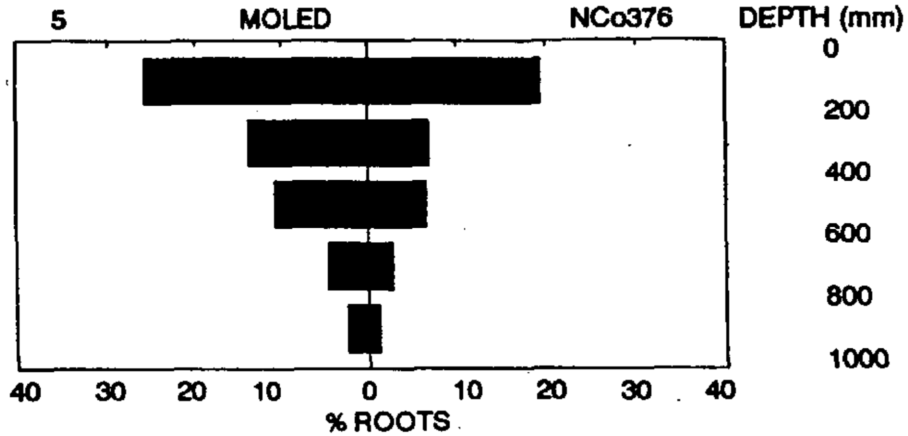
Table 2: Root distribution and counts from a moled and unmoled plot (Fourth ratoon, La Mercy).

PLOT NO. 5 TREATMENT MOLED VARIETY NCo376

DEPTH (mm)	GRID NO	1	2	3	4	5	6	TOTAL	%
0-200	A	36	50	70	60	75	21	312	45
200-400	B	22	27	47	23	25	25	169	24
400-600	C	17	19	34	22	24	16	132	19
600-800	D	8	7	15	10	9	6	55	8
800-1000	E	3	4	9	4	4	7	31	4
TOTAL								699	100

DATE 19/08/91 AREA LA MERCY

PLOT NO. 5 TREATMENT MOLED VARIETY NCo376

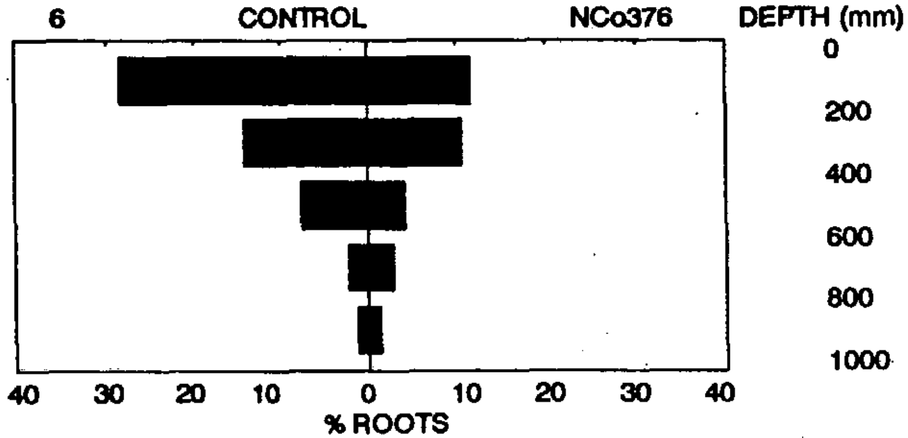


PLOT NO. 6 TREATMENT CONTROL VARIETY NCo376

DEPTH (mm)	GRID NO	1	2	3	4	5	6	TOTAL	%
0-200	A	60	67	68	42	30	25	292	47
200-400	B	53	30	35	24	42	9	193	31
400-600	C	26	14	16	17	9	10	92	15
600-800	D	4	4	5	5	13	0	31	5
800-1000	E	2	1	2	4	4	0	13	2
TOTAL								621	100

