A PRELIMINARY REPORT OF THE EFFECT OF SOIL MOISTURE LEVEL ON RESPONSES TO TEMIK AND CURATERR

By R. A. DONALDSON and P. E. T. TURNER

South African Sugar Association Experiment Station, Private Bag X02, Mount Edgecombe 4300

Abstract

An experiment was conducted on a sandy soil at the SASA Experiment Station's farm at La Mercy to assess the effects of soil moisture levels on the response of sugarcane to nematicides. Three soil moisture levels were maintained by means of trickle irrigation. The nematicides Temik and Curaterr were applied to 3 successive crops of NCo376 and N18. The results indicate that response to nematicides decreases in magnitude as soil moisture level increases. Response to Temik tended to be greater than that to Curaterr at the lowest soil moisture level, but the difference in responses at different moisture levels was not significant. There was also no statistical evidence to suggest that nematicides affected the two varieties differently. Sucrose yields of irrigated sugarcane were improved by about 25% by the application of nematicides although the responses of irrigated cane were smaller than those of rainfed cane.

Introduction

Soil moisture conditions at the time of applying nematicides and rainfall during the growth of the crop are likely to affect the response of sugarcane to treatment with nematicides (Bhirid & Pitre;[1] Dick & Spaull;[2] Donaldson;[3] Narian & Krishnamurthi;[6] Rostron[7]). In years of high rainfall the response to nematicide treatment can be expected to be comparatively small (Donaldson[3]). The results of an experiment with Temik led Moberly and Clowes[5] to conclude that the response of sugarcane to frequent applications of water, particularly through drip irrigation, would be greater than the response of cane to an application of nematicide on windblown coastal sands which receive moisture sporadically through rainfall alone. It was therefore generally believed that by providing roots damaged by nematodes with continuously high levels of soil moisture there would be no need for nematicides. The better responses frequently obtained from Temik, compared with those from Curaterr (Donaldson;[4] Moberly & Clowes[5]), are sometimes ascribed to the active ingredient of Temik being released at soil moisture levels lower than those which would similarly affect Curaterr. No comparative data could be found to support this contention.

This paper reports the results from one experiment (with a plant and 2 ratoon crops) which was conducted to measure the responses to Temik and Curaterr when applied to sugarcane grown under 3 moisture regimes. The varieties NCo376 and N18 were chosen for the experiment so that the response of a widely used variety, not highly tolerant of nematode damage, could be compared with that of a promising new variety likely to do well on weak sandy soils.

Methods and materials

A 3 × 3 × 2 × 2 factorial design with randomisation and one replication was used in 3 blocks of 12 plots. The treatments were: (a) 3 levels of soil moisture, (b) Temik, Curaterr, or no nematicide, (c) varieties N18 and NCo376, and (d) dry and moist soil at the time of applying the nematicides. Because of rainfall, the soil was moist at the time of planting and at the time of each harvest, so that the fourth treatment intended could not be imposed. The other treatments were applied to three successive crops in the same plots.

Plots were irrigated through dripper lines installed in each interrow (1,3 m apart), carrying emitters spaced at 600 mm intervals which were capable of delivering water at 2 ℓ h^{-1}. Two valves each controlled water-flow to 12 plots so that two irrigation regimes could be applied. Flow-meters were installed to monitor the amounts of water applied. Potable water was pumped to the plots and no filtration was necessary. Irrigation of about 13 mm of water was applied to 12 plots (W_2) whenever the calculated soil moisture deficit reached this level, so that the full water requirements of the crop were provided. A second irrigation regime (W_1) was intended to deliver about 13 mm of water to each of 12 plots whenever it was needed to maintain the available soil moisture level about half way between the levels in the rainfed plots (W_0), and those in the fully irrigated plots (W_2). Irrigation was assumed to be 100% effective when soil moisture levels were calculated. Rainfall occurring after the soil profile had been calculated to be saturated, was regarded as non-effective. Twelve plots were not irrigated (W_0) and received moisture from rainfall only.

In the plant crop the nematicides, Temik and Curaterr, were applied by hand in the planting furrows at 3 kg ai ha^{-1}. In the first and second ratoons the nematicides were applied within 2 weeks of harvesting the previous crop. In the second ratoon the Temik granules were applied directly over the cane rows; Curaterr in the first and second ratoons and Temik in the first ratoon were applied in shallow furrows drawn alongside the cane rows.

The effects of the treatments on growth were assessed by measuring the length, from ground to the top visible dewlap, of 20 randomly selected stalks per plot and counting the stalks in each plot at regular intervals. At the time of harvesting, cane yields were determined by weighing stalks in the central 4 rows (of a 6-row plot), after removing 1 m at the ends of each row. Twelve stalks were selected at random from each plot and were analyzed to assess cane quality.

Nutrient requirements were determined from soil samples taken before planting and after each harvest, and the plots were fertilized according to the recommendations of the Fertilizer Advisory Service of the South African Sugar Association Experiment Station. Analysis of soil samples and undisturbed soil cores provided data on textural and physical characteristics of the soil as well as the available moisture capacity (AMC).

Results and discussion

Analyses of soil samples taken in the eastern and western sections of the experiment site (Table 1) indicated that the soil varied from a sand to a loamy sand. Analyses of soil samples from each plot indicated that the clay content of the top 250 mm varied from 4 to 8% while that of the soil taken from a depth of 250 mm to 500 mm varied between 5 and 11%.

Table 1

Results of textural analyses from soil samples taken at La Mercy

Source of sample		Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Textural group
Eastern section	0–250 mm	6	4	59	30	1	Sand
	250–500 mm	6	4	59	30	1	
Western section	0–250 mm	7	5	56	31	1	Loamy sand
	250–500 mm	6	5	57	31	1	

Results of analyses from undisturbed soil core samples (Table 2) revealed that the AMC varied little between cores taken from the upper 150 mm and those taken from 450 mm depth. The mean AMC for the eastern section of the site was 91 mm m^{-1} while that of the western section was 88 mm m^{-1}. Rooting depth of cane treated with a nematicide was assumed to be about 1 200 mm and that of cane not treated with a nematicide about 800 mm. An average rooting depth of 1 000 mm was therefore used to estimate the total available moisture (TAM) of the profile, which was 90 mm for the entire trial site.

The soil moisture levels for each of the 3 moisture regimes (calculated from profit and loss accounts) are shown in Figures 1, 2 and 3 for the plant, first and second ratoon respectively. In the plant crop, differences in soil moisture level were small during the first 4 months of growth. After this, irrigation maintained the AMC at about 30 mm in the W_1 plots, while an AMC level of about 80 mm was maintained in W_2 plots (Figure 1). After mid-March available soil moisture in the W_0 plots was zero for 205 days (Table 3). High rainfall in the first ratoon (776 mm) and second ratoon (1 640 mm) (Tables 4 & 5) resulted in there being small differences in moisture status between W_1 and W_2 plots (Figures 2 & 3). The higher and more evenly distributed rainfall on the first ratoon crop compared with that received in the plant crop, is reflected in the substantially higher yield of W_0 plots which had been treated with a nematicide in the first ratoon crop (Table 6).

Table 2

Results of moisture retention characteristics of soil samples taken at La Mercy

Source of sample		Moisture % gravimetric 10 kPa	Moisture % gravimetric 1500 kPa	Bulk density (kg m^{-3})	AMC (mm m^{-1}) 10–1500 kPa
Eastern section	0– 50 mm	8,03	2,46	1 572	88
	50–300 mm	8,39	2,62	1 608	93
	300–450 mm	7,73	2,06	1 600	91
Western section	0– 50 mm	7,42	2,02	1 623	88
	50–300 mm	8,24	2,69	1 599	89
	300–450 mm	7,44	2,12	1 607	86

The results in Table 6 show that in the plant crop cane not treated with a nematicide responded to the water applied in W_2 plots by yielding 5,1 ts ha^{-1} more than W_0 plots. Although the total effective water received in W_2 plots was not greatly different from that received in W_1 plots (Tables 3 & 4), W_2 plots without nematicide in the plant and first ratoon crops yielded on average 2,6 ts ha^{-1} more than W_1 plots. In the second ratoon W_2 plots without nematicide yielded 1,9 ts ha^{-1} less than W_1 plots. With the exception of the response to Curaterr in W_1 plots (Figure 4) the average responses clearly indicate that response to nematicides decreases with an increase in available soil moisture.

The mean responses to nematicides were 37, 30 and 20,5 tc ha^{-1} for W_0, W_1 and W_2 moisture regimes, respectively. The greatest differences in sucrose yields between Temik- and Curaterr-treated cane occurred in the third crop. In the W_0 plots cane treated with Temik yielded 6,4 ts ha^{-1} more than cane treated with Curaterr. This result follows the general trend towards larger differences in yield at lower soil moisture levels.