DATE 19/08/91 AREA LA MERCY

PLOT NO. 6 TREATMENT CONTROL VARIETY NCo376



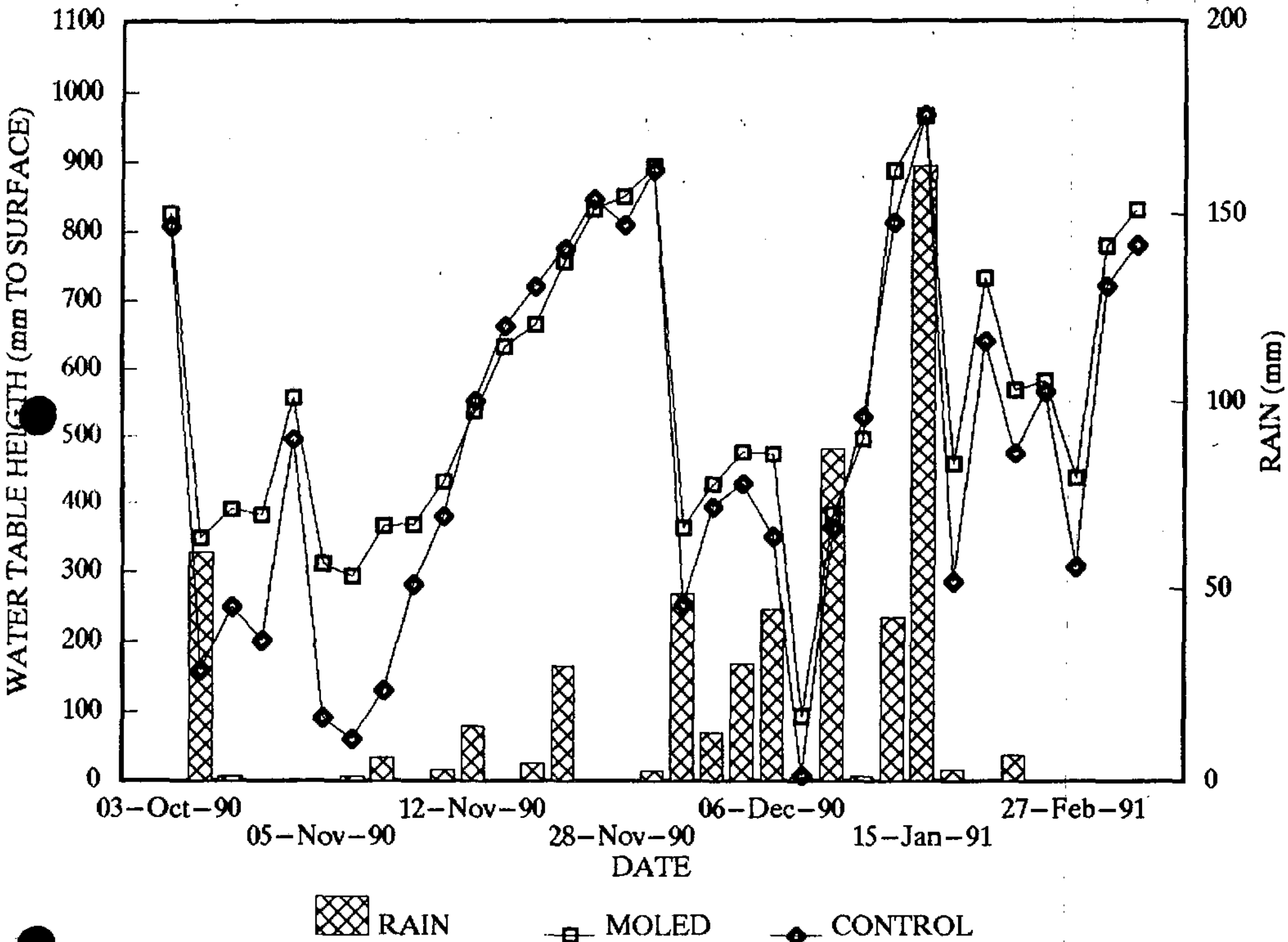


Fig. 1: Rain and the difference in water table height of the moled and control plots .