Temik-treated cane yielded on average 2,9 ts ha^{-1} more than Curaterr-treated cane in plots which received moisture

Table 3

Rainfall and irrigation received in the plant crop

Details		N	D	J	F	M	A	M	J	J	A	S	O	Total
Rainfall (mm)		53	58	122	327	8	0	26	12	2	4	28	33	673
Effective rainfall (mm)	W_0	53	58	71	108	8	0	26	12	2	4	28	33	403
	W_1	53	58	61	81	8	0	26	12	2	4	28	33	366
	W_2	53	43	32	42	8	0	26	8	2	4	27	23	268
Irrigation (mm)	W_1	0	37	0	14	58	136	95	48	87	106	92	103	776
	W_2	0	55	55	39	75	142	109	74	92	104	102	99	946
Total effective moisture received (mm)	W_0	53	58	71	108	8	0	26	12	2	4	28	33	403
	W_1	53	95	61	95	65	136	121	59	89	110	120	136	1 142
	W_2	53	98	87	81	83	142	135	81	94	108	128	122	1 214
No of days when TAM = 0 in plots	W_0	0	0	0	0	15	30	28	21	31	31	26	23	205

Table 4
Rainfall and irrigation received in the first ratoon

Details		Month													Total
		N	D	J	F	M	A	M	J	J	A	S	O	N	
Rainfall (mm)		76	86	117	36	161	74	0	30	1	36	35	90	34	776
Effective rainfall (mm)	W_0	76	86	117	36	140	74	0	30	1	36	35	90	34	755
	W_1	76	86	108	36	76	74	0	30	1	36	35	90	34	682
	W_2	76	80	46	36	59	51	0	9	1	36	35	87	34	552
Irrigation (mm)	W_1	0	23	58	91	85	82	83	45	92	101	69	63	0	792
	W_2	0	57	83	115	110	67	100	67	100	100	77	69	0	945
Total effective moisture received (mm)	W_0	76	86	117	36	140	74	0	30	1	36	35	90	34	755
	W_1	76	110	166	127	161	156	83	75	94	137	104	154	34	1 474
	W_2	76	138	130	150	169	118	100	76	102	135	112	155	34	1 497
No of days when TAM = 0 in plots	W_0	12	3	13	17	8	16	30	19	31	27	20	21	0	217

Table 5
Rainfall and irrigation received in the second ratoon

Details		Month													Total
		N	D	J	F	M	A	M	J	J	A	S	O	N	
Rainfall (mm)		104	159	130	128	141	69	71	68	11	77	465	98	120	1 641
Effective rainfall (mm)	W_0	104	128	118	128	141	69	71	68	11	77	306	98	120	1 439
	W_1	104	116	113	113	115	69	62	61	11	77	318	98	111	1 368
	W_2	84	95	98	83	95	56	30	59	11	77	248	98	105	1 139
Irrigation (mm)	W_1	0	0	0	43	39	30	61	7	58	39	56	7	15	355
	W_2	0	39	30	50	86	69	74	44	68	35	61	34	8	598
Total effective moisture received (mm)	W_0	104	128	118	128	141	69	71	68	11	77	306	98	120	1 439
	W_1	104	116	113	156	154	99	124	68	70	116	374	105	126	1 723
	W_2	84	134	128	133	181	125	104	103	80	112	309	131	113	1 737
No of days when TAM = 0 in plots	W_0	0	0	0	1	1	6	19	1	21	14	18	0	0	81

Table 6
Sucrose yields (ts ha[-1]) from 3 soil moisture regimes with and without nematicides

Treatment	Plant crop			Ratoon 1			Ratoon 2		
	W_0	W_1	W_2	W_0	W_1	W_2	W_0	W_1	W_2
Control	5,4	8,7	10,5	5,7	12,4	15,8	4,4	9,9	8,0
Curaterr	9,0	14,3	14,3	12,1	17,1	17,8	5,9	11,2	11,8
Temik	11,5	14,6	14,8	14,0	19,8	18,4	12,3	13,2	13,8
Mean	8,6	12,5	13,2	10,6	16,4	17,3	7,5	11,4	11,2
SED ±	1,35			1,33			1,27		
LSD (P=0,05)	2,86			3,20			3,66		

through rainfall only (W_0). In irrigated plots (mean of W_1 + W_2) the difference was substantially smaller with cane treated with Temik outyielding cane treated with Curaterr by only 0,7 ts ha[-1]. The differences in size of response however, did not reach a level of statistical significance.

The variety NCo376 responded to the increased soil moisture levels in W_1 and W_2 plots while yields of N18 were similar for W_1 and W_2 plots (Table 7). However, this difference in response was not significant. Responses of NCo376 to nematicides were larger than those of N18 (Table 8), but again not significantly so.

Table 7
Sucrose yields (ts ha[-1]) from 2 varieties and 3 soil moisture regimes

Variety	Plant crop			Ratoon 1			Ratoon 2		
	W_0	W_1	W_2	W_0	W_1	W_2	W_0	W_1	W_2
N18	8,5	13,2	13,1	9,6	16,3	16,2	6,5	10,9	10,1
NCo376	8,6	11,8	13,2	11,5	16,4	18,5	8,5	11,5	12,8
Mean	8,5	12,5	13,1	10,6	16,3	17,4	7,0	11,2	11,5
SED +	1,11			1,25			1,03		
LSD (P=0,05)	2,35			2,60			2,20		

Table 8
Sucrose yields (ts ha[-1]) from 2 varieties treated with Temik and Curaterr

Treatment	Plant crop		Ratoon 1		Ratoon 2	
	NCo376	N18	NCo376	N18	NCo376	N18
Control	7,3	9,2	11,5	10,6	7,9	7,0
Curaterr	12,3	12,7	16,1	15,2	10,5	8,8
Temik	14,2	12,9	18,6	16,0	14,4	11,9
Mean	11,3	11,6	15,4	13,9	10,9	9,2
SED ±	1,11		1,25		1,03	
LSD (P=0,05)	2,35		2,62		2,17	

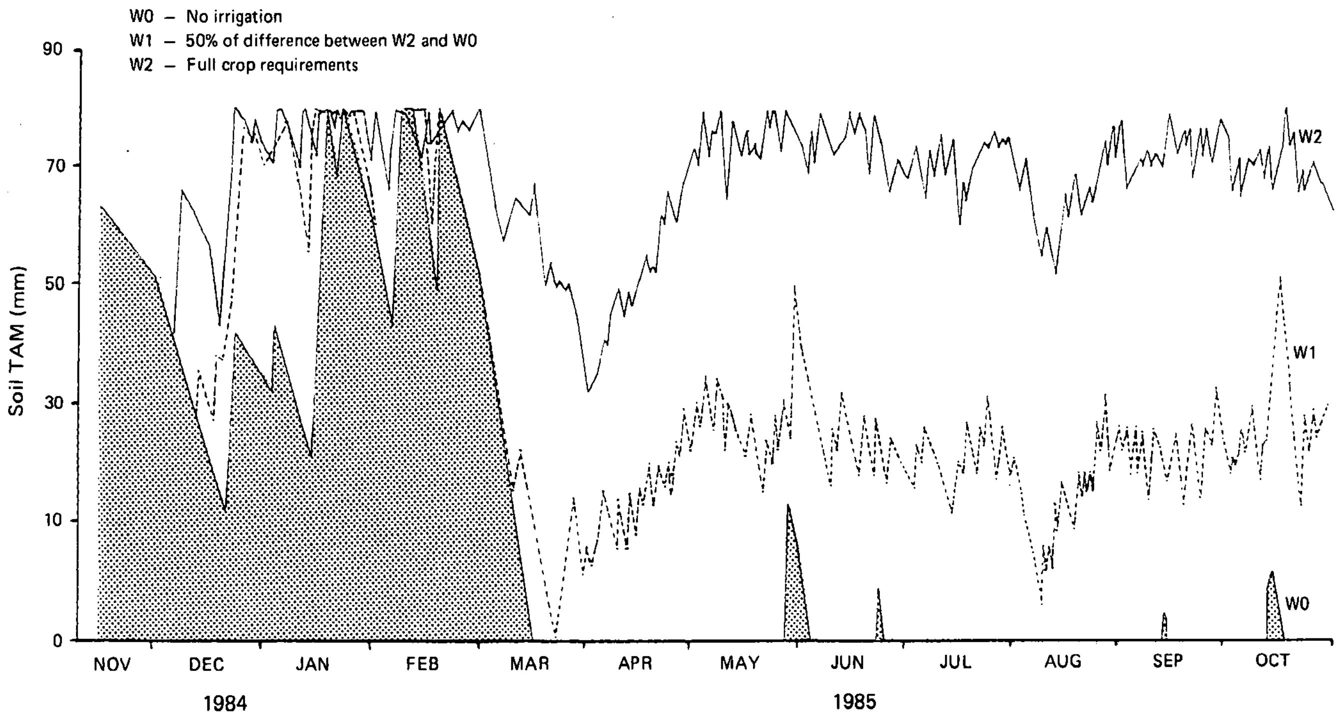

FIGURE 1 Soil moisture levels in 3 moisture regimes in Plant crop (using P & L account).