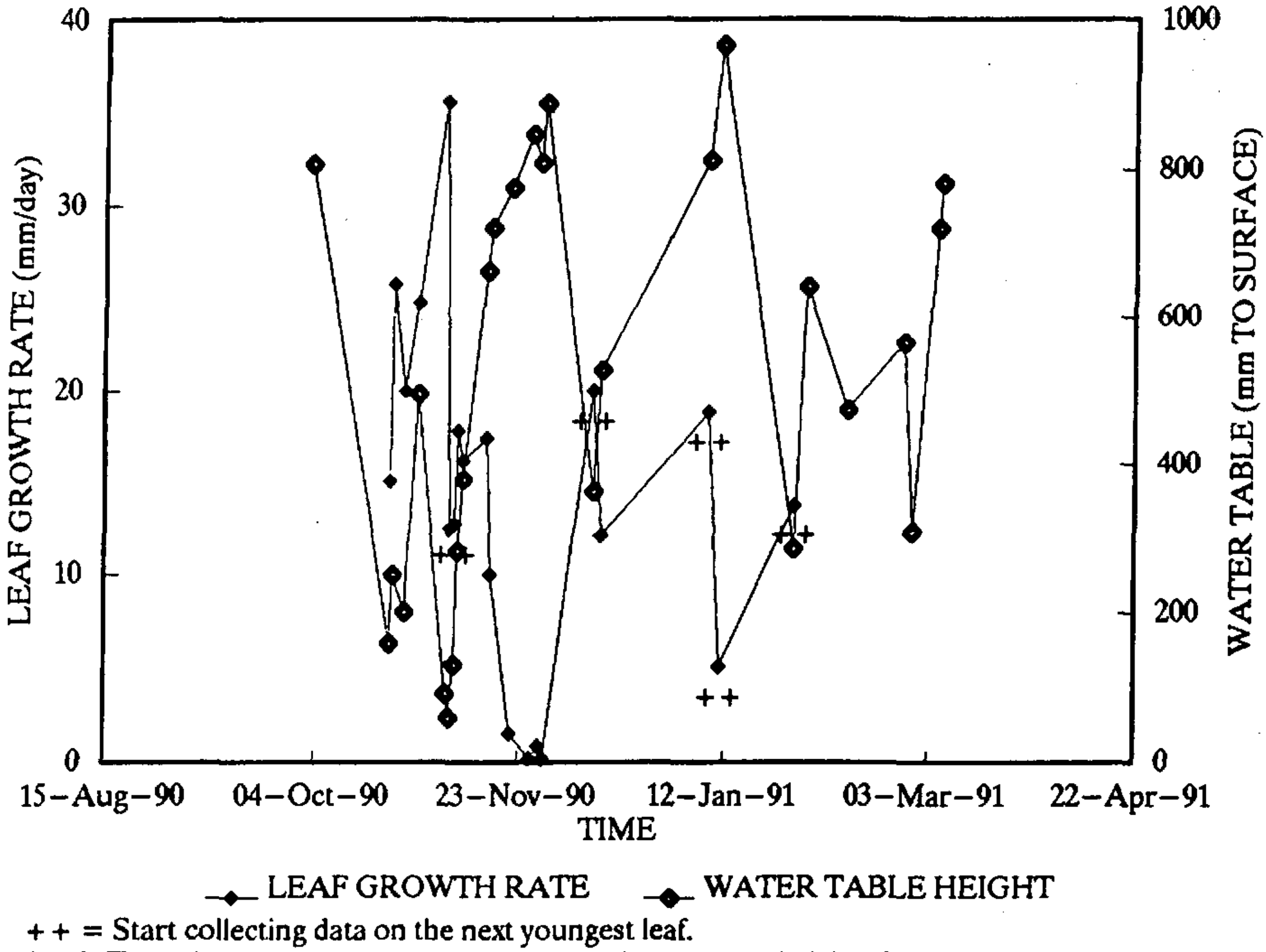
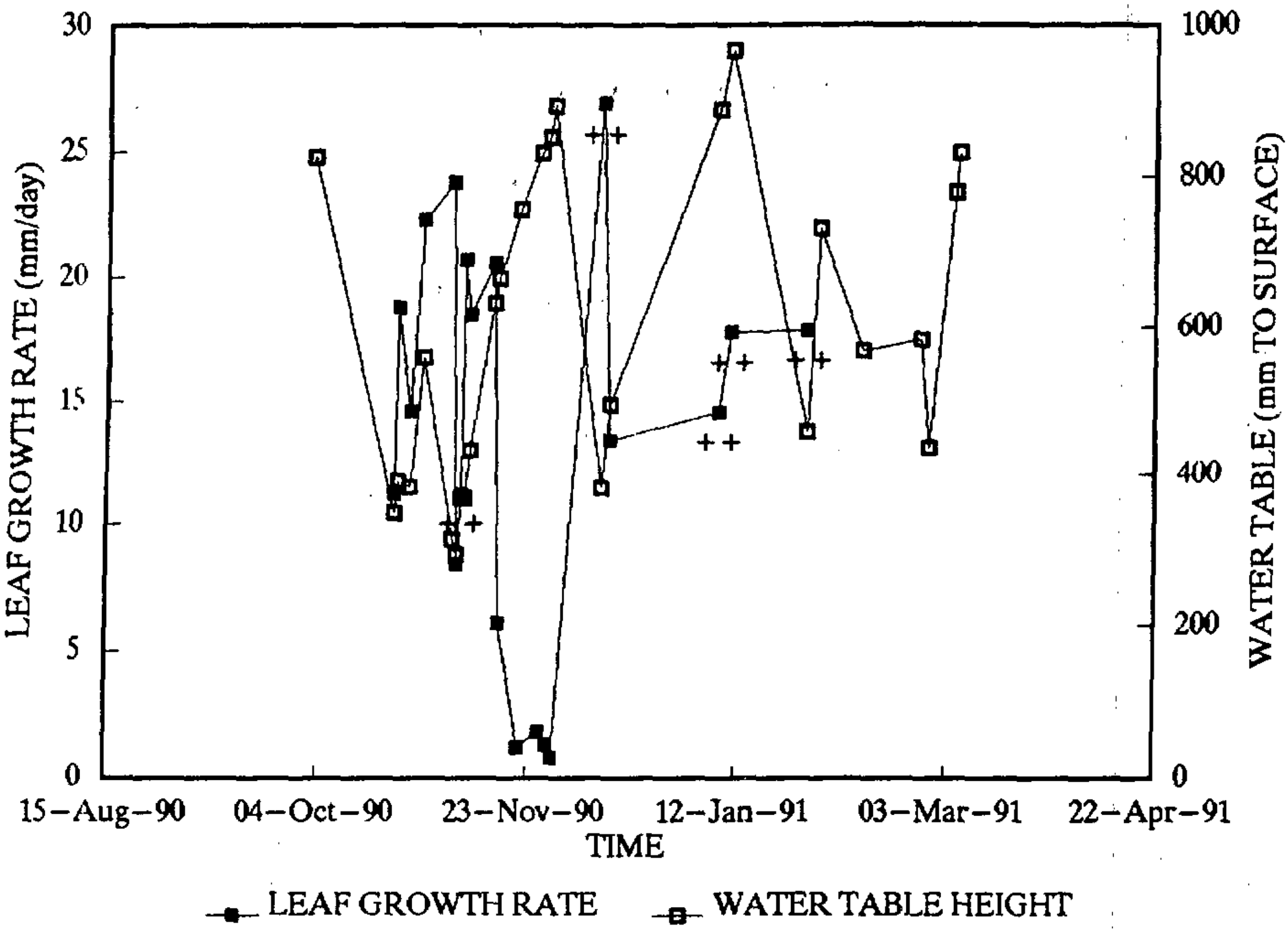


Fig. 2: The relationship between leaf growth and water table height of the control plot.



++ = Start collecting data on the next youngest leaf.

Fig. 3: The relationship between leaf growth rate and water table height of the moled plot.