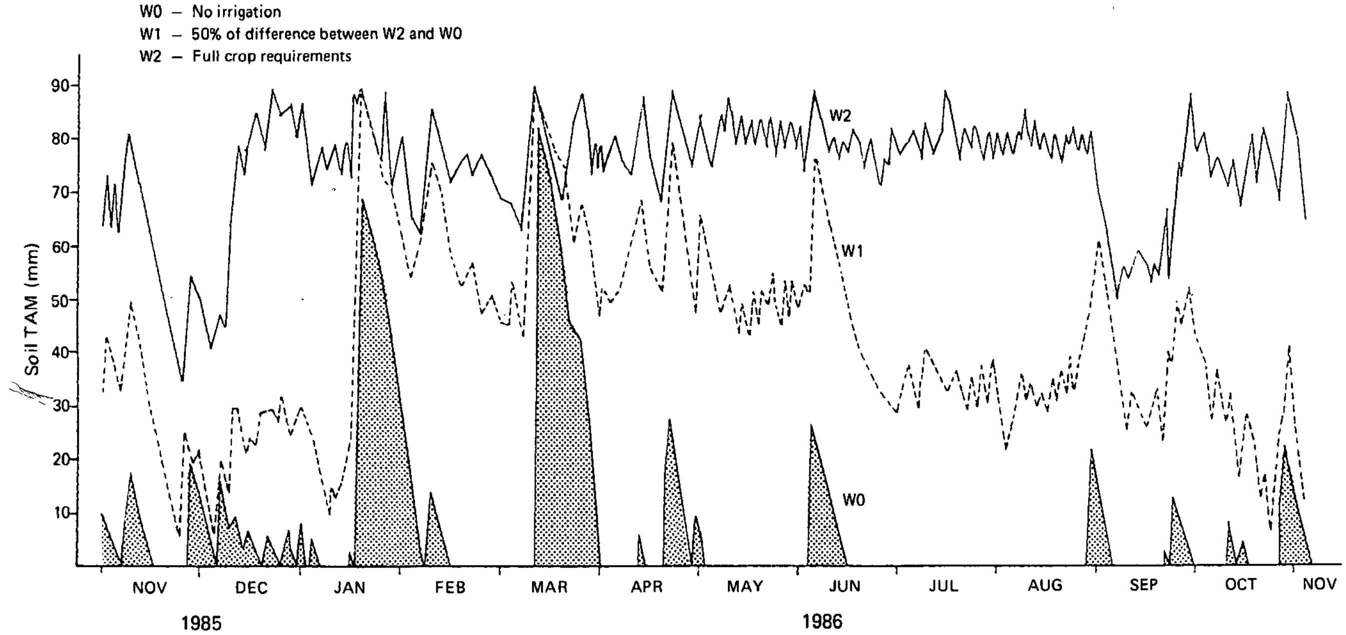

FIGURE 2 Soil moisture levels of 3 water regimes in 1st ratoon (using P & L account).

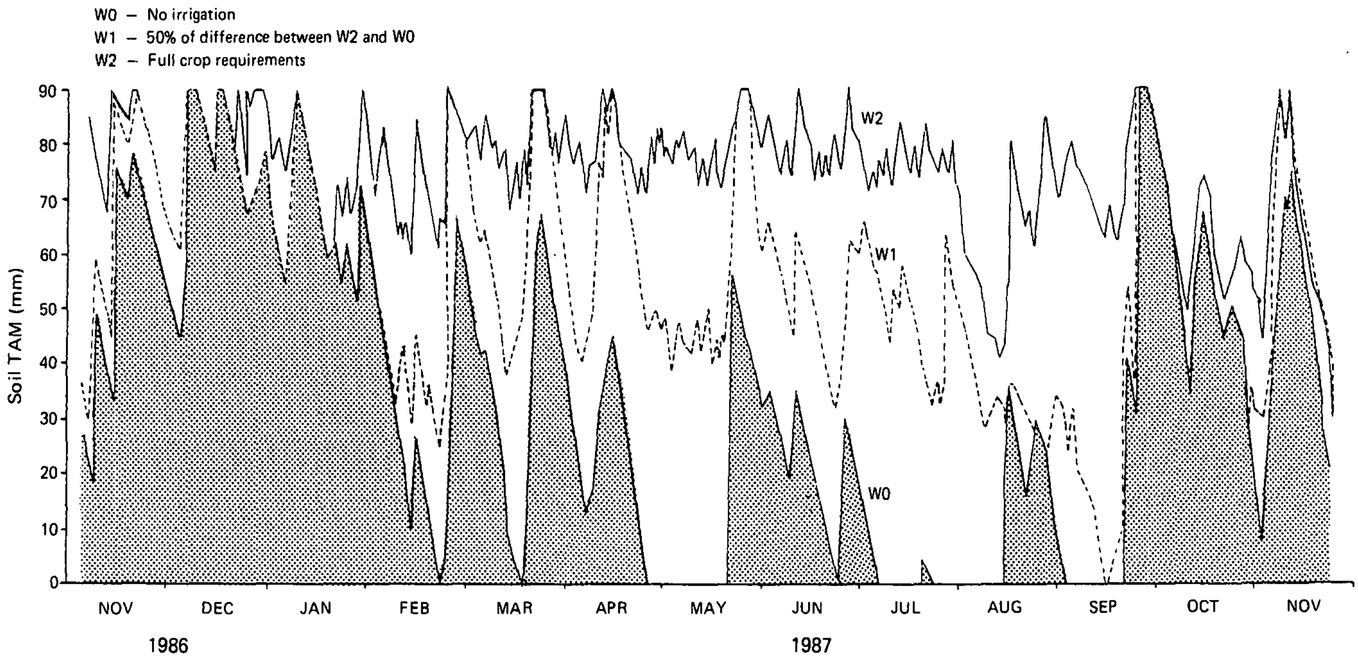

FIGURE 3 Soil moisture levels of 3 water regimes in 2nd ratoon (using P & L account).

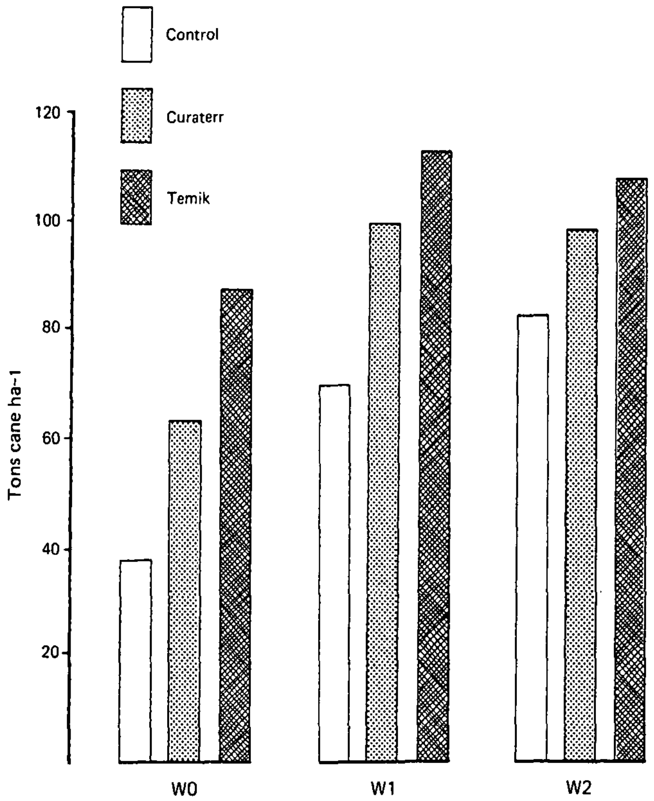

FIGURE 4 Mean cane yields (of 3 crops) from 3 moisture regimes with and without nematicides.

Conclusions

On average, the response to nematicides applied to rainfed cane along the Natal coastal region is likely to be similar to, or slightly greater than the response of cane to additional moisture provided through irrigation.

It is evident that neither a nematicide on its own, nor irrigation on its own, fully overcomes the effects of nematodes on sugarcane in sandy soils. Even if sugarcane grown in such soils is irrigated, the use of a nematicide may still be warranted.

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